Alignment of Ocean Literacy Framework to the NGSS for Grades 9–12

Standards by Disciplinary Core Idea (DCI)	OLP 1	OLP 2	OLP 3	OLP 4	OLP 5	OLP 6	OLP 7	Specific DCI & Performance Expectations (PE)
HS-ESS1 Earth's Place in the Universe	2	1						ESS1.C; ESS2.B; PE HS-ESS1-5
HS-ESS2 Earth's Systems	1	3	2	2		1		ESS2.A, C, D, E
HS-ESS3 Earth and Human Activity			1			1	2	ESS2.D; ESS3.B; ESS3.C; ESS3.D
HS-LS1 From Molecules to Organisms: Structures and Processes				4				LS1.C
HS-LS2 Ecosystems: Interactions, Energy, and Dynamics	2	1	2	3	2	1	3	LS2.A, B, C; LS4.D; ETS1.B
HS-LS3 Heredity: Inheritance and Variation of Traits								
HS-LS4 Biological Evolution: Unity and Diversity				2	3	1		LS4.A, C, D
HS-PS1 Matter and Its Interactions								
HS-PS2 Motion and Stability: Forces and Interactions	4							PS1A; PS2.A, B
HS-PS3 Energy			3			3		PS3.A, B, C
HS-PS4 Waves and Their Applications in Technologies for Information Transfer	3		4				3	PS4.A, B, C
HS-ETS 1 Engineering Design						3		ETS1.A, B

RATING SCALE for Alignment of Ocean Literacy Framework to Next Generation Science Standards (NGSS)

1

Verbatim or nearly verbatim language in both OL Framework (Guide or Scope & Sequence) and NGSS

This rating is self-explanatory. The connection and alignment should be obvious and not in need of any explanation.

2

Understanding these Ocean Literacy Principles and/or Fundamental Concepts is essential to helping students to achieve full understanding of these DCIs and/or PEs.

This rating is given for all the DCIs that have a terrestrial bias or ignore the uniqueness of ocean systems, such as: decomposition breaks things down into soil; references to only terrestrial habitats, ecosystems and food webs, etc. This rating says that a learner cannot achieve full understanding of the DCI without understanding the ocean component of the concept, e.g., you don't fully understand primary productivity if you don't understand chemosynthesis; you don't fully understand decomposition if you only understand how it relates to soil, but not to detritus and marine snow in the water column; you don't fully understand food webs and trophic levels unless you understand about microbes in the ocean because they play a very different role than plants do on land. The ocean "examples" are more than just examples; they illustrate different aspects of the concept than the terrestrial examples do.

3

Examples from the Ocean Literacy Framework (not just any ocean examples) are excellent for teaching and understanding these DCIs and/or PEs

This rating is given when an Ocean Literacy Framework example could be used to explain a general science DCI and/or PE, but using that example to explain that concept is not essential to ocean literacy, nor is it essential to understanding DCI, such as, ocean waves, as mentioned in some OLPs, are good examples of the physical properties of waves.

4

These DCIs and/or PEs are building blocks or foundational ideas that help students to understand these Ocean Literacy Principles and/or Fundamental Concepts

This rating is given for general science concepts that help students understand the mechanisms behind OL concepts, such as, force and motion helping to explain currents or phase change, and conservation of matter helping to explain the water cycle.

Examples of a 4:
K-PS2 Motion and Stability: Forces and Interactions.
Ocean Literacy Essential Principle 2: These basic ideas are important conceptual building blocks that help us understand waves, erosion, and landforms of the coast.

1-LS3 Heredity: Inheritance and Variation of Traits.
Ocean Literacy Essential Principle 5: DCI introduces concept of inheritance and variation and provides introduction to the concept of diversity described in OLP 5A & C.

[blank] No substantive or helpful relationship

No rating is given when there does not appear to be any plausible, helpful, or meaningful relationship between the OL Principles and/or Fundamental Concepts and the DCIs and/or PEs.

Example of a 5:
K-PS2 Motion and Stability: Forces and Interactions
Ocean Literacy Essential Principle 5: No relationship

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Explanation for Ratings

HS-ESS1 Earth's Place in the Universe

OLP 1. This is a 2 because in order to completely understand plate tectonics as the unifying theory to explain geologic history (DCI ESS2.B; PE HS-ESS1-5), one needs to understand that the lithosphere includes the seafloor and all of its geological features, and that ocean basins vary in size and shape due to movement of Earth's crust (OLP 1b; S&S 1A.3-4).

OLP 2. This is a 1 because there is alignment between the concepts that tectonic activity influences the physical structure and landforms of the coast (OLP 2e; S&S 2 A-A.4), many sedimentary rocks now exposed on land were formed in the ocean (OLP 2a), processes associated with plate tectonics move sediments (OLP 2c), and that plate tectonics is the unifying theory that explains the past and current movement of rocks at earth's surface (DCI ESS2.B; PE HS-ESS1–5).

HS-ESS2 Earth's Systems

OLP 1. This is a 1 because the OLP focuses on the concepts of the ocean is the defining feature of the planet (OLP 1a), the ocean transports energy and matter around Earth (OLP 1c; S&S 1C.7, 11, 12), and the unique properties of water (OLP 1e; S&S 1B). These concepts are closely aligned with the abundance of liquid water on Earth and its unique properties being central to the planet's dynamics (DCI ESS2.C).

OLP 2. This is a 3 because the ocean literacy principles provide important Earth system examples of the core idea that feedbacks between the biosphere and other Earth systems cause the co-evolution of life and Earth's surface (DCI ESS2.E). Examples include biogeochemical cycles and sedimentary rocks found on land originated in the ocean (OLP 2a); and the ocean is the largest reservoir of rapidly cycling carbon on Earth, which is then used by shell and reef building organisms (OLP 2d; S&S 2B strand).

OLP 3. This is a 2 because in order to fully understand the concepts that interactions and feedback effects between Earth's systems cause changes to climate (DCI ESS2.A) and the foundation of the climate system is energy from the sun and interactions with the atmosphere, ocean and land (DCI ESS2.D), one must have an understanding of the concepts of the interaction of oceanic and atmospheric processes controls climate by dominating the Earth's energy, water, and carbon systems (OLP 3a; S&S 3A & B strands), the ocean moderates climate by absorbing most of the solar radiation reaching Earth and heat exchange between the ocean and atmosphere drives oceanic and atmospheric circulation (OLP 3a-b, f; S&S 3A and B strands), and that changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere (OLP 3g; S&S 3C strand).

OLP 4. This is a 2 because in order to fully understand the concepts of changes in Earth's atmosphere and feedbacks between Earth's systems, (DCI ESS2.D, E), one must have an understanding of the influence of the ocean on the formation of and changes to Earth's atmosphere and interaction with other systems (OLP 4a, c; S&S 4A & B strands).

OLP 6. This is a 1 because concepts addressing changes in the atmosphere due to human activity are described in both the DCI (ESS2.D) and the S&S (6D.1-2).

HS-ESS3 Earth and Human Activity

OLP 3. This is a 1 because the core ideas of weather and climate models (DCI ESS2.D) are addressed in the Ocean Literacy Framework, which also provides additional examples of the ocean's influence on weather and climate (OLP 3f, g; S&S 3B.1-2,5-6).

OLP 6. This is a 1 because there are strong connections between three DCIs and the Ocean Literacy Framework. The core idea about natural hazards (DCI ESS3.B) is aligned with ideas about human actions increasing the effects of hurricanes and tsunamis (OLP 6f; S&S 6D.4-6). Ideas about resource availability and their effect on human society (DCI ESS3.C) are aligned with concepts about foods, medicines, and mineral and energy resources from the ocean that humans depend on (OLP 6b; S&S 6A strand); ideas about human impacts and management of Earth systems (DCI ESS3.C) are aligned with concepts on ocean resource management (OLP 6e; S&S 6A.2, D.1, E.3-5). Concepts about discovering and modeling Earth's systems (ESS3-D) are aligned with making discoveries about the ocean-atmosphere-biosphere interactions and managing human impacts, including climate change (OLP 6g; S&S 6D.14-15, E.2).

OLP 7. This is a 2 because in order to fully understand the core idea of modeling future climate (DCI ESS2.D), an understanding of ocean exploration and new technologies is needed (OLP 7d-e; S&S 7A.5, C.2-6). In order to fully understand the concepts about global climate change (ESS3.D), an understanding of the complexities and limitations of ocean modeling are needed (S&S 7C.5).

HS-LS1 From Molecules to Organisms: Structures and Processes

OLP 4. This is a 4 because in order to understand oxygen production and the effect of oxygen on life on Earth (OLP 4a; S&S 4A), students will need to know about the process of photosynthesis as described in the DCI (LS1.C).

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

OLP 1. This is a 2 because in order to fully understand cycles of matter and energy transfer in ecosystems and ecosystem dynamics (DCI LS2.B, C), an understanding of how ocean circulation transports (heat) energy and matter and how changes to it affect climate and climate stability are needed (OLP 1c).

OLP 2. This is a 1 because the concepts that many biogeochemical cycles originate in the ocean (OLP 2a), the role that rapidly cycling carbon plays in the ocean (OLP 2d) and the connection of these cycles to the processes of photosynthesis and respiration (S&S 2B strand) are strongly aligned with the cycles of matter and energy transfer, including photosynthesis, respiration and the carbon cycle as described in the DCIs (LS2.B).

OLP 3. This is a 2 because in order to fully understand ecosystem dynamics, functioning and resilience (DCI LS2.C) an understanding of the ocean's influence on climate change and stability is needed (OLP 3e-g; S&S 3B & C strands). Additionally, in order to fully understand cycles of matter and energy transfer in ecosystems (DCI LS2.B), students need to understand the ocean's role in the carbon cycle (OLP 3e; S&S B.1-8).

OLP 4. This is a 3 because the concept of Earth's changing atmosphere (OLP 4c; S&S 4A strand) provides an example of ecosystem dynamics, functioning, and resilience found in the DCI (LS2.C)

OLP 5. This is a 2 because in order to fully understand matter and energy transfer in ecosystems (DCI LS2.B) an understanding of the role that microbes play as primary producers in the ocean ecosystem (OLP 5b; S&S 5A strand) is needed. Understanding the uniqueness and diversity of ocean ecosystems (OLP 5e, g; S&S 5B strand) and the diversity of life and adaptations of ocean organisms (OLP 5c-d, f, h; S&S 5C strand) are essential to comprehending how ecosystems are defined by environmental factors and the community of organisms living there (DCI LS2.A).

OLP 6. This is a 1 because human interactions with the ocean and ocean-atmosphere ecosystems may have negative consequences (OLP 6d-e; S&S 6D strand) is closely aligned to the concept that complex ecosystem interactions are affected by stability vs extreme fluctuations and anthropogenic effects such as pollution, overexploitation and climate change (DCI LS2.C). Also, humans depend on living resources and benefit from biodiversity (DCI LS4.D), which aligns to the concept that humans benefit from the food, medicine, resources, biodiversity and inspiration provided by the ocean (OLP 6a-d; S&S 6A & B strands).

OLP 7. This is a 3 because many examples of different technological advances to explore the ocean are provided, each with strengths and limitations which must be considered (OLP 7c-e; S&S 7C strand) when exploring how human activity impacts ecosystems (DCI LS2.C) and when evaluating solutions (DCI ETS1.B) to sustain biodiversity (DCI LS4.D).

HS-LS4 Biological Evolution: Unity and Diversity

OLP 4. This is a 2 because understanding that the earliest evidence of life is found in the ocean (OLP 4b; S&S 4B strand) is essential to fully understanding evidence of common ancestry and diversity as described in the DCI (LS4.A).

OLP 5. This is a 3 because the ocean provides excellent and diverse examples of adaptations as well as environmental conditions and variations (OLP 5d, g, h; S&S 5B and C strands) introduced in the DCI (LS4.C) which focuses on the process of adaptation and connections to environmental change.

OLP 6. This is a 1 because the concepts that humans are dependent on natural resources and other benefits provided by biodiversity, and on preserving landscapes for recreation and inspiration (DCI LS4.C, D) are strongly aligned with the ocean literacy concepts that although there is a strong interconnection to the environment, humans are having adverse impacts on biodiversity and resources (OLP 6d-e; S&S 6A and D strands).

HS-PS1 Matter and Its Interactions

No alignment between OL and NGSS.

HS-PS2 Motion and Stability: Forces and Interactions

OLP 1. This is a 4 because students need to understand the structure and properties of matter (DCI PS1.A), as well as forces and motion (DCI PS2.A, B) in order to understand thermal expansion and the forces at play in ocean circulation (OLP 1c-d; S&S 1C strand).

HS-PS3 Energy

OLP 3. This is a 3 because the ocean literacy concepts provide important Earth system examples of fundamental physical energy principles including definitions of energy (DCI PS3.A) and conservation of energy and energy transfer (DCI PS3.B, C). Examples include absorption of solar radiation by the ocean, and the energy exchange between the ocean–atmosphere system, which drives Earth's circulation, moderates climate, and provides the energy for hurricanes (OLP 3a-d; S&S 3A, A.1, 4–8, 13).

OLP 6. This is a 3 because the ocean literacy concepts provide examples of energy resources from the ocean (OLP 6b; S&S 6A.5) which help to apply fundamental physical energy principles, including definitions of energy (DCI PS3.A; PE HS-PS3-3).

HS-PS4 Waves and Their Applications in Technologies for Information Transfer

OLP 1. This is a 3 because the core ideas about ocean waves, including how waves transfer energy over a long distance, but with very little horizontal movement (S&S C.15-17), provide strong examples and an application of the concept of wave properties (DCI PS4.A).

OLP 3. This is a 4 because in order to understand solar radiation and heat exchange between the ocean and atmosphere (OLP 3b, c; S&S 3A & B strands) it is helpful to understand electromagnetic radiation, absorption, and conversion to thermal energy (DCI PS4.B).

OLP 7. This is a 3 because the development and use of information technologies in ocean exploration (OLP 7d; S&S 7C strand) is an example of the importance of applying our understanding of waves and their interactions with matter in the use and development of essential tools (DCI PS4.A, C).

HS-ETS1 Engineering Design

OLP 6. This is a 3 because as the human population, climate change and impact on ocean resources increases (OLP 6d; S&S 6A.6, D.1), achieving environmental sustainability in the ocean depends upon action based on scientific research and exploration (S&S 6E), as well as regulations (S&S 6E.2-8,10). These ocean examples of global challenges may be addressed through engineering (DCI ETS1.A). When evaluating these solutions, it is important to take into account social, cultural and environmental impacts (DCI ETS1.B).