WEST COAST GOVERNORS
ALLIANCE on OCEAN HEALTH
CALIFORNIA OREGON WASHINGTON
Action Coordination Teams

June 1, 2012

Achieve
1400 16th Street NW, Suite 510
Washington, DC 20036

Subject: Comments on Next Generation Science Standards

Dear Achieve:

Thank you for the opportunity to comment on the draft Next Generation Science Standards. We respectfully submit this letter on behalf of the Ocean Awareness and Literacy Action Coordination Team of the West Coast Governor's Alliance on Ocean Health (WCGA). A list of the Team members is attached.

Here is some background on the WCGA to help frame our comments. The WCGA was formed in September 2006, when the Governors of Oregon, Washington and California signed the West Coast Governors' Agreement on Ocean Health. Under this agreement, the three States, working together with tribal leadership, and consulting with federal agency leads and stakeholders, developed a bold set of actions to improve the health of our ocean and coastal resources. On July 29, 2008, the three States released a final Action Plan that outlines many activities on a range of issues. In 2011, the WCGA became the West Coast Governors Alliance on Ocean Health.

"Increasing the ocean awareness and literacy among our citizens" was identified as Priority Area 5 in the WCGA Action Plan. One of the specific actions that the WCGA is focusing on to reach this goal is as follows: *Integrate ocean science and conservation into expanded environmental education curricula by encouraging changes to education content standards enhancing ocean literacy.*

In addition to advancing the goals of the WCGA action plan, the new science standards have the potential to advance the National Ocean Council's draft National Ocean Policy Implementation Plan by achieving the first Milestone under *Action 6: Increase ocean and coastal literacy*, "Include ocean content in Next Generation Science Standards.

This is a matter of great economic, social and scientific importance to the people of our states, and to all Americans. The future of our nation and our environment depend on the next generation gaining a broad, scientific understanding of the ocean, especially its influences on the economy, climate, biodiversity, our food sources, and to the overall quality of our lives. The next generation will need to be ocean literate if they are to pursue the academic and career paths, make the informed consumption choices, understand the complex issues surrounding our use of ocean resources, and practice the civic engagement necessary to confront the environmental challenges of the 21st century. Improving this

understanding is also a critical step toward developing research-based, sustainable and balanced ocean policies.

While the NGSS does include some reference to ocean science, there are some serious scientific misconceptions promoted in the draft standards that could be easily corrected through the suggested revisions detailed below. Additionally there are opportunities to enhance the science concepts in the domains of Life (biology) and Earth and Space science through examples and clarifying statements referencing ocean science concepts.

The COSEE/NMEA Critical Stakeholder Group for the NGSS prepared comments on the K-5 and Middle School standards, which are aimed at achieving the critical goal of advancing ocean literacy specifically and promoting accurate and relevant science education in general, as articulated above. We support these comments, both as they apply to the K-5 and Middle School standards, as well as to the standards overall, and reiterate them below.

Sincerely,

Christiane Parry and Nancy Reichley
Co-Chairs, Ocean Awareness and Literacy Action Coordination Team
West Coast Governor's Alliance on Ocean Health

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**General Comments:**

There is an overwhelmingly terrestrial bias to almost all the K-5 and Middle School Life Science standards. This takes the form of 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, referring to photosynthesis as the only mechanism of primary productivity (ignoring chemosynthesis), etc. These oversights actually are factual errors, and result in incomplete or inaccurate treatment of many fundamentally important concepts. They also, if allowed to stand, unintentionally ensure that most students will never be given opportunities to learn about the unique and ecologically important organisms that occupy the vast majority of the living space on Earth--in the ocean. Curriculum developers, text book publishers and teachers need to understand that it is critical to represent all life on Earth, not just those forms most like us or that live in immediate proximity to us. At the very minimum, we must ensure that the NGSS do not

categorically preclude the inclusion of ocean ecosystems and marine phyla through the use of oversimplified and misleading language. We would like to see one or several ocean scientists contribute directly to the writing or the internal reviewing of the next draft of the Standards before they are released to the public. We would be delighted to help Achieve to identify ocean scientists and ocean sciences educators who can be of assistance. We would also like to draw the attention of the Standards authors to the Ocean Literacy Scope and Sequence for Grades K-12 that was developed and vetted by hundreds of scientists and educators over a five-year period. The portion of the Ocean Literacy Scope and Sequence focused on, for example, Principle 5: "The Ocean Supports a Great Diversity of Life and Ecosystems" for Grades K-5 can be found at http://oceanliteracy.wp2.coexploration.org/?page_id=1523 and will be of great utility to standards writers. The following are a subset of important concepts from this document that we hope the NGSS will address.

**Grades K-2**

More different kinds of organisms are found in the ocean than on land.

Many groups of organisms exist only in the ocean.

There are distinct and unique ocean habitats throughout the ocean and on the coast, offshore, in the deep ocean and at the surface.

**Grades 3-5**

The sunlit surface layers of the ocean are where the sun's energy is captured by photosynthetic phytoplankton (algae and bacteria). This layer only extends down about 200 meters.

There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms.

The ocean provides most of Earth's living space…

The great diversity of ecosystems in the ocean provides opportunities for organisms to develop a great diversity of adaptations, many of which are unique to organisms living in the ocean.

There are many groups of organisms that occur in the ocean that do not occur on land or in fresh water, such as sea stars, squid, jellyfish, corals, many types of worms and seaweeds.

## Review of Elementary K-5

**K.OTE Organisms and Their Environments**

Performance Expectations a., b., c.

Unclear:

a. For Kindergartners, classifying organisms based on what they need to survive is counter-intuitive and confusing. They will classify at that grade by observable traits. What they need to survive is not observable. What they do and look like is observable. Also there are other living things besides plants and animals, and kids at the earliest ages can be introduced to that idea. The clarification statement is simply not accurate. Most animals on Earth do NOT need air, and in fact die when exposed to air for too long a time. Presenting air as a resource that animals need to survive leads students to think that all animals live on land or in the air, and excludes the possibility of including ocean and aquatic animals.

b. Students cannot observe how animals and plants depend on air, land and water, only that they interact with them or use them. Also, "in turn" is not the appropriate way to refer to organisms changing their environment. That should simply be a separate idea. Beavers building dams is good aquatic example. From the ocean, corals build reefs.

c. Clarification Statement: Many herbivores don't eat plants, they eat algae.

Improving:

a. Use observations and information to classify living things as plants, animals or other organisms based on what they look like and what they do. (Clarification Statement: To live and grow, animals need food water and oxygen. Plants need water, light and air to live and grow.)

b. Improving: Use observations to describe how plants, animals and other living things interact with air, land and water where they live to meet their needs. Living things can change their environment. (NOTE: these seem like two very different unrelated ideas.)

c. Clarification Statement: Animals get their food by various means. Some animals eat plants or algae, some eat other animals, and some eat both.

**1. SF Structure and Function**

Performance Expectation b:

Unclear because: Examples of body parts should include those from a broader range of animals, such as fins, gills, antennae. This should be divided into two statements. These are two separate ideas: Animals have body parts obtain and convey information; and Animals respond to the information they obtain with behaviors that help them grow and survive.

Could be improved: b. The clarification statement could be: Animals use body parts such as eyes, ears, nose, gills and antennae to obtain information. Animals have developed behaviors such as the ability to find food or escape from a predator to respond to that information.

**1. PC Patterns and Change**

Performance Expectations c., e.:

Unclear: c. If the goal is for students to observe patterns, why limit them to the sky? Include observation of patterns on land and in the ocean.

e. This is an opportunity to introduce many types of technology that help us to make observations not possible with our unassisted senses, of all parts of the natural world, including the ocean.

Improving:

b. Add example in Clarification Statement: tides are cyclical.

c. Add example in Clarification Statement: wave height, wave frequency, tidal cycles. e. Obtain information and communicate that there are tools that allow people to see more objects in the sky "and ocean" and in greater detail. Add an example in Clarification Statement: underwater gliders, cameras, buoys, moorings, etc.

**2. ECS Earth's Changing Surface**

Performance Expectation a.

Unclear: a. The clarification statement should refer to "the ocean..." not "oceans." Ocean should always be singular (see Ocean Literacy: The Essential Principles of Ocean Sciences K-12).

Improving: a. Clarification Statement: Students should gather information on the ocean, rivers, lakes, ponds and moisture in the soil.

**2. SPM Structure, Properties, and Interactions of Matter**

Performance Expectation b.

Improving: b. Revise Performance Expectation: Collaborate with others to design and build an object from a small set of pieces to solve a technological problem.

**2. IOS Interdependence of Organisms and their Surroundings**

Performance Expectations a., b., c., d., e., f., g.

Unclear: All performance expectations should refer to living things, not only plants and animals.

a. For plants, algae & animals living in an aquatic environment, the need for water serves a different purpose than for terrestrial organisms.

e. What does "shapes of both land and water features" mean? "Shape" is confusing.

Improving: a. Revise Performance Expectation: Construct a representation in which living things depend on their terrestrial or marine environment and each other to meet their needs.

c. Revise Clarification Statement: Examples of different settings could be a sunny vs. shady area, a garden vs. a parking lot, or terrestrial vs. marine environment.

e. Revise Performance Expectation: Analyze a representation of a particular habitat showing the locations of both land and water features of that habitat and communicate how the land and water support living things.

g. Add example in Clarification Statement: sharks which resemble megalodons.

**3. WCI Weather, Climate, and Impacts**

Performance Expectations d., e.

d. Add in Clarification Statement: hurricanes and tornadoes. e. Add in Clarification Statement: solutions should include natural barriers such as sand dunes and not building on the beach.

**3. EIO Environmental Impacts on Organisms**

Performance Expectations a.-g.

Unclear: a. The clarification statement should include examples of marine habitats. b. This is poorly worded. Is it about how well organisms survive in any particular environment, or that organisms are suited to live in particular environments? They have specific features that enable them to survive (so alluding to adaptation) because even in the desert, there are diverse plants that live there.

Improving: a. Add in Clarification Statement: open ocean, estuary, deep sea

f. Add in Clarification Statement: killer whales stay in a pod to protect their young and hunt together.

**3. SFS Structure, Function and Stimuli**

Performance Expectations a. – g.

Unclear: a. This should include plants and algae.

d. Students should be classifying living things (organisms) not only plants and animals.

Improving: a. Revise Performance Expectation: Investigate and explain how internal and external structures in plants and algae serve functions of growth, survival, behavior, and reproduction. Clarification Statement: Examples of internal and external structures include roots, thorns, veins in leaves, stipes, holdfasts and blades.

d. Revise Performance Expectation: Use observations and models to design a simple process to classify plants, animals and other organisms based on their structures. Add in Clarification Statement: fish have fins, kelp has a holdfast.

e. Add in Clarification Statement: antennae, fins.

**4. LCT Life Cycles and Traits**

Performance Expectations a. – h.

Unclear: a. students should be learning about life cycles of organisms not just plants and animals.

Improving: a. Revise Performance Expectation: Investigate the life cycles of organisms including plants, algae and animals to compare similarities and differences among organisms. Add in Clarification Statement: kelp, salmon, crabs.

f. Add in Clarification Statement: fish with brighter colored scales are more likely to attract mates.

h. Add in Clarification Statement: medicines.

**4. PSE Processes that Shape the Earth**

Performance Expectations a. – i.

Unclear: h. Include Clarification Statement: Geological hazards such as earthquakes, floods, volcanic eruptions, landslides...

Improving: h. Include Clarification Statement: Geological hazards such as earthquakes, floods, volcanic eruptions, landslides...

**4. E Energy**

Performance Expectations a. – g.

Improving: d. Add in Clarification Statement: Remotely Operated Vehicles (ROVs)

**4. WAV Waves**

Performance Expectations a. – g.

Unclear: f. Include other real world examples by including audio or acoustics technologies or devices for research and exploration.

g. Include other real world examples by including audio or acoustics technologies or devices for research and exploration.

Improving: g. Add in clarification statement: "satellites".

**5. MEE Matter and Energy in Ecosystems**

Performance Expectations a. – h.

Unclear: a. Food webs with plants, animals and fungi are only in terrestrial ecosystems. There have to be marine and aquatic examples.

b. Cycling of matter between air and soil and among plants only happens on land. It is not correct to imply that these processes only occur on land. The ocean is a critical part of these cycles, from water to carbon.

c. Decomposition & the recycling of materials does not just happen in the soil for plants. Decomposition occurs in fresh and salt water, and also decomposition in water is a different process than in soil.

d. This statement is very focused on the needs of endothermic animals. It does not include ectotherms & poikilotherms, which applies to marine organisms.

e. This refers only to photosynthesis by plants, leaving out algae, photosynthetic microorganisms and chemosynthesis.

f. This refers only to land plants, ignoring most of the photosynthetic organisms on Earth that are not plants.

g. This should include algae and other photosynthetic organisms.

Improving: a. Revise Performance Expectation: Construct models of food webs to explain the interrelationship among plants, animals and fungi within terrestrial ecosystems, and algae, microbes and animals in marine ecosystems.

b. Revise Performance Expectation: Use models to trace the cycling of particles of matter between the air, soil and water and among living things.

c. Revise Performance Expectation: Use models to describe how decomposition eventually returns (recycles) some materials back to the soil on land or the water in the ocean for living things to use.

e. Revise Performance Expectation: Obtain and communicate information tracing the source of energy for burning fuel or metabolism back to energy from the sun that was captured by plants, algae and other photosynthetic organisms, or to chemosynthesis in deep sea vents.

f. Revise Performance Expectation: Use models to communicate that plants, algae other photosynthetic organisms obtain matter to grow chiefly from carbon dioxide and water, and energy to grow from the sun.

g. Revise Performance Expectation: Plan and carry out investigations to determine the role of light in the growth of plants, algae and other photosynthetic organisms.

**5. ESI Earth Systems and Their Interactions**

Performance Expectations a. – h.

Unclear: e. Why wait until 5th grade before introducing the ocean-atmosphere relationship? The ocean is a critical part of weather and climate and that has been completely overlooked. So far, weather and climate has been presented as if things just happen, even when students are challenged to collect data and look for patterns. The ocean, or other large bodies of water like the Great Lakes, are part of what affects the weather and climate.

**Review of Middle School Grades 6-8**

**MS.LS-SFI**

Performance Expectations a. – f.

Unclear: c: This PE only deals with eukaryotic organisms. What about prokaryotes or archaea? Organisms in those domains make up much of the biomass on Earth (esp. when the marine/aquatic environment is taken into account). Viruses and Bacteria lack a nucleus and mitochondria. This PE should not be more limited in scope than the Disciplinary Core Idea.

d: Clarification statement limits the organisms that can be used to construct models/representations.

Improving: c: Construct an explanation for the function of specific parts of cells for maintaining a stable internal environment.

d: Because clarification statement is limiting, we suggest removing altogether.

**MS.LS-GDRO Growth, Development, Reproduction of Organisms**

Performance Expectations a. – h.

Unclear: d. The PE only refers to plant structures. This is an important opportunity to introduce the structures of other photosynthetic organisms.

Improving: d. Plan and conduct investigations to gather evidence for the relationship among specialized structures of plants, specific animal behaviors, and the successful reproduction of that plant. Compare this with specialized structures of algae and other photosynthetic organisms that typically do not depend on interactions with animals.

**MS.LS-MEOE Matter and Energy in Organisms and Ecosystems**

Performance Expectations a. – f.

Unclear: a. The PE should state, as does the Framework, the various groups of organisms that are photosynthetic. When students first learn about primary productivity they should have the opportunity to be introduced to the concept of chemosynthesis in the deep ocean, as well as, photosynthesis. They don't need to learn chemical equations, but that it is critical that they understand that not all food webs depend on energy from the sun. Hydrothermal vent communities are important ecologically, and have an important influence on cycling of matter, flow of energy and chemical balancing in the ocean.

Improving: a. Develop an explanation for the role of photosynthesis by plants, algae (including phytoplankton) and many microorganisms, and the role of chemosynthesis by many organisms in deep sea hydrothermal vents, in the cycling of matter and flow of energy on Earth.

**MS.LS-IRE Interdependent Relationships in Ecosystems**

Performance Expectations a. – f.

Unclear: b. Referring to "various" ecosystems is too vague. The PE should specify ecosystems that are substantively different from one another enough to be instructive, e.g., terrestrial and marine.

c. Referring to "varied" ecosystems is too vague. The PE should specify ecosystems that are substantively different from one another enough to be instructive, e.g., terrestrial and marine.

Improving: b. Construct explanations to describe competitive, predatory, and mutually beneficial interactions as patterns across terrestrial, marine and aquatic ecosystems.

c. Ask investigable questions about the ways organisms obtain matter and energy across multiple and varied terrestrial, marine and aquatic ecosystems.

**MS.ESS-SS Space Systems**

Performance Expectations a. – d.

Unclear: c. Construct and use models to describe the size and location of Earth with respect to the sizes and structures of the solar system, Milky Way Galaxy, and universe.

Improving: c. Revised PE: Construct and use models to describe the size and location of Earth with respect to the sizes and structures of the solar system, Milky Way Galaxy, and universe.

**MS.ESS-HE The History of the Earth**

Performance Expectations a. – e.

Unclear: a. "patterns in geologic evidence" is awkward and confusing phrasing. c. earth system processes is preferable to geologic processes. The clarification statement is unclear: is the focus only on scale or process/impact on Earth’s evolution (of features?) If it is on process, the processes in the ocean should also be included—such as earthquakes, landslides and resulting Tsunami’s and their impact on coastal processes. It implies all actions are terrestrial…

d: It is unclear if the focus is just terrestrial, and could be read that way--- leading to the idea that all of these events happened on land.

e: It implies that the biosphere and geosphere have co-evolved without accounting for the other Earth systems that would interact on each one, such as the hydrosphere (it is mentioned in the clarification but should be made more clear). The hydrosphere must be included with the geosphere and biosphere in this performance expectation. Life evolved in the ocean for most of earth history. Also, ocean life and chemistry regulated the evolution of the composition of the atmosphere (i.e. O2 rich atmosphere).

Improving: a. Alternate wording: Construct explanations for how geologic evidence, including patterns and fossils in rock strata, can be used to determine the relative ages of a sequence of events that have occurred in Earth's past.

c. Use "earth system processes" rather than "geologic processes". The framework uses "earth systems" when describing this core idea.

d. Change "past geologic events" to "past events in earth history." Several major extinction events are thought to possibly be caused in part or in whole to changes in ocean stratification and chemistry. While this is a geologic event, the wording places an implicit emphasis on terrestrial geology, losing the rich context of earth as a system. In general that is a problem in the wording of these standards....the earth system context is not emphasized (e.g. replacing framework language that includes the term earth system with the term geologic). Improving: Waves from ocean and other bodies of water continually shape coastlines, some may be gradual over long periods of time while other events can cause coastal landslides which can change coastal features quickly and dramatically. This is especially relevant for coastal states. Improving: in the clarification (if there is one) add an example of the mass extinction Permian–Triassic extinction event or something similar and somewhere include an explanation that many of these took place in the ocean. Also including a reference the fact that for most of Earth history, life existed only in the ocean, would be a good clarification example.

**MS. ESS-EIP Earth's Interior Processes**

Performance Expectations a. – f.

Unclear: f. There are not enough examples of hazards, especially coastal hazards.

Improving: f. It would be helpful to add additional examples of hazards, e.g., landslides, hurricanes, storm waves.

**MS. ESS ESP Earth's Surface Processes**

Performance Expectations a. – f.

Unclear: a. Seascapes or bathymetry is missing and needs to be added.

c. Rather than density affecting the separation of water masses, it affects the formation of water masses.

e. This seems to be a forced fit with the engineering practice. While not unclear, it is a narrowly focused standard. This PE seems to promote levees and dams and there are many environmental issues regarding these solutions.

f. It focuses on formation of soil and leaves out sand.

Improving: a. Use models to explain how weathering, erosion and deposition of Earth materials, by the movement of water, shape landscapes, seascapes and underground formations. The ocean is a major driver in weathering and erosion, and acts as the major depositional basin for eroded sediments. These ocean-related processes and the resultant rock strata can be seen throughout geologic time in the rock record and reflect processes that take place at the ocean's edge or beneath the ocean surface (seascapes). There are many kilometers (thickness) of continental sediment on the continental shelf and slope.

b. In the clarification Statement, it is important to include the ocean as part of the water cycle process so it does not become just a terrestrial (lake, pond) example as is traditional in most text books. The ocean is the main driver of the cycle.

e. Missed opportunity here to talk about engineering solutions to detecting, predicting and mitigating natural hazards. The earth system concept is somewhat lost in this standard. Although the standard is named "Earth's surface processes", there is a disproportionally strong focus on weathering, erosion and deposition (3 of the 6 performance expectations) almost to the exclusion of physical processes that take place in the ocean (70% of the surface). These processes also are driven (ultimately) by incoming solar radiation, as elegantly articulated in the framework text. Notably missing from a complete treatment of earth's surface processes is the surface (wind driven) circulation of the ocean. The density driven circulation is presented, but energy and mass transfer in the ocean depend on both processes and their interconnectedness. These are very important concepts related to earth's climate. The framework refers to the earth's "surface systems" and this standard has taken the narrow view in looking primarily at surface processes in a terrestrial geologic context. In the clarification statement, examples should include methods engineers can engage in that are not environmentally destructive (as often are dams and levees) -- such as planning better soils management, runoff patterns, permeable surfaces, etc. All of those can be considered engineering practices/skills as well, calculating amount/quantity, speed of water movement, etc.

f. Understanding the formation of sand is also of value and is eroded from land sources, transported by rivers to the ocean, but sand is also eroded from coastal sources by surf and redistributed by waves and coastal currents.

**MS. ESS WC Weather and Climate Systems**

Performance Expectations a. – h.

Improving: It is confusing to have density driven circulation in the ocean separated from wind driven circulation. They are integral to the overall mass and energy transfer in the ocean, a major influence on climate, and to separate them between two standards is problematic. Move the density driven ocean circulation concept to this standard.

h. This PE needs to be connected to constructing explanations and designing solutions.

**West Coast Governors' Alliance on Ocean Health**
**Ocean Awareness and Literacy Action Coordination Team Members**

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