Marine Science

Length of Course: Full Year

Elective/Required: Elective

Course Description

“The Ocean defines and dominates everything about our planet. It covers most of our planet, is home to most of the life on Earth, regulates our weather and climate, provides most of our oxygen, and feeds much of the human population.

Stories about climate change, ocean acidification, overfishing, hurricanes, tsunamis, etc. dominate the news. And the ocean provides over $43 billion per year to the economy in California alone. While it is obvious why understanding and protecting the ocean is so critical to the future health of our planet, it is sometimes difficult to understand how we got quite where we currently are” (http://oceanliteracy.wp2.coexploration.org/ocean-literacy-network/rationale-of-the-network/).

This course demands successful completion of physics, chemistry, and biology while at AUL. It is strongly advised students be in their junior and senior years while taking this class.

Introduction to marine science seeks to successfully blend the physics and chemistry of marine science with the ecosystems and organisms that are more famous for living in them. Introductory marine science courses often focus primarily on the physical features of Earth and its seawater. Students entering the course will find that this course takes a holistic approach and seeks to tell a story about the ocean. The physical and chemical features of marine science make life possible in the seas and on land. Each unit comprises biological and physical science of distinct marine ecosystems, and the human driven effects that influence them.

AUL

Syllabus & Pacing Guide

PACING GUIDE		
Unit/Topic/Skill	**Suggested Time Frame**	**Notes**
Living on a Blue Planet	2 weeks	Intro to course, lab safety, critical thinking and nature of science, ocean influence on life, chemical and physical properties of water (brief), begin introducing ocean zones and Ocean Literacy standards
Marine Biodiversity: Taxonomic Review	1 week	Taxonomic review Important as it is sometimes not covered in biology (time constraints?), many students need review over prokaryote vs. eukaryote, plant vs. animal, vertebrate vs. invertebrate, brief review of vertebrate classifications (fish through mammals)
Marine Ecosystems	2 weeks	Introduce ocean zones, review (and/or reteach) ecology of food webs and energy transfer between organisms as needed, discuss marine producers, analyze flow of energy and interdependence
Marine Ecosystems	1 week	discuss marine producers, predators, symbiotic relationships such as mutualism, discuss populations
Estuaries	3 weeks	Use estuaries to review some key concepts about salt and/or fresh water differences, ecosystems (biotic/ abiotic factors), osmoregulation, evaluate New Jersey as a coastal state with harbors, rivers, etc. Show aerial pictures of New Jersey and New Jersey Coast, barrier islands. Begin field/lab trips to the waterfront and other NJ areas.

The Deep	2 weeks	Hydrothermal vent communities, deep ocean exploration, plate tectonics, earthquakes/tsunamis, abiotic ocean factors (pressure, temperature, light), adaptations of deep sea organisms, whale fall ecosystems
Open Ocean	2 weeks	Open ocean as a “desert” adaptations of plankton, adaptations of nekton, Current, volcanoes as new feeding grounds, ocean as a distributor of energy, migration (?), schooling fish, fisheries, human impact, climate change
Open Ocean: Currents	1 week	
Polar Seas	2-3 weeks	Explanation of poles, axis of earth, amount of sunlight, adaptations to pole climate, north vs. south pole, life beneath ice,
Seasonal Seas	2-3 weeks	Temperate waters as most productive on earth, seasonal algae blooms, photosynthesis, food webs, migrations, climate change effects,
Coral Reefs	2-3 weeks	Cnidarians, coral-zooxanthellae symbiosis, feeding behaviors, temperature, ocean acidity, bleaching, human impact, biodiversity,
Tidal Seas	3-4 weeks	Tides, tidal pools, forces that cause tides, adaptations to survive change of physical and chemical factors during tide changes in intertidal zones, moon phases, tidal fluctuations
Coasts	1 week	Sandy beaches, island coasts, erosion, waves and effects on shores, coasts as mating grounds and territories, pinnipeds,

Marine Science

CURRICULUM GUIDES

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Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Life on a Blue Planet**	**Time Frame**	**2 weeks**

Overview/Rationale

During the first 1-2 weeks of school, students should experience a variety of small group activities that foster team building and critical thinking skill use. Activities that begin as individual activities then progress to small, and finally large group discussions prepare them step by step for oral exchange of ideas (as they are prepared by individual or small group work). Constant use of quick engineering challenges (tower or bridge building, buoyancy of clay boats, etc.) serve the same purpose for creating a group or social dynamic. These activities are inquiry, hands-on, and involve critical thinking or problem solving at a time where content focused lab plans may not yet be appropriate. Lab periods and single period days at beginning of year (and throughout) should begin such work.
As the beginning of September progresses students will be asked to think about the appearance and features of planet Earth. It is a common misconception that life on Earth is largely due to terrestrial characteristics. Students should be shown satellite images, research maps on Google earth that will create a true image of planet Earth and specifically New Jersey.
The ocean as a whole will be introduced here, as well as the course outline used in this curriculum to guide marine inquiry and learning. Students will be introduced to the Ocean Literacy Framework and Climate Literacy standards. Each ecosystem that will be studied is intertwined with climate causes/ effects. This unit will introduce the idea that humans and all life are inextricably connected to the ocean and all life in the ocean (and set this as a premise for thinking the rest of the course). Ocean Literacy Framework Guide and the Climate Literacy Guide

Desired Results

Critical Content Standards

- Ocean Literacy Principle #1: The Earth has one big ocean with many features.
- Ocean Literacy Principle #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy Principle #3: The ocean is a major influence on weather and climate.
- Ocean Literacy Principle #4: The ocean makes the Earth habitable.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- Ocean Literacy Principle #7: The ocean is largely unexplored.
- 5.1.12.A1-3
- 5.1.12.B1-4
- 5.1.12.C1-3
- ELA Standards
    - RST.11-12.3 Follow a precise multistep procedure
    - RST.11-12.2 Determine the central ideas or conclusion of a text; summarize complex concepts
    - WHST.11-12.2 Write informative texts
- Math Standards
- S-IC.1:
- S-IC.6:
- S-IC.6:

Enduring Understandings	Essential Questions

Students will understand that: • The Earth's oceans are a dominant physical feature of the planet. • While the ocean covers most of the planet it is not a uniform body of water. • Most of Earth's water (97%) is contained in the ocean. • Scientific method involves analyzing and evaluating problems and data. • The one world ocean is divided into specific zones to enable more specific study. • Connections between humans and the ocean are important and have existed for thousands of years of human history. • Everyone on every continent is responsible for the health of the ocean.	• How is the scientific method used for marine science problem solving? • How can critical thinking and problem solving be used in the lab classroom environment? • How do I stay safe in the laboratory? • How many oceans exist on earth? • How do scientists divide the ocean to better study it and its inhabitants? • What is sustainability? • How are oceans used for human needs? • How does technology change human impact on the world ocean? • What are some ways humans have an impact on the ocean and marine life?
Student Objectives	
Students will be able to: • Develop habits for collaboration and group work in the classroom. • Discuss and record student led suggestions for classroom policies and rules. • Distinguish types of variables in experiments by performing labs and reading other experimental results. • Analyze and create graphs of data from their own labs, or by using data provided to them. • Identify all of Earth's oceans. Debate if they are separate systems, or one large ocean. • Compare inferences and observations. • Evaluate how data is used and communicated in the scientific world. • Create a dialog and written account for the question(s) "How do human actions change the Perth Amboy (and/or New Jersey) coast? Are these changes harmful and/or helpful? What actions/changes are needed to improve the health of Perth Amboy's waterfront or New Jerseys coasts?" • Understand that these questions will be revisited all year long.	
Assessment Evidence	
Formative Assessment(s)	**Summative Assessment(s)**
• Small critical thinking projects/activities (quick engineering labs: build floating boat of clay, build bridge team activity) • Lost at Sea activity • Ocean Exploration timeline • Scientific Method lab	• Identifying controls and variables writing assignment • Scientific Method Lab questions • Quiz on formation of earth's oceans, how scientists divide the ocean to study more efficiently • Written assignment/activity on experimental design and data collection • Lab practical: brine shrimp experiment
Teaching and Learning Actions – Instructional Strategies – Activities	

1. Collaborate with a group or team of students to perform basic “engineering” type problems such as building a boat out of clay that floats
2. Evaluate and rank items from most to least important in the “Lost at Sea” survival activity. Students must rank items alone, then with a randomly assigned team.
3. Group students together and have them identify or develop a list of reasons that make studying the marine world important.
4. Compare and contrast working alone to working with a team of people
5. Explain the progression of the marine science course to the students
6. Discuss features of New Jersey within small groups. View teacher delivered slide show of New Jersey coastline (aerial). Compare and critique descriptions of New Jersey from before and after the slides (or photos on tables).
7. Reinforce the main divisions of the ocean into only a few major ecosystems (how the course in designed and written) Estuaries, deep ocean, open ocean, frozen seas, coral, seasonal, tidal seas, and finally coastal areas (estuaries and beaches revisited)
8. Relay to students that the course will include both living and non-living (biotic/abiotic) characteristics of marine environments. Pair students up and have them list as many biotic/abiotic factors as they can in a timeframe.
9. Create and analyze note-keeping techniques.
10. Create a Google drive and examine the pros/cons of notes online vs. keeping a notebook.

Vocabulary

Collaboration, Scientific Method, hypothesis, experiment, control, dependent variable, independent variable, accuracy, inference, observation, data, qualitative, quantitative, ocean, marine, zones, ecosystem, water testing kits, water quality

Resources

- Lost at Sea activity: lost at sea pdf
- http://mynasadata.larc.nasa.gov/lesson-plans/lesson-plans-hs-educators/?page_id=474?&passid=3
- http://www.aquariumofpacific.org/exhibits/ocean_exploration/oe_timeline
- http://teachoceanscience.net/pdfs/os_ocean_exploration_through_time.pdf
- http://earthobservatory.nasa.gov/GlobalMaps/?eocn=topnav&eoci=globalmaps
- Quick engineering challenges: http://www-tc.pbskids.org/designsquad/pdf/parentseducators/DS_Act_Guide_complete.pdf
- http://www.thetech.org/educator-resources/design-challenge-lessons
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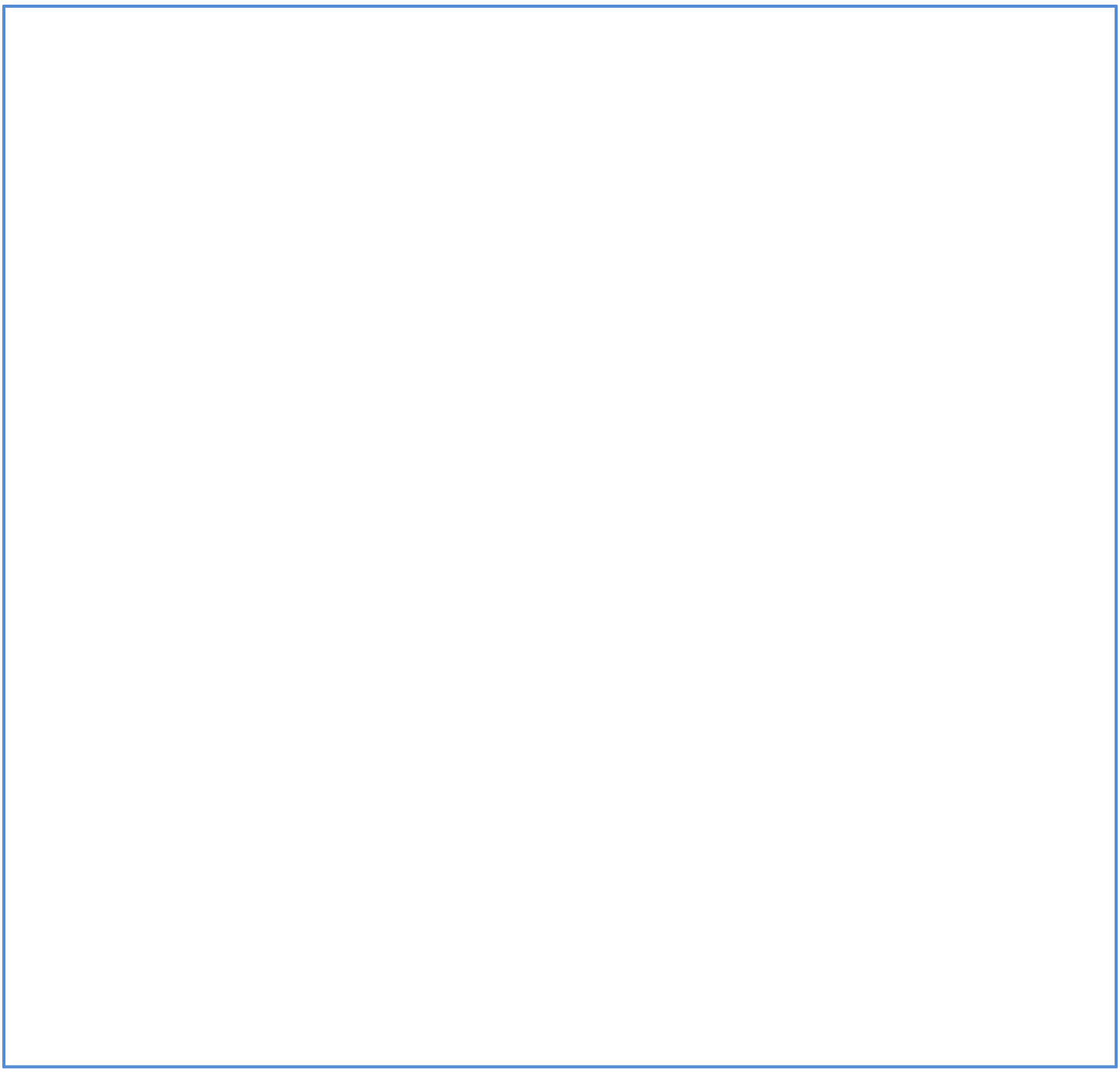
Differentiation

Enrichment	• Greater in-depth look at ocean importance, timeline of history of earth to scale, analyze importance of human communities throughout history and location in reference to ocean ports
Intervention	• Small group focus, individual interaction with teacher during group activities, visual aids, pictures, videos, assistance with lab procedure reading, follow all modifications set forth by 504 or IEP
ELLs	• Visual aids, maps, hands on pictures and videos, dictionaries (dual language), group or collaborative seating for communication, visual aids and pictures for water testing kit instructions, water testing kit instructions are also in Spanish

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
x	Health Literacy	*ETA*	Communication
	Civic Literacy	*ETA*	Collaboration
	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** ocean literacy, climate literacy
Notes-Observations-Reflections			



Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Biodiversity in the Oceans (taxonomy)**	**Time Frame**	**1 week**
Overview/Rationale			
Each unit in this curriculum involves a comprehensive look at functioning ecosystems, taxonomic order will not be presented in the traditional way. There are some basic misconceptions encountered at the high school level about basic taxonomy of fish, mammals, etc. Setting a standard for understanding the diversity of life will occur here, early in the course. All organisms in marine environments interact and depend on each other. Recognizing that there are characteristics that are similar, but some vastly different will help scaffold and build schema for deeper understanding later in the course. If classification is not covered in biology, students will not have had any taxonomic practice since middle school life science (roughly six years between exposure). Review of biodiversity of life will help enrich all students, gifted, intervention, and ELL.			
Desired Results			
Critical Content Standards			

- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- Ocean Literacy Principle #7: The ocean is largely unexplored.
- 5.1.12.A.1-3
- 5.1.12.B.1-4
- 5.1.12.C.1-3
- HS-LS4-1.: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- HS-LS4-2.: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- HS-LS4-4.: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- HS-LS4-5.: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- HSS-IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- HSS-IC.B.6: Evaluate reports based on data.

Enduring Understandings	Essential Questions
Students will understand that: • Life on Earth is thought to have started in the ocean. • The earliest evidence of life is found in the ocean. • Ocean life ranges from smallest microbes to largest animal on Earth (blue whale). • Most ocean life exists as microbial level. • Microbes are the most important primary producers in the ocean (possibly planet). • There are several different Kingdoms of life. • Key similarities exist within each taxonomic level of classification.	• Why are organisms classified? • How do we classify (marine) organisms into groups? • What are the key differences between plants and animals? • Are there marine plants? • What separates invertebrates and vertebrates? • What are evolutionary relationships between organisms and how do we illustrate those in a cladogram? • How is a dichotomous key used? • What are the distinguishing characteristics of the kingdoms and representatives of each?

Student Objectives

Students will be able to:
- Discuss importance of biodiversity and analyze its function in an ecosystem.
- Provide examples of biodiversity and key organisms in the marine environment
- Classify organisms based on their characteristics
- Elaborate on similarities and differences between major groups of organisms
- Explain how structure of some marine organisms support their functions
- Identify the characteristics that all living things share

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Separating pictures of living organisms into groups within small groups of 3-4 students then getting 10 minutes of instruction of correct classifications according to kingdoms, etc. Have students regroup pictures accordingly and critique their original groupings versus the correct groupings. • Keeping log of kingdoms, phylums, etc. for each group discussed (continue throughout year as different/new levels are discussed)	• Performance assessment for correct use and identification of dichotomous key for marine fish • Multiple choice test questions that cover taxonomy • Test questions that use cladogram images for multiple choice or free response

Teaching and Learning Actions – Instructional Strategies – Activities

1. As an opening activity teacher should distribute a baggie or envelope of different pictures of animals and other organisms (a mushroom, plankton, etc.) to each lab group. Give instruction "Arrange into groups." When students are done have them justify their reasoning for the groupings. Do a walk and talk, to view other groupings and debate reasoning with other students.
2. After that, begin lesson on "Why do we classify?" ask students how we classify things. Ask them to give examples of classifications they use at home, school, etc.
3. Compare and contrast plants and animals.
4. Discuss the meaning of the word microbe. Provide examples and look at pond/sea water.
5. Explain the differences between invertebrates and vertebrates using pictures and biology textbook.
6. Create chart that shows distinctions between groups of vertebrates (Fish through mammals).

Vocabulary

Taxonomy, classification, kingdom, phylum, class, order, family, genus, species, invertebrate, vertebrate, organism, plant, animal, prokaryote, eukaryote, fish, amphibian, reptile, bird, mammal, warm-blooded, cold-blooded, evolution, common ancestor, family tree, phylogenetic tree, cladogram, binomial nomenclature, dichotomous key, homologous/analogous structures

Resources

http://www-tc.pbs.org/wgbh/nova/education/activities/pdf/2215_reef.pdf
http://www.nclark.net/Classification

Differentiation

Enrichment	• Exploration into careers involving marine biology
Intervention	• Small group focus, individual interaction with teacher during group activities, visual aids, pictures, videos, assistance with lab procedure reading, follow all modifications set forth by 504 or IEP
ELLs	• Visual aids, maps, hands on pictures and videos, dictionaries (dual language), group or collaborative seating for communication

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation

x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
	Health Literacy	*ETA*	Communication
	Civic Literacy	*ETA*	Collaboration
	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean Literacy

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Marine Ecosystems: Food Webs**	**Time Frame**	**2 weeks**

Overview/Rationale

A small portion of time in class will be spent in the beginning of the year reviewing food webs and energy transfer in an ecosystem. Though PAHS currently follows physics to chemistry to biology progression, a review of basic ecology concepts would be useful for any transfer students who may not have had biology since freshman or sophomore year. Feeding relationships and interdependence between organisms and their environment is a key focus for the rest of the course. Each ecosystem will be evaluated in terms of human influence on productivity, and a strong foundation in ecology is necessary.

Desired Results

Critical Content Standards

- Ocean Literacy Principle #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy Principle #4: The ocean makes the Earth habitable.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- 5.3.12.B.1
- 5.3.12.B.2
- 5.3.12.B.3
- 5.3.12.C.1
- 5.3.12.C.2
- HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- WHST.9-12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- MP.2: Reason abstractly and quantitatively.
- HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSS-IC.B.6: Evaluate reports based on data.

Enduring Understandings	Essential Questions

Students will understand that: • Plants and animals are connected within an ecosystem. • The flow of energy through living things allows them to maintain complex organization • The interconnectivity of abiotic and biotic factors influences the biodiversity and the productivity of marine environments.	• How is energy transferred in marine ecosystems? • What is a food web? • Why do phytoplankton (producers) have such a critical role in marine food webs? • What happens to the energy available at each tropic level of a pyramid? • Why is it important for scientists to understand and utilize food webs?

Student Objectives

Students will be able to:
- Review all of Earth's oceans, with specific identification of major ocean zones.
- Interpret zonation maps.
- Infer and investigate feeding relationships.
- Distinguish between food chain and food web.
- Illustrate energy flow through a marine food web of an ecosystem distributed by the teacher.
- Evaluate the importance of energy transfer from the sun (radiant energy) to living organisms (chemical energy).
- Compare and contrast photosynthesis to chemosynthesis in marine waters.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Creation of food web from written instructions. • Calculate the amount of energy/calories at levels in food chain. • Oral discussion about the shape of the trophic pyramid in relation to amount of energy stored by each successive level. • Correct use of arrows to show flow of energy to each level. • Construct two food webs for comparison of photosynthesis and chemosynthesis (one ocean surface food web and one deep sea food web).	• Performance assessment: construct a food web based on a fictitious student's notes and research • Test on food web unit; students will analyze graphs and images pertaining to energy in a food chain in multiple choice and free response questions

Teaching and Learning Actions – Instructional Strategies – Activities

1. Have students create two food webs (one ocean surface, one deep sea) compare the main source of energy for each, compare appearance of organisms, watch short video clips of these organisms feeding in their respective ecosystems
2. Have students identify producers, consumer, autotrophs, heterotrophs in quick diagram assignments to reinforce vocabulary usage in between teacher directed information sessions
3. Provide students with three different trophic pyramids and have them calculate the energy at each successive level
4. Students should hypothesize why apex predator (top predators) have specialized physical and behavioral adaptations for hunting. Discuss why they receive the least amount of energy in the food web.
5. Have students select areas on a map where they think the most productive ocean regions are. Many students select tropical and equatorial waters, which is a misconception. While they are biologically diverse, temperate waters are highly productive. Give some time in class for students to research reasons for productive ocean areas. Guide inquiry towards the prescience of nutrients.
6. Use the above learning activity to guide inquiry to next section of course: Interdependence and Relationships. Use the question "Why are waters around New Jersey and other Northeast coastal areas not clear like tropical waters?"

Vocabulary

Ecosystem, community, organism, population, biome, biosphere, biotic, abiotic, producer, food web, energy, trophic level, apex, predator, producer, autotroph, consumer, heterotroph

Resources

- http://www.ridge2000.org/SEAS/downloads/curriculum/seas_unit4_activity1.pdf
- http://www.ridge2000.org/SEAS/downloads/curriculum/seas_unit4_activity2.pdf
- http://teachoceanscience.net/teaching_resources/education_modules/aquatic_food_webs/get_started/
- http://earthobservatory.nasa.gov/Features/Phytoplankton/page1.php
- http://www.bigelow.org/foodweb/
- http://cce.lternet.edu/sites/default/files/L1_fnl_Plankton%20Food%20Web_TEACHER.pdf
- http://education.nationalgeographic.com/education/activity/marine-food-chains-and-biodiversity/?ar_a=1&ar_r=999

Differentiation

Enrichment	• Calculations of energy transferred and calories used up at each trophic level, in-depth evaluation of connectivity of a food chain/web. Infer the effect of biomagnification and bioaccumulation as a result.
Intervention	• Individual time for charts, pictures, graphs, small groups to build food webs, any accommodations
ELLs	• Use of charts, diagrams, pictures, videos, and other visual representations of concepts, small group discussions, vocabulary review, discuss shape of food pyramid (by the USDA) to the food pyramid (trophic levels) and use of both

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* **21st Century Skills**	
X	Global Awareness	*ETA*	Creativity and Innovation
X	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
X	Health Literacy	*ETA*	Communication
X	Civic Literacy	*ET*	Collaboration
X	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean, Climate literacy

Notes-Observations-Reflections

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Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Marine Ecosystems: Interdependence and Relationships**	**Time Frame**	**1 week**

Overview/Rationale

This unit will cover some crucial ecological habits and relationships. Symbiosis, feeding behaviors, and dependence on abiotic factors in an ecosystem are covered briefly in biology, but require an in-depth look in Marine Science. Discussion of symbiosis will briefly review the three types. Each type will be evaluated in more depth throughout the curriculum of the course. Predator-prey relationships and other feeding behaviors should be introduced here as separate from symbiosis. Many students identify predators as parasites. Scavengers and decomposers Many marine science students (in previous years) continually identify temperate, coastal waters as "dirty" because they range in color from green to brown. This is a misconception. Tropical waters are usually lacking in nutrients for successful phyto/ zooplankton growth.

Desired Results

Critical Content Standards

- Ocean Literacy #5
- Ocean Literacy #6
- 5.3.12.C.1
- 5.3.12.C.2

NGSS:
HS-LS2-1.

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2.

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6.

Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7.

Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8.

Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

ELA/Literacy -

RST.9-10.8

Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Mathematics -

MP.2

Enduring Understandings	Essential Questions
Students will understand that: • Relationships exist between living organisms that make them interdependent. • Symbiotic relationships occur in every ecosystem in three distinct types. • Predator-prey relationships are not symbiotic. • Scavengers and decomposers are a crucial part of each marine ecosystem that will be studied. • There are a variety of marine environments. • Some species are plankton for entire life, others begin as plankton then become nekton.	• How are marine ecosystems classified? • What are the characteristics of marine ecosystems? • What is symbiosis? • What is a predator prey relationship? • What is scavenging? • What type of organisms are decomposers? • Why are the marine, bay, harbor, and beach waters in and around New Jersey green or brown (not blue)?

Student Objectives

Students will be able to:
- Review all of Earth's oceans, with specific identification of major ocean zones.
- Evaluate the benefits and/or costs of the three types of symbiotic relationships.
- Analyze the function of decomposers.
- Explain the importance of predators in a system.
- Relate the color of water in temperate areas to the presence of nutrients and plankton.
- Create a diagram that shows the interdependence between plankton and the rest of marine food webs.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Labeling of ocean maps • Using smart board in small groups to Google earth different oceans, or ocean zones • Oral discussion (to guess or try and name) as many ocean ecosystems as possible. • Discuss living in Perth Amboy and see if students list this as a marine environment • Play "Guess that baby plankton" to show students how many larger species (mackerel, lobster, crab, etc. begin life as plankton but do not remain plankton) reinforce haloplankton/meroplankton usage	• Written performance assessment to identify the correct symbiotic relationship of given pairs, justify reasoning based on pictures and given written info • Quizzes to assess understanding after smaller topics • Unit test on ecosystems (multiple choice and free response)

Teaching and Learning Actions – Instructional Strategies – Activities

1. Use the PBS lesson plan for predator-prey and symbiotic relationships. It includes worksheets to take notes and help students hypothesize about the type of relationship they will witness while watching several video clips between sharks and various other organisms. The video clips each show an example of sharks as predators, mutualistic, commensalistic organisms. Teacher must find a video or have students research examples of marine parasitic relationships as the students should deduce that is the only symbiotic relationship not shown.
2. Have them spend 1-2 class periods using technology to find and write about other examples of marine symbiosis not covered. Post examples and Blog about human interactions and possible affects on feeding or symbiotic relationships in the ocean.

Vocabulary

Ecosystem, community, organism, population, biome, biosphere, biotic, abiotic, producer, food web, energy, trophic level, haloplankton, meroplankton, planktonic, benthic, nektonic, zooplankton, phytoplankton

Resources

http://www.pbs.org/wnet/nature/lessons/symbiotic-strategies/lesson-overview/1494/
http://www.pbs.org/wnet/nature/lessons/symbiotic-strategies/lesson-activities/1495/
http://www-tc.pbs.org/wnet/nature/files/2008/12/symbiotic-strategies.pdf (printer friendly symbiosis from PBS)
http://njseagrant.org/wp-content/uploads/2014/03/plankton.pdf

Differentiation

Enrichment	• Calculations of energy transferred and calories used up at each trophic level, hypothesize about effects of disappearances of apex predators have on marine food webs (continue this idea regarding disappearance of marine predators and effect on human use of ocean resources)
Intervention	• Individual time for charts, pictures, graphs, small groups to build food webs, any accommodations
ELLs	• Use of charts, diagrams, pictures, videos, and other visual representations of concepts, small group discussions, vocabulary review,

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. 21st Century Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* 21st Century Skills	
X	Global Awareness	*ETA*	Creativity and Innovation
X	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
X	Health Literacy	*ETA*	Communication
	Civic Literacy	*ET*	Collaboration
	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean Literacy

Notes-Observations-Reflections

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Curriculum Guide

Content Area	Marine Science	Grade Level	11-12
Topic/Concept/ Skill	**Estuary environments**	Time Frame	**3 weeks**

Overview/Rationale

The majority of liquid water on earth's surface is salt water. Many people associate this with the open ocean environment and beaches. Estuaries are the end of everything that flows down river, but only the beginning of its journey into the sea. Perth Amboy City exists in a bay or harbor environment. Its history is rich and dependent on being located near waterways used for transport and recreation. The waterfront can be used as a site to conduct labs and water testing. Estuaries exist along most of the Eastern seaboard but are rarely discussed. Human impacts in these areas (and other coastal environments) are most severe. Students will be able to relate to this locally, as most will have witnessed the effects of hurricane Sandy. Estuaries will serve as a starting point in the story of the sea and welcome students into the intertwined relationship between Earth, humans, and the ocean features that make life possible.

Desired Results

Critical Content Standards

- Ocean Literacy #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy #7: The ocean is largely unexplored.
- Climate Literacy #1: The Sun is the primary source of energy for Earths climate system.
- 5.1.12.A, B, D Science Practices
- 5.3 Life Science
  - ➢ Strand C: Interdependence
  - ➢ Strand E: Evolution and Diversity
- ELA Standards
  - ➢ RST.11-12.3 Follow a precise multistep procedure
  - ➢ RST.11-12.2 Determine the central ideas or conclusion of a text; summarize complex concepts
- Math Standards
  - ➢ S-IC.3:
  - ➢ S-IC.6:

Enduring Understandings	Essential Questions
Students will understand that: • Estuaries are a critical habitat that provides a nursery environment for multiple marine species. • Estuaries are highly productive ecosystems. • Estuaries are dynamic, diverse ecological communities that serve as a buffer zone between land and ocean. • Human activities affect estuary systems. • An estuary is a system and something that happens in it affects the system as a whole.	• What are the characteristics of an estuary? • What are the functions of estuaries? • What are the structures that make up estuaries? • Where do large portions of ocean inhabitants begin their life cycle? • Where are estuaries located? • Does New Jersey have estuaries? • Why are estuaries critical to marine environments? • Why are estuaries important to human activities? • What happens when fresh and salt water meet?

Student Objectives

Students will be able to:

- Analyze and Explain why estuaries function as the ocean's nursery (i.e. nutrients and food sources, protection from predators, protection/shelter from elements, calm waters, etc.)
- Demonstrate how estuaries act as a buffer zone against chemical and physical environmental changes (discuss and explain sediment and filtration, floods, anaerobic bacteria, pH, grasses)
- Recognize and understand the interdependence between organisms and the estuary environment.
- Identify adaptations that allow organisms to survive in an estuary environment.
- Perform a lab experiment regarding osmosis (should include plasmolysis observation to compare contrast cellular response to salinity)
- Design an experiment using a live arthropod found in estuaries or tolerant to salinity (brine shrimp)
- Investigate characteristics of arthropods
- Research the results of sewage/chemical runoff (fertilizer and/or road salt) on the homoeostasis of an estuary environment.
- Investigate eutrophication as a negative human impact, caused by abiotic and biotic factors that affect the health of an aquatic system.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Group discussions • Reading media articles • Jig-saw estuary features • Graphic organizers • Lab demos of filtration and runoff • Compare and contrast different salinities of estuary systems in groups • Water quality testing • Picture walk and talk • Think pair share • Draw and label arthropods and fish common to estuaries	• Performance assessment on runoff and the nitrogen cycle. Read problem and hypothesize about a large die off of organisms and a sudden dead zone in a local estuary. Justify algae bloom as cause using facts from student reading. • Lab write up from water quality testing • Formal assessment of multiple choice/free response

Teaching and Learning Actions – Instructional Strategies – Activities

1. Group discussions
2. Suggested readings
3. Current events, news related articles
4. Graphic organizers for comparison
5. Research of one cause or effect of human impact on estuary environment. Pair with another student that has the corresponding cause/effect.
6. Compare adaptations to different salinities of estuaries around the world
7. Estuary web quest to research structure and functions of estuaries.
8. Water quality testing labs
9. Group research on estuary locations in New Jersey.
10. Model flow of water through a river to an estuary and out to sea using technology like Google earth, NASA, or NOAA maps
11. Perform osmosis and diffusion lab, analyze effects of placing plant cells into salt water (plasmolysis)

Vocabulary

Nutrients, nitrogen, carbon, oxygen, water quality, estuary, bay, harbor, river, river mouth, systems, storms, severe weather, coastal, salinity, fresh water, plankton, salt water, salts, solids, gases, osmosis, diffusion, nurseries, drainage

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Resources

http://people.oregonstate.edu/~doverl/SMILE/STW08/STW08%20Resources/Plankton.pdf
http://oceanservice.noaa.gov/education/yos/curriculum/Grades%208-12/est101_all.pdf
http://estuary-webquest.tripod.com
http://water.epa.gov/type/oceb/nep/
http://njseagrant.org/wp-content/uploads/2014/03/EsturaineMetaphors.pdf
http://www.harborestuary.org/pdf/teachersguide.pdf

Differentiation

Enrichment	• In-depth research on eutrophication, severe weather/storm effects on estuary, benefits of estuary presence in areas prone to storms
Intervention	• Any IEP, 504, or other modifications, group work, extra discussion time, extra time on assignments,
ELLs	• Make analogies where needed to explain estuary functions and importance, provide extra videos and illustrations, work with vocabulary and meanings, oral discussion, extra time on assessments, dual language dictionaries/translation devices

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
X	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ET*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean literacy

Notes-Observations-Reflections

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Curriculum Guide

Content Area	Marine Science	Grade Level	11-12
Topic/Concept/ Skill	**Deep Sea: Geology and Life**	Time Frame	**2 weeks**

Overview/Rationale

The bottom of our ocean is one of the least explored places in our solar system. Humans currently know more about the surface of Mars and other planets' moons, than they do about the seafloor. The largest mountain range on Earth exists under the Atlantic ocean. Hydrothermal vent communities (HTVs) flourish on volcanoes under complete darkness. As they were only discovered a little over 25 years ago, HTVs are driving today's studies using new technologies to survey the sea floor. Abiotic features covered in this unit will be centered on the extreme temperature, pressure, depth, and chemical makeup present at these places along the ocean floor. Plate tectonics will be studied as the major driving force of geological and environmental change on earth's surface as well as deep ocean basins. Ocean basin exploration is key in predicting and forecasting some of earth's most sudden natural disasters; earthquakes and tsunamis. While rare, these phenomena are examples of the invaluable existence of deep-sea research to human society. This unit should illustrate the key idea that Earth is an ever-changing biosphere to which humans and all life must continually adapt.

Desired Results

Critical Content Standards

- Ocean Literacy #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy #7: The ocean is largely unexplored.
- 5.1 Science Practices
- 5.2 Physical Science: Strand D
- 5.3 Life Science
  - ➢ Strand C: Interdependence
  - ➢ Strand E: Evolution and Diversity
- 5.4 Earth Systems Science
  - ➢ Strand B: History of Earth
  - ➢ Strand C: Properties of Earth Materials
  - ➢ Strand D: Tectonics
- ELA Standards
  - ➢ RST.11-12.3 Follow a precise multistep procedure
  - ➢ RST.11-12.2 Determine the central ideas or conclusion of a text; summarize complex concepts

Enduring Understandings	Essential Questions

Students will understand that: • The environment is a complex assemblage of interacting and evolving chemical, physical, and biological processes. • When the theory of plate tectonics was developed it unified various aspects of earth science. • Earth's crust is divided into various sized plates; their movement generates various geologic phenomena. • Plate movement is due to convection beneath crust. • HTVs involve very unique extremophile organisms that live in conditions that until recently were not probable. • Vent research is allowing scientists to better understand the earth's history and how organisms transfer energy. • Natural disasters are not necessarily preventable, but are predictable with the use of scientific tools and exploration.	• What geologic processes drive ocean floor features and changes to those features? • What scientific research contributed to the Theory of Plate Tectonics? • What are the major plates and how/why do they move? • What is bathymetry? • How does their movement influence geologic formations and also catastrophic disasters (earthquakes, volcanoes, tsunamis)? • What are Hydrothermal Vent Communities? • How are deep-ocean organisms adapted to cope with the harsh abiotic conditions of the sea floor? • How does light behave in ocean water and how does this influence the coloration and other adaptations of deep-sea animals? • How are HTV community food webs different from food webs on land or open or surface ocean?

Student Objectives

Students will be able to:
- Identify ocean floor and geologic features.
- Apply the theory of sea floor spreading to the development of topographic features
- Describe the mechanism that drives plate tectonics.
- Discuss problems scientists face in studying the deep ocean.
- Describe and communicate technologies used to study the ocean floor.
- Compare physical properties of the deep ocean to the photic zone.
- Create a Venn diagram comparing photosynthesis and chemosynthesis.
- Investigate a recent technology used to map the ocean floor from space, or from the ocean's surface.
- Differentiate between energy sources that serve bases of HTV food webs and photic zone food webs.
- Determine the effect of increased depth on pressure.
- Apply behavior of light in ocean to coloration in deep-sea animals.
- Relate adaptations of deep-sea organisms to their function in coping with abiotic factors of Deep Ocean.
- Summarize how sea floor movement and spreading contributes to geologic phenomena like earthquakes and tsunamis.
- Investigate tsunami early detection/warning systems.
- Hypothesize how humans may use knowledge of the sea floor for energy sources.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Group discussions • Individual reading and sharing of recent deep sea topics in media • Modeling or demonstrations at lab stations of plate movement • Analyze active fault lines by labeling and mapping the sea floor • Graphic organizer of geologic features • View and rate videos on geologic features and explain function of studying these features	• Create an ecological model of a HTV community and distinguish the key difference in flow of energy from most food webs • Recreate a map of Pangaea and explain in written format why earth appears so different today • Written assessment in multiple choice and free response format

Teaching and Learning Actions – Instructional Strategies – Activities

[Type here]

1. Research on extremophiles and their characteristics
2. Group discussions and investigations of geologic or technologic advances in regards to ocean floor dynamics. Engage in discussion regarding its benefits for early detection/warning systems.
3. Discuss how tech advancement has negative side as well. Cite seismic testing that occurred at Jersey shore over the summer of 2014. Have students discuss what purposes that may have scientifically, how did it affect marine life?
4. Directed reading about sea-floor discoveries in the media.
5. Mapping the ocean floor activities
6. Reconstruct Pangaea using patterns and cut-out pieces
7. Diagram/model three types of plate boundaries
8. Map out the most active fault lines and investigate the pattern
9. Create imaginary, virtual tour of a hydrothermal vent community online, share on website. Be sure to include adaptations and features unique to deep-sea animals. Justify these adaptations using abiotic factors present in environment.

Vocabulary

Boundary, plate, tectonics, divergent, convergent, transform, theory, convection, hydrothermal, vent, tsunami, rift, earthquake, ring of fire, fault, mid-ocean ridge, submersible, satellite, sonar, abyss, abyssal plain, continental shelf, trench, bathymetry

Resources

http://oceanexplorer.noaa.gov/explorations/06fire/background/edu/lessonplans.html#Grades912
http://www.csa.com/discoveryguides/vent/review2.php
http://oceanexplorer.noaa.gov/edu/curriculum/section2.pdf
http://oceanservice.noaa.gov/facts/bathymetry.html
http://www.mbari.org/earth/mar_geo/bathy/under/under_ocean.html
http://projectniu.org/lesson-plans/science/sonar-and-the-ocean-floor/
http://www.iel.spokane.edu/LNB/Web-Lessons/Instructor-Resources/Science/Docs/BathymetryTeacherLessonPlan.aspx
http://ocean.si.edu/for-educators/lessons/watered-down-topo-map

Differentiation

Enrichment	• Research and use GIS systems to investigate current studies on ocean floor mapping
Intervention	• IEP, 504 modifications where necessary, provide extra time, use visual aids, hands on map making in groups
ELLs	• Extra time, vocabulary focus, images, video research, dual language resources where necessary

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration

x	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean and Climate Literacy

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**The Open Ocean**	**Time Frame**	**2 weeks**

Overview/Rationale

It is important to discuss the open ocean as a desert type ecological space. While open ocean covers most of the planet it does not hold the most biologically diverse populations. The open ocean section should include abiotic factors such as current and the Coriolis Effect (waves/tides will be covered in the tidal and coastal sections of the course). The history of the Gulf Stream and navigation can be discussed here. Migration and schooling behaviors can also be discussed here as multiple species use currents and other aspects of the open ocean to move around to feeding and/or mating grounds. Though not full of a multitude of organisms, the open ocean is home to several well-known species, such as tuna and some sharks. Adaptations of organisms (including plankton) to an open ocean environment will be covered. Students will explore adaptations for energy conservation during long travel periods in the open ocean. Migration can be covered here (or in seasonal seas). It is important to note that species such as sea turtles have been known to cross the Atlantic ocean multiple times in their life cycle. Garbage patches can be discussed in reference to ocean gyre and human impact.

Desired Results

Critical Content Standards

- Ocean Literacy Principle #4: The ocean makes the Earth habitable.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- 5.1.12.A-D
- 5.3.12.C.1-2
- HS-LS2-1.: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2.: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6. :Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7.: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-LS2-8.: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- WHST.9-12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- MP.2: Reason abstractly and quantitatively.
- MP.4: Model with mathematics.
- HSS-IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- HSS-IC.B.6: Evaluate reports based on data.

Enduring Understandings	Essential Questions
Students will understand that: • The photic zone (top/surface of the ocean) varies greatly from the aphotic zone (lower ocean zones) when comparing both biotic and abiotic factors. • When compared to other marine communities on the planet it is important to understand the open ocean is a biological desert. • Ocean currents are like highways or "rivers" within the ocean. • Fisheries follow currents and other ecological cues to feed and mate. • Open ocean organisms (plankton and some species of fish) have specialized adaptations for survival. • Humans use open ocean currents and fishery populations for food and commercial use. • Commercial fishing has long-term effects on fish populations and sustainability.	• How are open ocean organisms (including some plankton, sharks/fish, and migratory marine mammals) adapted for this environment? • What are some common structures of fish? • How are different classes of fish adapted for ocean life? • What conservation efforts are humans using or developing to help preserve the ecology of open oceans? • How are surface currents made and affected by the Coriolis effect? • What is a gyre? • How does fishing equipment affect the amount of fish and bycatch caught in a fishery? • How can we change the way we fish to use the ocean better?
Student Objectives	

[Type here]

Students will be able to:
- Design a fish (or other open ocean creature) that is well adapted for a niche in the open ocean.
- Apply adaptations of plankton that make them well suited for drifting.
- Understand plankton means “to drift” and nekton means “to swim.”
- Label the correct external anatomy of a bony fish.
- Compare the anatomy of bony and cartilaginous fish.
- Analyze the importance of sharks to the overall balance and health of the ocean ecosystem.
- Identify human behaviors and habits that lead to disturbances of open ocean ecosystems.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• think pair share • graphic organizers of zones • jig-saw to share information in reviewing those zones • view and discuss video about GPGP • view and discuss video on bycatch • Debate commercial fishing pros and cons • Discuss adaptations of bony fish vs. cartilaginous fish	• Compare and Contrast abiotic and biotic factors of the photic vs. aphotic zone of open ocean in writing as free response • Quizzes • Multiple choice/free response test

Teaching and Learning Actions – Instructional Strategies – Activities

1. Compare primary productivity of shallow waters to that of deeper water
2. Construct a food web using sample species from an open ocean zone.
3. Research an abyssal organism.
4. Create a graphic organizer to compare different open ocean zones (photic vs. aphotic)

Vocabulary

fish, shark, cartilage, bone, gills, swim bladder, fins, pectoral, plankton, nekton, adaptations, commercial fishing, bycatch, photic, aphotic, abyssal, benthic, pelagic, oceanic, schooling behavior, migration

Resources

Survival in the open ocean: http://www.mbari.org/earth/Pelagics/survival.pdf
http://calechoes.wordpress.com/lesson-plans/
http://smithsonianeducation.org/educators/lesson_plans/ocean/acrobat/polsol.pdf
http://www.blueworldtv.com/images/uploads/lesson-plans/Lesson_Plan_Webisode21TropicalFish_Current.pdf
http://oceanservice.noaa.gov/education/kits/currents/05currents1.html
bycatch activity: http://hilo.hawaii.edu/affiliates/prism/documents/Open_Ocean_6.pdf
http://www.teachengineering.org/view_lesson.php?url=collection/uoh_/lessons/uoh_dig_mapping_less3/uoh_dig_mapping_less3.xml
http://hilo.hawaii.edu/affiliates/prism/documents/Open_Ocean_6.pdf

Differentiation

Enrichment	• Extra research assignments, self-guided learning in content area, presentations for other students, small learning group assignments, tutoring others, content area reading, faster pace as needed, wide variety of testing and assessment methods
Intervention	• Extra time and modifications as dictated in IEP/504, small learning groupings, individual time with teacher, extra focus on key vocabulary, extra practice reading, wide variety of testing and assessment methods

ELLs	• Recognize and use appropriate context, create a schema for background knowledge, extra time, utilize technology in all forms, dual language dictionary, extra focus on key vocabulary, extra practice reading, one to one teacher support, wide variety of testing and assessment methods

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:** Ocean, and Climate Literacy, Technology standards

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Open Ocean: Currents and Energy Distribution**	**Time Frame**	**1 weeks**

Overview/Rationale

This topic has been given it's own section within the Open Ocean section of the curriculum as it is the critical to the reason life exists on Planet Earth. The sea serves as the great energy distributor on our planet. The ocean is a working, observable system that makes earth habitable. Current, climate, and energy dissipation greatly influence life, both marine and terrestrial. The sun, winds, and "rivers in the sea" drive weather patterns and transfer energy and nutrients around the planet. Currents are used in navigation and greatly impact shipping routes. Science and technology are investigating currents like never before, using satellite, buoy, and other imaging data. Students should gain an understanding of how closely humans are tied to physical features of the open ocean and currents.

Desired Results

[Type here]

Critical Content Standards

- Ocean Literacy #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy #3: The ocean is a major influence on weather and climate.
- 5.1.12 Science Practices
- 5.4.12.C.1-2: Properties of Earth Materials
- 5.4.12.E.2: Energy in Earth Systems
- 5.4.12.F.2-3: Climate and weather
- HS-ESS2-1: Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2.:Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-4.:Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- WHST.9-12.1: Write arguments focused on discipline-specific content.
- SL.11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
- MP.2: Reason abstractly and quantitatively.

Enduring Understandings	Essential Questions
Students will understand that: • The ocean is one large interconnected system powered by wind, tides, and forces of earth's rotation. • The atmosphere moves in response to solar heating and Earth's rotation. • Shapes of basins and continents influence ocean circulation. • Human activities have drastic effects on the open ocean and its inhabitants. • Ocean currents influence both marine and terrestrial life. • The ocean has and will continue to have a direct and recognizable influence on climate by absorbing, storing, and moving heat, carbon, and water.	• Does the ocean have the same temperature everywhere? • How do we know ocean temperatures? • What forces are responsible for currents? • What influences direction of currents? • How do currents affect weather and climate? • How do scientists, fishermen, and boaters use buoy data? • What is an El Nino pattern?

Student Objectives

Students will be able to:

- Plot and label ocean currents on a map.
- Visualize and explain how ocean basins are connected by flow of currents.
- Recognize that these surface currents are driven by wind and the flow of ocean water is driven by wind and gravity.
- Define terms like gyre, Coriolis Effect, current.
- Relate heat capacity of the ocean to Earth's habitability.
- Analyze and identify sea surface temperatures (SST) and ocean currents using satellite data.
- Relate SST to changes in marine ecosystems and organism movement.
- Research characteristics of an El Nino weather pattern.
- Predict effect of currents changing on shipping, fishing, and/or navigation.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)

[Type here]

• Discuss energy transformations and the meaning of the Law of conservation of energy. • Map readings and labeling • Worksheets	• Write a children's book about climate and currents • Diagram and write the cause and effects of depth/pressure and the "bends" • Performance assessment • Written exam

Teaching and Learning Actions – Instructional Strategies – Activities

1. Map out and plot key areas in the ocean for current flow and gyre formation
2. Explain the Coriolis effect to another student by creating a demo that shows effect of rotation on movement
3. Investigate the formation of the Great Pacific Garbage Patch as a result of gyre activity.
4. Directed reading about the Great Pacific Garbage Patch.
5. Design a way to explain currents and their importance to the shipping or fishing industry

Vocabulary

Open ocean, Coriolis Effect, gyre, current, prevailing winds, navigation, circulation, climate

Resources

http://www.scienceoc.org/ocean-gyre-project/ocean-gyre-lesson-plans/#sthash.hAHKpz4t.dpbs
http://www.teachengineering.org/view_lesson.php?url=collection/uoh_/lessons/uoh_dig_mapping_less3/uoh_dig_mapping_less3.xml
http://www.adoptadrifter.noaa.gov/lessons/ADP_LessonPlan_Climographs_Cook.pdf
http://education-portal.com/academy/lesson/ocean-circulation-patterns-effect-on-climate.html#lesson
http://www.discoveryeducation.com/teachers/free-lesson-plans/understanding-oceans.cfm
http://hilo.hawaii.edu/affiliates/prism/documents/Open_Ocean_6.pdf

Differentiation

Enrichment	• Extra research assignments, self-guided learning in content area, presentations for other students, small learning group assignments, tutoring others, content area reading, faster pace as needed
Intervention	• Extra time and modifications as dictated in IEP/504, small learning groupings, individual time with teacher, extra focus on key vocabulary, extra practice reading
ELLs	• Recognize and use appropriate context, create a schema for background knowledge, extra time, utilize technology in all forms, dual language dictionary, extra focus on key vocabulary, extra practice reading

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E**, **T**, **A** on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration

x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:**

Notes-Observations-Reflections

Curriculum Guide

Content Area	Introduction to Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Polar Regions (Frozen Seas)**	**Time Frame**	**2-3 weeks**
Overview/Rationale			

Recent years have made polar ice regions quite popular. New research and discoveries have shown a multitude of life flourishing under what was once thought of as barren ice. Our story continues from the open ocean and currents to the Arctic and Antarctic regions of planet Earth. Salinity and temperatures here drive much of our planet's climate and seasonal changes. The very tilt of the Earth's axis causes seasonal fluctuations that take place even in the farthest reaches of the poles. Both north and south poles experience complete darkness and unsetting sun for brief times of the year. Neither region can escape the burdens of climate change. Case studies should be used in this unit to cover the effects of a changing climate on such vital and faraway regions. Students should explore the idea of glaciers and their function as fresh water storage. They should research and discover seasonal fluctuations of sea ice cover, and it's effects on everything from microorganisms, to the ever-famous polar bear (Earth's largest land carnivore). Human influence will be evaluated as it has been/should be in each unit in this curriculum. Seasonal changes in polar ice and ecosystems should lead down the globe into the next unit "Seasonal Seas."

Desired Results

Critical Content Standards

- Ocean Literacy Principle #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy Principle #3: The ocean is a major influence on weather and climate.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- HS-LS4-5.: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- HS-LS4-6.: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- HS-ESS2-4.: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- HS-ESS2-5.: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-6.: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- HS-ESS2-7.:Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
- RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- WHST.9-12.1: Write arguments focused on discipline-specific content.
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- HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Enduring Understandings	Essential Questions

Students will understand that: • Modern science and technology have contributed to the discovery of life beneath the ice in Polar Regions. • Adaptations to polar seas include changes in metabolism, structure, and behavior. • Thermohaline circulation affects all ocean water on planet earth. • Both the North and South poles are affected by climate change. • Glacier size and movement are changing in response to the climate. • Though cold, polar seas have unique qualities that allow ecosystems to flourish.	• What is a glacier? • How do temperature and salinity affect the density of water? • How/why do the Artic and Antarctic (North and South poles) differ? • Is there life under the ice in these regions? • What adaptations do organisms have to cope with the conditions and climate of Polar Regions? • How are thermohaline current different from surface currents? • Is Earth going through a warming period? • How are polar seas affected by global climate change?
Student Objectives	
Students will be able to: • Describe the unique characteristics of cold-water ecosystems. • Explain the types of technology used to survey and study glacial and polar ice. • Relate density currents and upwelling to productivity in polar sea food webs. • Observe water currents that for as a result of density and salinity differences. • Describe changes in glaciers and ice shelf data/measurements using satellite images and climatologist data. • Analyze climate change data. • Recognize the importance of currents in regulating regional climates.	
Assessment Evidence	
Formative Assessment(s)	**Summative Assessment(s)**
• Split up into small groups and jigsaw differences between arctic and Antarctic, and similarities • Design a way to show and explain the greenhouse effect. • Discussion groups • Use of video and other tech media to visualize and listen to climate change data and studies • Map out the regions and compare sea ice to glacial land ice	• Formal written test • Performance assessment • Lab write-ups
Teaching and Learning Actions – Instructional Strategies – Activities	

1. Give the “Climate Change and the Arctic: Is it True?” quiz to gauge students knowledge and beliefs pertaining to climate change in the North Pole.
2. Discuss results.
3. Assess knowledge of polar organisms by group discuss and pictures on the smart board.
4. Have them use post its to ask any questions about the Arctic and Antarctic regions.
5. Show them a greenhouse used to grow plants. Ask them why we would call a cause of climate change the “greenhouse effect”
6. Modify http://www.polarbearsinternational.org/sites/default/files/polar_bears_in_a_warming_world_activities.pdf for high school level students.
7. Case study of the Bering Sea http://www.polartrec.com/resources/lesson/salty-or-not-a-taste-of-the-bering-sea

8. Use the “you’re as cold as ice” PBS Lesson plan (objectives are 62-67)
9. Define key terms pertaining to glaciers and glaciation;
10. Describe the formation process of glaciers and glacial motion;
11. Explain several ways in which glaciers erode the land;
12. Describe features of glacial deposition and explain how they occur;
13. Recognize features of glacial erosion and deposition on landscapes;
14. Explain the relationship between glaciers/ice caps and climate patterns.
15. Use: http://www.blueworldtv.com/images/uploads/lesson-plans/Lesson_Plan_Webisode34Antarctica.pdf for self-guided inquiry research
16. Research and present info on deep-sea coral
17. Create a blog entry to explain the importance of polynyas

Vocabulary

Polar, pole, north pole, south pole, radiation, ice cover, glacier, glacial, glacial motion, erode, deep sea coral, deposition, ice caps, frozen, thermohaline, climate change, greenhouse effect, retreat, exposure, Bering sea, southern ocean, density, salinity, Antarctica, Antarctic Circle, Arctic, Arctic Circle

Resources

http://www.polartrec.com/resources/lesson/salty-or-not-a-taste-of-the-bering-sea
http://www.pbs.org/wnet/nature/lessons/youre-as-cold-as-ice/lesson-overview/1611/
http://www.polartrec.com/resources/lesson/salty-or-not-a-taste-of-the-bering-sea
http://ocean.si.edu/ocean-news/arctic-lesson-plans-noaa
http://www.pbs.org/kqed/oceanadventures/educators/arctic/
http://www.ei.lehigh.edu/eli/cc/climate_framework.pdf
http://www.encountersnorth.org/wildexplorer/lessons/polar-bears-natural-history.html
http://ocean.si.edu/for-educators/lessons/what-do-people-know-about-arctic-and-antarctic
http://dotearth.blogs.nytimes.com/2009/12/31/polar-pressure-snow-storms-and-sea-ice/?_php=true&_type=blogs&_r=0
http://ocean.si.edu/deep-sea-corals
http://www.divediscover.whoi.edu/ecosystem/links.html
http://www.polartrec.com/expeditions/spring-plankton-and-changing-ice-cover

Differentiation

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	Health Literacy	*ETA*	Communication
	Civic Literacy	*ETA*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:** Ocean climate, tech literacy

Notes-Observations-Reflections

Curriculum Guide

Content Area	Introduction to Marine Science	**Grade Level**	11-12
Topic/Concept/ Skill	**Seasonal Seas**	**Time Frame**	**2-3 weeks**
Overview/Rationale			

With the changing of seasons also comes changes in the ocean. Seasonal, or temperate waters, are one of the most important to human life. They are highly productive ecological areas and as a result are of great biological and commercial importance. The majority of seafood consumed come from these regions. Seasonal waters support both residential and migratory species. The availability of nutrients and variability of water temperature influence seasonal algae blooms. As the surface warms in the early spring, nutrients are present for the photosynthesis and growth done by phytoplankton. As a result, some of Earth's most productive ocean areas are in temperate places such as New Zealand, Patagonia, and local estuaries such as the Chesapeake Bay. This unit should stress the importance of the tilt of Earth's axis as a cause of seasonal changes (not how far we are from the sun). Seasonal changes, temperatures, and characteristics of upwellings and nutrient distribution should be discussed. Limiting nutrients and the nitrogen cycle should be revisited, as food webs collapse towards the end of summer/beginning of fall. Students should also investigate seasonal blooms globally and at different points during the year.

Desired Results

Critical Content Standards

- Ocean Literacy #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy #4: The ocean makes the Earth habitable.
- Ocean Literacy #5: The ocean supports a great diversity of life and ecosystems.
- 5.1.12
- 5.3.12.C.3
- 5.4.12.G.1-3
- HS-LS4-5.: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
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Enduring Understandings	Essential Questions

Students will understand that: • Algae can bloom seasonally • These seasonal blooms create temporary, seasonal feeding grounds. • Solar and temperature cues influences the reproduction, feeding, and movement of marine life. • Migrations of organisms such as marine mammals like whales, rely on the seasonal cues given by the sun and ocean. • Marine life success depends upon physical and biological environmental factors. • Kelp forests are an example of a seasonal and temperate sea ecosystem. • Human interactions can interfere with wildlife feeding and migratory behavior.	• What causes earth's seasonal changes? • What is an axis and how does earth sit on its axis? • If the Earth were not tlited, would energy received at different latitudes differ from each other? • Can algae/phytoplankton seasonally appear much like terrestrial plant life? • How do food webs appear and collapse during seasonal changes? • Why are temperate waters the most productive? • How do marine mammals respond to seasonal changes? • What time of year do whales and other marine migrators travel? • What is a keystone species?

Student Objectives

Students will be able to:
- Explain the change of seasons on planet Earth in terms of axial tilt, and intensity of solar radiation.
- Understand that Earth's slightly varying distance from the sun has nothing to do with seasonal changes.
- Create a diagram of seasonal influences on temperate seas.
- Outline and correlate seasonal or temperate sea area with latitudes and longitudes on a map.
- Gather evidence on the limiting factors of nutrient and light in seasonal sea areas.
- Understand that phytoplankton productivity varies with local conditions
- Compare seaweeds and marine plants to other primary producers.
- Observe migratory routes of select marine species using satellite and real time data provided by scientists and websites that track radio signals (from tags placed on fish or other animals).
- Assess a tiger shark or sea otter as a keystone species in a seasonal marine ecosystem.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Labs • Group discussion • Self-guided research on seasonal cues and migration • Read scientific articles on human impact on migration • Discuss positive and negative human influence on migratory animals • Map labeling and tracking • Explore and list how many household products have kelp, seaweed, or algae in them. Have an online discussion about it on class website	• Formal written test • quizzes • Performance assessment on keystone species and importance to seasonal plankton and grasses • Lab write-ups • Written essay predicting the effects of seasonal changes as climate warms, and ice mass is lost, explain effect of more ocean surface exposure

Teaching and Learning Actions – Instructional Strategies – Activities

1. Illustrate how the angle of insolation relates to differential heating of Earth's surface.
2. Plot location data on a map and evaluate reasons for migrations and animal movement
3. Diagram a seasonal food web. Discuss its eventual collapse.
4. Make predictions about how physical factors affect marine species migratory behavior
5. Describe scientific discoveries that were made possible by satellite technology
6. Model Earth's revolution around the sun and the changes in insolation with respect to latitude
7. List examples of animals that travel and ones that do not
8. Write and/or draw a children's comic strip that explains the reasons for seasonal changes and post it online

Vocabulary

Revolution, rotation, latitude, longitude, autumnal equinox, vernal equinox, winter solstice, summer solstice, diurnal cycle, differential heating, feeding, feeding grounds, seasonal, temperate, axis, tilt, insolation, migration, cues, response, sea grasses, kelp forest, canopy, forest floor, sea urchin, sea otter

Resources

http://www.cengage.com/resource_uploads/static_resources/0495112860/16118/Ch14.html
http://montereybay.noaa.gov/resourcepro/resmanissues/fishing.html
http://www.montereybayaquarium.org/-/m/pdf/education/activities/aquarium-poster-activity-teacher-guide.pdf
http://www2.vims.edu/bridge/search/bridge1output_menu.cfm?q=algae
http://www.nps.gov/glba/forteachers/the-kelp-forest.htm
http://www.usc.edu/org/seagrant/Education/curriculum/SC_KELP_BOOKsm2.pdf
http://education.nationalgeographic.com/archive/xpeditions/lessons/08/g35/seasshark.html?ar_a=1
http://education.nationalgeographic.com/education/encyclopedia/keystone-species/?ar_a=1
http://www.usc.edu/org/quikscience/Projects/2013/MS/SJF-LP.pdf

Differentiation

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Intervention	• Extra time and modifications as dictated in IEP/504, small learning groupings, individual time with teacher, extra focus on key vocabulary, extra practice reading, wide variety of testing and assessment methods
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In this unit plan, the following 21st Century themes and skills are addressed.

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x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration

x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:** Ocean literacy, climate literacy, technology

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12

Topic/Concept/ Skill	Reef Ecosystems	Time Frame	2-3 weeks

Overview/Rationale

When most students think of the ocean coral reefs are named as the largest and most familiar place in the sea. While they may be the most familiar, reefs are not the largest or most common ecosystems in the ocean or along coastlines. Coral reefs occupy the smallest fraction of the ocean (at about 1% of the sea floor) yet provide an environment for over a quarter of all life in the sea. This characteristic is key to understanding a single and critical idea of ecology: biodiversity. Spending instructional time on coral reef ecosystems is vital in proving the importance of biodiversity to an environmental system. Biologically diverse ecosystems are resistant to swift change and should be able to withstand significant ecological disturbances. As a result, coral reefs offer a great wealth of services to mankind. They provide food, pharmaceutical or medical benefits, protect fragile coastlines from storms, and create value in ecotourism and economies. NOAA estimates that worldwide, reefs create annual revenue of 5.5 billion dollars each year. The South Pacific reef system is estimated to be worth 2.3 billion by itself. Students should be aware of the relationship between ocean and reef biodiversity and human existence. They will research environmental problems (like marine debris, climate change, and fishing) plaguing reef systems today and explore possible solutions to save the remaining reef systems.

Desired Results

Critical Content Standards

- Ocean Literacy #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy #4: The ocean makes the Earth habitable.
- Ocean Literacy #5: The ocean supports a great diversity of life and ecosystems.
- 5.1.12
- 5.3.12.C.3
- 5.4.12.G.1-3
- HS-LS4-5.: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
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Enduring Understandings	Essential Questions
Students will understand that: • Extremely delicate and most diverse marine community, the reef, is restricted by specific environmental parameters. • Recognize the characteristics that classify coral as animals in the phylum Cnidarian. • The symbiotic (mutualistic) relationship between coral and zooxanthelle is key to the survival and construction of reef structures and ecosystems. • Coral reefs are extremely important to humans for ecological, commercial, and economic successes. • Describe how the use of technology and single use products has influenced the demography and environment of reef ecosystems.	• What characteristics classify coral as Cnidarians? • How do coral reef ecosystems form? • What symbiotic relationship is essential to formation and survival of reef systems? • What is coral bleaching? • How does the carbon cycle and ocean acidity affect animals that produce calcium carbonate structures? • How/why are reef environments and coral pertinent and vital to human economy and existence? • How do products we use on land affect coral reefs and what can humans do to solve this problem?

Student Objectives

Students will be able to:
- Explain the effects of temperature, salinity, light, pollution, and human activity on coral reef ecosystems.
- Summarize how visible light drives the mutualistic relationship between coral and zooxanthelle.
- Recognize the interdependence found between organisms within the reef environment.
- Correlate the structures of the coral polyp to its function on the reef.
- Catalog sponges and corals as animals (phylum Porifera and Cnidaria respectively)
- Distinguish between types of reef systems and their distinct characteristics.
- Connect climate change to coral reef bleaching.
- Determine the effects of natural and human influenced threats to coral reefs.
- Categorize different types of marine debris.
- Determine how a material can influence what becomes marine debris.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Group discussions • Modeling of coral reef • Jig Saw of different reef structures • Blog about current events or news articles regarding medicinal value of coral • Selection of a reef system and research of its organisms • Diagram and discussion for review of mutualistic relationships	• Formal written test using both multiple choice and free response • Lab analysis of ocean acidification experiment

Teaching and Learning Actions – Instructional Strategies – Activities

1. Use textbook and Internet to research characteristics of animals, and of Cnidaria. How/why are coral animals? Use different examples of coral to explain.
2. Draw and explain a picture of a healthy coral reef and an unhealthy coral reef in column form. Compare each side, talk with a lab partner about the differences.
3. Make a prediction about different trash items from school/home and the possibility of them becoming marine debris. Test whether it sinks or floats or could be easily carried by wind. Record data in table form. Discuss buoyancy and level or harmfulness to different marine organisms.
4. Develop a hypothesis about what items are the most harmful or abundant types of marine debris. Have groups think about how going to the beach would allow them to test their hypotheses. What other ways could they perform their research.
5. Perform a lab experiment on ocean acidification and its effects on calcium carbonate structures (use vinegar for ocean acidity and chalk or seashells for calcium carbonate). Record and analyze results.
6. Hypothesize why the mutualistic relationship between coral and zooxanthelle is so vital. Discuss when coral feed. Ask a lab partner why this is important.
7. Diagram photosynthesis.

Vocabulary

Coral, biodiversity, reef, zooxanthelle, mutualistic, human impact, marine debris, photosynthesis, acidification, calcium carbonate, polyp, interdependence, pharmaceutical, medicinal, ecological, economical, ecotourism, blast fishing, coral bleaching, nutrients, carbon cycle, juvenile fish

Resources

http://coralreef.noaa.gov/aboutcorals/values/biodiversity/
http://coral.org/coral-reefs-101/coral-reef-ecology/coral-reef-biodiversity/
http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/what_lives_on_a_coral_reef/
http://www.qm.qld.gov.au/microsites/biodiscovery/05human-impact/importance-of-coral-reefs.html
entire marine debris lesson (Hawaii standards but can be modified) http://hilo.hawaii.edu/affiliates/prism/documents/Lesson6.pdf
YouTube videos
planet earth: shallow seas
Blue Planet: Coral Reefs

Differentiation

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Intervention	• Extra time and modifications as dictated in IEP/504, small learning groupings, individual time with teacher, extra focus on key vocabulary, extra practice reading, wide variety of testing and assessment methods
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x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy		**Other Interdisciplinary standards:** Ocean, and Climate Literacy, Technology standards

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12

[Type here]

Topic/Concept/ Skill	Tidal and Intertidal Zones	Time Frame	1 week

Overview/Rationale

Studying tidal zonation will build a schema and background to successfully segue into a deeper understanding of coastal ecosystems. While the majority of the ocean is unexplored (as it is deep sea or open ocean) coastal areas are so intricate and vital for marine food webs and human survival. Navigation, port design, leisurely travel, commercial seafood production, and finally natural disasters shape they way humans live, and will live in years to come. The physical features of tidal zones make survival quite hard for the organisms that live there, and make a good case for studying adaptations. By introducing waves, tides, and tidal area changes students will be prepared for greater study of marine organisms on coastal waterways, as well as the human uses of them.

Desired Results

Critical Content Standards

- Ocean Literacy Principle #1: The Earth has one big ocean with many features.
- Ocean Literacy Principle #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- 5.1.12
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- HS-ESS2-6.: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- HS-ESS2-7.:Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
- RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- WHST.9-12.1: Write arguments focused on discipline-specific content.
- SL.11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
- MP.2: Reason abstractly and quantitatively.
  - HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Enduring Understandings	Essential Questions

Students will understand that: • Throughout the ocean there is one interconnected system powered by wind, tides, and the force of Earth's rotation. • Ocean habitats are defined by environmental factors. • Tides, waves, and predation cause vertical zonation patterns along the shore influencing distribution/diversity of organisms. • Plants and animals that live in the intertidal zone survive in dynamic and diverse conditions that change with the tide (sun exposure, temperature, salinity, etc.) • Ocean waves move energy across the surface. • Tides are the longest waves of all. • Power can be extracted from tidal motion. • Human transport, energy harvesting, and shipping routes can change the shape and biodiversity of a tidal area greatly.	• How do animals change their behavior with the tides? • Why is the Bay of Fundy significant to researching tidal zones? • What are the causes of tides? • What is a tidal bore and how are they significant? • In a diurnal tidal pattern how long is it from high tide to low tide? • How does the environment change with the tide? • What causes ocean waves? • How do waves interact with landforms? • Why is the intertidal zone such a dangerous place to live? • What adaptations allow organisms on rocky shores or in the intertidal zone to be successful? • What characteristics define echinoderms? • How do humans influence intertidal areas?

Student Objectives

Students will be able to:
- Describe the cause of tides and tidal fluctuations.
- Relate tides to the alignment and natural forces (gravitational) of Earth, sun, and moon.
- Distinguish between tides, currents, and waves.
- Explain the effects of tides on intertidal zones (temperature change, salinity, wave energy)
- Research the occurrence of tide pools
- Run an experiment to measure the amount of time that different tidal zones (high, middle, and low) spend out of the water during one tidal cycle.
- Identify and explain the ecological differences between the splash zone, intertidal zones, and subtidal zone.
- Compare adaptations needed for survival at each level of the tidal zone.
- Discuss desiccation as an effect of changing tides
- Investigate the effects of using tidal energy for power (underwater turbines, coastal windmills)
- Emphasize how tidal and intertidal animals are connected to the greater marine food web.
- Understand human influence on tidal areas
- Recognize tidal zones as part of a larger coastal ecosystem

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Labeling worksheets/diagrams of intertidal zonation • Research on adaptations for tidal zone survival • Group discussion • Individual work • Use of computer or other device to look at pictures of rocky shore ecosystems • View the "Tidal Seas" episode of Blue Planet and review clips of different tidal locations • Think-pair-share • Jig-saw • Individual work • Modeling of a tidal zone	• Formal written test • quizzes • Performance assessment • Lab write-ups

Teaching and Learning Actions – Instructional Strategies – Activities

1. After watching the episode "Tidal Seas," ask students to define the word "tide."
2. Ask students to write one example from the video of how tides affect sea life.
3. Determine the Water Level Tidal Predictions for Perth Amboy, NJ for the next month and state whether this area experience semi-diurnal, diurnal, or mixed tides
4. Complete a web quest on the Bay of Fundy and create an online video or slide show signifying the importance of this ecosystem to the greater area
5. work in pairs to create their own "Tidal Trivia" game
6. discuss specific examples of how tides affect the hunting, survival, or breeding behaviors of animals

Vocabulary

Tide, tidal, wave, forces, high tide, low tide, intertidal, subtidal, desiccation, tidal range, mean low water, physical features, moisture, homeostasis, heat balance, muscular foot, threads, osmoregulation, dynamic, diverse, pilings, mollusk, shells, zonation, ports, piers, channels, coast, starfish, echidna, cnidarian, jellyfish, harvesting

Resources

http://www.marine.ie/NR/rdonlyres/3DA7BC5C-1F8E-4417-BBBB-47B494B72FF7/0/SeashoreEcologySeashoreSurvey.pdf
http://rjd.miami.edu/assets/pdfs/learning-tools/high-school/MODULE%201%20Ocean%20and%20Coastal%20Habitat%20-%20SECTION%204%20Intertidal%20Zones.pdf
http://www.cosee-se.org/files/southeast/HomeSweetHomeintheIntertidalZone_Lesson6.pdf
http://www.sfbaymsi.org/documents/2012-2013%20Teacher%20Guides/Tidepool%20Expedition%20Educators'%20Guide.pdf
http://www.discoveryeducation.com/teachers/free-lesson-plans/blue-planet-tidal-seas.cfm
http://ciese.org/curriculum/tideproj/teachertidalzone/
http://www.mpa.nsw.gov.au/docs/final_simp_mod2.pdf
http://www.smithsonianeducation.org/educators/lesson_plans/contrast/acrobat/lesson3.pdf
https://www.bigelow.org/mitzi/images/teacher%20resources/CSI.pdf

Differentiation

Enrichment	• Extra research assignments, self-guided learning in content area, presentations for other students, small learning group assignments, tutoring others, content area reading, faster pace as needed, wide variety of testing and assessment methods
Intervention	• Extra time and modifications as dictated in IEP/504, small learning groupings, individual time with teacher, extra focus on key vocabulary, extra practice reading, wide variety of testing and assessment methods
ELLs	• Recognize and use appropriate context, create a schema for background knowledge, extra time, utilize technology in all forms, dual language dictionary, extra focus on key vocabulary, extra practice reading, one to one teacher support, wide variety of testing and assessment methods

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are E-Encouraged, T-Taught, or A-Assessed in this unit by marking E, T, A on the line before the appropriate skill.* **21st Century Skills**	
x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving

[Type here]

x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:**

Notes-Observations-Reflections

Curriculum Guide

Content Area	Marine Science	**Grade Level**	11-12

Topic/Concept/ Skill	Coastal Ecosystems	Time Frame	3-4 weeks

Overview/Rationale

Following the unit on tides and tidal fluctuations, students in this course will come "full circle" with the final ecosystem unit: Coastal areas. The beginning of coastal ecosystems should begin with a brief review of estuaries and their ecological function (both physical and biological). Identify estuaries as a part of this broader topic. From there the study of rocky shores, islands, and sandy beaches should progress. Coastal ecosystems have played a part in human history for thousands of years, most notably beginning with the importance of major societies establishing territories near access to waterways and the sea. Human economic and recreational use of coastlines has both great value and detrimental impact to the biotic and abiotic features that are found within them. These should be explored on both a local (ex: beach erosion in NJ after hurricane Sandy) to global (ex: release of ballast water from tanker ships). Commercial harvesting of seafood (such as certain mollusks) will be looked at as well. Current and future use as well as preservation of these areas will be analyzed.

Desired Results

Critical Content Standards

- Ocean Literacy Principle #1: The Earth has one big ocean with many features.
- Ocean Literacy Principle #2: The ocean and life in the ocean shape the features of Earth.
- Ocean Literacy Principle #3: The ocean is a major influence on weather and climate.
- Ocean Literacy Principle #4: The ocean makes the Earth habitable.
- Ocean Literacy Principle #5: The ocean supports a great diversity of life and ecosystems.
- Ocean Literacy Principle #6: The ocean and humans are inextricably interconnected.
- Ocean Literacy Principle #7: The ocean is largely unexplored.
- 5.1.12
- 5.3.12.C.1-2
- 5.4.12.F.2-3
- HS-ESS2-1: Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2.:Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-4.:Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- WHST.9-12.1: Write arguments focused on discipline-specific content.
- SL.11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
- MP.2: Reason abstractly and quantitatively.
-

Enduring Understandings	Essential Questions

Students will understand that: • Coastal ecosystems are areas where water and land meet to create unique ecosystems with distinct physical structures, assortments of life, and flow of energy. • Erosion occurs in coastal areas as wind, waves, and storms. • Currents in rivers, estuaries, and the ocean move sediments. • Sand consists of tiny rock, animals, plants, and minerals. • Most beach sand is eroded from land sources and carried to the coast by rivers. Sand is also eroded by coastal surf. • Investigate the effects of hurricane storm surge on low-lying areas near the coast • Determine the distance inland that the storm surge will reach • Ocean scientists are relying more and more on new technologies such as satellites, buoys, subsea observatories, and unmanned submersibles. • Human building and energy harvesting have affected marine bird and reptile species population growth. • Islands and coats are vital to the reproduction od seabirds and sea turtles, though they spend adult lives at sea. • Changing climate will directly impact coastal features with changes in weather patterns and rising sea levels. • Geologic forces, such as volcanoes, can create new island ecosystems. • As water warms it experiences thermal expansion. • Coastlines are used for energy and power by means of oil drilling, wind and wave turbines.	• How do geological, physical, and chemical processes alter the structure and function of coastal areas? • What defines a coastal ecosystem and what properties do they have in common? • What is sand and how does it give clues about where it originated? • How do physical forces such as waves, riptides, and hurricanes affect beaches? • What kind of life is found at the beach and how are they adapted to the area? • How does a hurricane's storm surge of a hurricane affect the low-lying areas along the coast? • What are gastropods and bivalves? • How are clams and oysters adapted to their environment? What ecological function do they provide for coastal structure? • How are harmful algae blooms hazardous to marine and human life? • What are islands and how can they form? • How are seabirds adapted for life? • Why are sea turtles endangered and how are humans positively and negatively affecting their lives along coastline breeding grounds? • Why are island coastlines essential to many marine vertebrates (such as marine reptiles, birds, and pinnipeds)? • What challenges do different coastal ecosystems present for their management and preservation?
Student Objectives	

Students will be able to:

- Determine the origination of sand samples based on analyzing physical properties.
- Explain how physical forces (rip currents, waves, and hurricanes) affect beaches and beach inhabitants.
- Analyze and explain the effects of manmade structures on beach erosion.
- Analyze and explain the effects of manmade structures on seabirds and sea turtles.
- Label the parts of a wave.
- Use mathematical calculations to measure the amount of beach erosion over a period of time.
- Evaluate a proposal for constructing a coastal wave power plant, wind farm, or offshore oil rig.
- Explain how to escape a rip current.
- Identify various types of life found at beaches.
- Classify gastropods and bivalves (and their shells).
- Relate structure to function of bivalves and filter feeding.
- Connect increase in nutrients to algal blooms, filter feeding of mollusks, to human health and ocean dead zones (hypoxic zones).
- Identify characteristics of cndarians and relate structure to function of jellyfish.
- Research cnidarian blooms along New Jersey coastlines and waterways in Barnegat Bay.
- Relate scuba diving with coastal exploration and research.
- Evaluate the most suitable technology for a given exploration mission of island life.
- Realize the difficulty and expense in attempting to clean up oil spills from a coastline, including organisms affected.
- Compare seals with sea lions.
- Develop a list of human actions that impact sea turtle populations.
- Recognize the importance of islands to seabirds, marine reptiles, and pinnipeds.
- Illustrate why coastal ecosystems are so particularly vulnerable to human impact.
- Explain how a country's coastal ecosystems directly and indirectly contribute to its economic and recreational resources.
- Defend the benefits of establishing marine sanctuaries, protected areas, and preservation zones.

Assessment Evidence

Formative Assessment(s)	Summative Assessment(s)
• Quizzes • Small assessments on beach ecosystems • Small assessments on climate change and erosion • Do-now questions • Duscussions (large group) • Discussions (small group) • Individual work and research using computers • Charts of ecosystem features • Graphic organizers • Homework • Readings of coastal problems in New Jerey and online blog discussions • Think-pair-share • labeling of ecosystems • Exit slips	• Written unit test • Performance assessments regarding each smaller unit (islands, beaches, human impact) • Beach ecosystem model • Island ecosystem model

Teaching and Learning Actions – Instructional Strategies – Activities

1. Model how oysters once found along the coastlines of New York to Maryland were ecologically important in food webs and physical characteristics of the coastline. http://www.mdsg.umd.edu/topics/k-12-lesson-plans/k-12-lesson-plans
2. Complete the sea-level rise experiment from epa: http://www.epa.gov/climatestudents/documents/sea-level-rise.pdf
3. Complete "Is Global Warming Affecting Hurricanes?" http://www.nwf.org/pdf/Hurricane%20Sandy/hurricane_part2.pdf
4. Have students map, simulate, calculate hurricane storm surges, damages, and increase/decrease in frequency or severity
5. Research energy and power plants near coastal areas. Investigate effects.
6. Model thermal expansion and ice melting as causes of sea level rise.
7. Explain rise in seal populations in certain coastal areas and also on coastal wave/wind turbine properties.
8. Observe sea turtles and sea birds and have students discuss the evolutionary connections between the two.
9. Analyze the ranges of sea turtles using satellite tracking and data
10. Research effects of light pollution in coastal areas.
11. Measure the effectiveness of designating marine sanctuaries.

Vocabulary

Beach, sand, coast, coastal, erosion, waves, hurricanes, sea level, thermal expansion, jellyfish, cnidarian, bloom, algae bloom, red tide, rip current, tides, bivalve, mollusk, gastropod, clam, oyster, turbines, power plant, oil rig, oil spill, island, seabird, avian, reptile, sea turtle, iguana, volcano, preservation, sanctuary, migration, light pollution, pinniped, seal, sea lion, climate change, surge, storm surge, flooding, SCUBA, submersible,

Resources

http://www.smithsonianeducation.org/educators/lesson_plans/contrast/acrobat/lesson3.pdf
https://www.bigelow.org/mitzi/images/teacher%20resources/CSI.pdf
http://www.mpa.nsw.gov.au/docs/final_simp_mod2.pdf
http://www.sfbaymsi.org/documents/2012-2013%20Teacher%20Guides/Tidepool%20Expedition%20Educators'%20Guide.pdf
http://www.usc.edu/org/cosee-west/Dec2012/Activities%20and%20lessons/MS_intertidal_ecology_PBS.pdf
http://www.discoveryeducation.com/teachers/free-lesson-plans/biomes-coastlines-and-seas.cfm
http://oceanservice.noaa.gov/education/classroom/lessons/09_coastmanag_erosion.pdf
http://oceanservice.noaa.gov/education/yos/lesson/Grades%208-12/ocean_motion.pdf
http://www2.vims.edu/bridge/search/bridge1output_menu.cfm?q=lesson&Audience=school
http://www.mdsg.umd.edu/topics/k-12-lesson-plans/k-12-lesson-plans
http://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Hurricane-Sandy/Activites-Lesson-Plans.aspx
http://www.epa.gov/climatestudents/documents/sea-level-rise.pdf
http://secoora.org/classroom/virtual_hurricane/surge_of_the_storm

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x	Global Awareness	*ETA*	Creativity and Innovation
x	Environmental Literacy	*ETA*	Critical Thinking and Problem Solving
x	Health Literacy	*ETA*	Communication
x	Civic Literacy	*ETA*	Collaboration
x	Financial, Economic, Business, and Entrepreneurial Literacy	*ETA*	**Other Interdisciplinary standards:** Ocean, climate, technology

Notes-Observations-Reflections

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

The descriptions that follow are not standards themselves but instead offer a portrait of students who meet the standards set out in this document. As students advance through the grades and master the standards in reading, writing, speaking, listening, and language, they are able to exhibit with increasing fullness and regularity these capacities of the literate individual.

They demonstrate independence.

Students can, without significant scaffolding, comprehend and evaluate complex texts across a range of types and disciplines, and they can construct effective arguments and convey intricate or multifaceted information. Likewise, students are able independently to discern a speaker's key points, request clarification, and ask relevant questions. They build on others' ideas, articulate their own ideas, and confirm they have been understood. Without prompting, they demonstrate command of standard English and acquire and use a wide-ranging vocabulary. More broadly, they become self-directed learners, effectively seeking out and using resources to assist them, including teachers, peers, and print and digital reference materials.

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They build strong content knowledge.

Students establish a base of knowledge across a wide range of subject matter by engaging with works of quality and substance. They become proficient in new areas through research and study. They read purposefully and listen attentively to gain both general knowledge and discipline-specific expertise. They refine and share their knowledge through writing and speaking.

They respond to the varying demands of audience, task, purpose, and discipline.

Students adapt their communication in relation to audience, task, purpose, and discipline. They set and adjust purpose for reading, writing, speaking, listening, and language use as warranted by the task. They appreciate nuances, such as how the composition of an audience should affect tone when speaking and how the connotations of words affect meaning. They also know that different disciplines call for different types of evidence (e.g., documentary evidence in history, experimental evidence in science).

They comprehend as well as critique.

Students are engaged and open-minded—but discerning—readers and listeners. They work diligently to understand precisely what an author or speaker is saying, but they also question an author's or speaker's assumptions and premises and assess the veracity of claims and the soundness of reasoning.

They value evidence.

Students cite specific evidence when offering an oral or written interpretation of a text. They use relevant evidence when supporting their own points in writing and speaking, making their reasoning clear to the reader or listener, and they constructively evaluate others' use of evidence.

They use technology and digital media strategically and capably.

Students employ technology thoughtfully to enhance their reading, writing, speaking, listening, and language use. They tailor their searches online to acquire useful information efficiently, and they integrate what they learn using technology with what they learn offline. They are familiar with the strengths and limitations of various technological tools and mediums and can select and use those best suited to their communication goals.

They come to understand other perspectives and cultures.

Students appreciate that the twenty-first-century classroom and workplace are settings in which people from often widely divergent cultures and who represent diverse experiences and perspectives must learn and work together. Students actively seek to understand other perspectives and cultures through reading and listening, and they are able to communicate effectively with people of varied backgrounds. They evaluate other points of view critically and constructively. Through reading great classic and contemporary works of literature representative of a variety of periods, cultures, and worldviews, students can vicariously inhabit worlds and have experiences much different than their own.

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COLLEGE AND CAREER READINESS ANCHOR STANDARDS

Reading

The K-12 standards on the following pages define what students should understand and be able to do by the end of each grade. They correspond to the College and Career Readiness (CCR) anchor standards below by number. The CCR and grade-specific standards are necessary complements—the former providing broad standards, the latter providing additional specificity—that together define the skills and understandings that all students must demonstrate.

Standards in this strand:

CCSS.ELA-Literacy.CCRA.R.1
CCSS.ELA-Literacy.CCRA.R.2
CCSS.ELA-Literacy.CCRA.R.3
CCSS.ELA-Literacy.CCRA.R.4
CCSS.ELA-Literacy.CCRA.R.5
CCSS.ELA-Literacy.CCRA.R.6
CCSS.ELA-Literacy.CCRA.R.7
CCSS.ELA-Literacy.CCRA.R.8
CCSS.ELA-Literacy.CCRA.R.9
CCSS.ELA-Literacy.CCRA.R.10

Key Ideas and Details:

CCSS.ELA-Literacy.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-Literacy.CCRA.R.2
Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCSS.ELA-Literacy.CCRA.R.3
Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

Craft and Structure:

CCSS.ELA-Literacy.CCRA.R.4
Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCSS.ELA-Literacy.CCRA.R.5
Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

CCSS.ELA-Literacy.CCRA.R.6
Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas:

CCSS.ELA-Literacy.CCRA.R.7
Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.[1]

CCSS.ELA-Literacy.CCRA.R.8
Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

CCSS.ELA-Literacy.CCRA.R.9
Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity:

CCSS.ELA-Literacy.CCRA.R.10
Read and comprehend complex literary and informational texts independently and proficiently.

Note on range and content of student reading

To build a foundation for college and career readiness, students must read widely and deeply from among a broad range of high-quality, increasingly challenging literary and informational texts. Through extensive reading of stories, dramas, poems, and myths from diverse cultures and different time periods, students gain literary and cultural knowledge as well as familiarity with various text structures and elements. By reading texts in history/social studies, science, and other disciplines, students build a foundation of knowledge in these fields that will also give them the background to be better readers in all content areas. Students can only gain this foundation when the curriculum is intentionally and coherently structured to develop rich content knowledge within and across grades. Students also acquire the habits

DRAFT

Construct Measured	Score Point 4	Score Point 3	Score Point 2	Score Point 1	Score Point 0
Reading Comprehension of Key Ideas and Details *Notes: Type of textual evidence required is grade and prompt specific and included in the scoring guide		The student response demonstrates accurate and full comprehension of the central ideas expressed in the text(s) and references the text explicitly.	The student response demonstrates accurate comprehension of the central ideas expressed in the text(s) and references the text explicitly	The student response may reference the text explicitly, but demonstrates limited comprehension of the central ideas expressed in the text(s).	The student response does not demonstrate comprehension of the ideas expressed in the text(s).
Writing Written Expression		--The student response addresses the prompt and shows effective development of the topic and/or narrative elements by using reasoning, details, text-based evidence, and/or description; the development is largely appropriate to the task and purpose. --The student response consistently demonstrates purposeful and controlled organization and includes an introduction and conclusion. --The student response uses linking words and phrases, descriptive words, and/or temporal words to express ideas with clarity.	--The student response addresses the prompt and shows some development of the topic and/or narrative elements by using some reasoning, details, text-based evidence, and/or description; the development is somewhat appropriate to the task and purpose. --The student response demonstrates purposeful and controlled organization. and includes an introduction and conclusion. --The student response uses linking words and phrases, descriptive words, and/or temporal words to express ideas with clarity.	--The student response makes reference to the topic of the prompt and develops the topic and/or narrative elements minimally by using limited reasoning, details, text-based-evidence, and/or description; the development is limited in its appropriateness to the task and purpose. --The student response demonstrates purposeful organization. that sometimes is not controlled and may or may not include an introduction and/or conclusion. --The student response uses linking words and phrases, descriptive words, and/or temporal words to express ideas with limited clarity.	--The student response may not address the prompt, does not develop the topic or narrative elements, and is therefore inappropriate to the task and purpose. --The student response demonstrates little or no organization. --The student response does not use linking words and phrases, descriptive words, and/or temporal words to express ideas with clarity.

Writing Knowledge of Language and Conventions	The student response demonstrates command of the conventions of standard English consistent with effectively edited writing. Though there may be a few minor errors in grammar and usage, meaning is clear throughout the response.	The student response demonstrates command of the conventions of standard English consistent with edited writing. There may be a few distracting errors in grammar and usage, but meaning is clear.	The student response demonstrates inconsistent command of the conventions of standard English. There are a few patterns of errors in grammar and usage that may occasionally impede understanding.	The student response demonstrates limited command of the conventions of standard English. There are multiple distracting errors in grammar and usage that sometimes impede understanding.	The student response demonstrates little to no command of the conventions of standard English. There are frequent distracting errors in grammar and usage that often impede understanding.

PARCC – GRADE 3 LAL Condensed Scoring Rubric for Prose Constructed Response Items

PARCC – GRADE 3 LAL Condensed Scoring Rubric for Prose Constructed Response Items (Cont'd)

NOTE:

- The reading dimension is not scored for elicited narrative stories.
- Per the CCSS, narrative elements in grades 3-5 may include: establishing a situation, organizing a logical event sequence, describing scenes, objects or people, developing characters personalities, and using dialogue as appropriate.
- The elements of organization to be assessed are expressed in the grade-level standards W1-W3 and elucidated in the scoring rules for each individual PCR.

Coded Responses: (All coded responses are scored with a 0 on the rubric)

A=No response
B=Response is unintelligible or undecipherable
C=Response is not written in English
D=Response is too limited to evaluate

Note—additional codes may be added after the tryout or field testing of tasks

PARCC – GRADE 4-5 ELA Condensed Scoring Rubric for Prose Constructed Response Items

Construct Measured	Score Point 4	Score Point 3	Score Point 2	Score Point 1	Score Point 0
Reading Comprehension of Key Ideas and Details *Notes The type of textual evidence required is grade and prompt specific and included in the scoring guide.		The student response provides an accurate analysis of what the text says explicitly and inferentially and references the text explicitly to support the analysis, showing full comprehension of complex ideas expressed in the text(s).	The student response provides a mostly accurate analysis of what the text says explicitly and inferentially and references the text to support the analysis, showing extensive comprehension of ideas expressed in the text(s).	The student response provides a minimally accurate analysis of what the text says and may reference the text showing limited comprehension of ideas expressed in the text(s).	The student response provides an inaccurate analysis or no analysis of the text, showing little to no comprehension of ideas expressed in the text(s).
Writing Written Expression		--The student response addresses the prompt and provides effective and comprehensive development of the topic and/or narrative elements by using clear reasoning, details, and/or description; the development is consistently appropriate to the task, purpose, and audience. --The student response demonstrates effective coherence, clarity, and cohesion and includes a strong introduction and conclusion. --The student response uses language well to attend to the norms and conventions of the discipline. The response includes concrete words and phrases, sensory details, linking and transitional words, and/or domain-specific vocabulary effectively to clarify ideas.	--The student response addresses the prompt and provides effective development of the topic and/or narrative elements by using reasoning, details, and/or description; the development is largely appropriate to the task, purpose, and audience. --The student response demonstrates coherence, clarity, and cohesion$_2$, and includes an introduction and conclusion. --The student response attends to the norms and conventions of the discipline. The response includes concrete words and phrases, sensory details, linking and transitional words, and/or domain-specific vocabulary to clarify ideas.	--The student response addresses the prompt and develops the topic and/or narrative elements minimally by using limited reasoning, details, and/or description; the development is limited in its appropriateness to the task, purpose, and/or audience. --The student response demonstrates limited coherence, clarity, and/or cohesion$_2$, and may or may not include a clear introduction and/or conclusion. -The student response shows limited awareness of the norms of the discipline. The response includes limited descriptions, sensory details, linking and transitional words, or domain-specific vocabulary to clarify ideas.	--The student response is underdeveloped and therefore inappropriate to the task, purpose, and/or audience. --The student response demonstrates a lack of coherence, clarity and cohesion. --The student response shows little to no awareness of the norms of the discipline. The student response lacks the descriptions, sensory details, linking and transitional words, or domain-specific vocabulary needed to clarify ideas.
Writing Knowledge of Language and Conventions	The student response demonstrates command of the conventions of standard English consistent with effectively edited writing. Though there may be a few minor errors in grammar and usage, meaning is clear throughout the response.	The student response demonstrates command of the conventions of standard English consistent with edited writing. There may be a few distracting errors in grammar and usage, but meaning is clear.	The student response demonstrates inconsistent command of the conventions of standard English. There are a few patterns of errors in grammar and usage that may occasionally impede understanding.	The student response demonstrates limited command of the conventions of standard English. There are multiple errors in grammar and usage demonstrating minimal control over language. There are multiple distracting errors in grammar and usage that sometimes impede understanding.	The student response demonstrates little to no command of the conventions of standard English. There are frequent and varied errors in grammar and usage, demonstrating little or no control over language. There are frequent distracting errors in grammar and usage that often impede understanding.

PARCC – GRADE 4-5 ELA Condensed Scoring Rubric for Prose Constructed Response Items (Cont'd)

NOTE:

- The reading dimension is not scored for elicited narrative stories.
- Per the CCSS, narrative elements in grades 3-5 may include: establishing a situation, organizing a logical event sequence, describing scenes, objects or people, developing characters personalities, and using dialogue as appropriate.
- The elements of organization to be assessed are expressed in the grade-level standards W1-W3 and elucidated in the scoring rules for each individual PCR.

Coded Responses: (All coded responses are scored with a 0 on the rubric)

A=No response
B=Response is unintelligible or undecipherable
C=Response is not written in English
D=Response is too limited to evaluate

Note—additional codes may be added after the tryout or field testing of tasks

PARCC – GRADE 6-11 LAL Condensed Scoring Rubric for Prose Constructed Response It

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Construct Measured	Score Point 4	Score Point 3	Score Point 2	Score Point 1	Score Point 0
Reading Comprehension of Key Ideas and Details *Notes The type of textual evidence required is grade and prompt specific and included in the scoring guide.	The student response provides an accurate analysis of what the text says explicitly and inferentially and cites convincing textual evidence to support the analysis, showing full comprehension of complex ideas expressed in the text(s).	The student response provides a mostly accurate analysis of what the text says explicitly and inferentially and cites textual evidence to support the analysis, showing extensive comprehension of ideas expressed in the text(s).	The student response provides a generally accurate analysis of what the text says explicitly or inferentially and cited textual evidence, shows a basic comprehension of ideas expressed in the text(s).	The student response provides a minimally accurate analysis of what the text says and cited textual evidence, shows limited comprehension of ideas expressed in the text(s).	The student response provides an inaccurate analysis or no analysis of the text, showing little to no comprehension of ideas expressed in the text(s).
Writing **Written Expression**	--The student response addresses the prompt and provides effective and comprehensive development of the claim, topic and/or narrative elements by using clear and convincing reasoning, details, text-based evidence, and/or description; the development is consistently appropriate to the task, purpose, and audience. --The student response demonstrates purposeful coherence, clarity, and cohesion and includes a strong introduction, conclusion, and a logical, well-executed progression of ideas, making it easy to follow the writer's progression of ideas. --The student response establishes and maintains an effective style, while attending to the norms and conventions of the discipline. The response uses precise language consistently, including descriptive words and phrases, sensory details, linking and transitional words, words to indicate tone, and/or domain-specific vocabulary.	--The student response addresses the prompt and provides effective development of the claim, topic and/or narrative elements by using clear reasoning, details, text-based evidence, and/or description; the development is largely appropriate to the task, purpose, and audience. --The student response demonstrates a great deal of coherence, clarity, and cohesion, and includes an introduction, conclusion, and a logical progression of ideas, making it fairly easy to follow the writer's progression of ideas. --The student response establishes and maintains an effective style, while attending to the norms and conventions of the discipline. The response uses mostly precise language, including descriptive words and phrases, sensory details, linking and transitional words, words to indicate tone, and/or domain-specific vocabulary.	--The student response addresses the prompt and provides some development of the claim, topic and/or narrative elements by using some reasoning, details, text-based evidence, and/or description; the development is somewhat appropriate to the task, purpose, and audience. --The student response demonstrates some coherence, clarity, and/or cohesion, and includes an introduction, conclusion, and logically grouped ideas, making the writer's progression of ideas usually discernible but not obvious. --The student response establishes and maintains a mostly effective style, while attending to the norms and conventions of the discipline. The response uses some precise language, including descriptive words and phrases, sensory details, linking and transitional words, words to indicate tone and/or domain-specific vocabulary.	--The student response addresses the prompt and develops the claim, topic and/or narrative elements minimally by using limited reasoning, details, text-based evidence and/or description; the development is limited in its appropriateness to the task, purpose, and/or audience. --The student response demonstrates limited coherence, clarity, and/or cohesion, making the writer's progression of ideas somewhat unclear. --The student response has a style that has limited effectiveness, with limited awareness of the norms of the discipline. The response includes limited descriptions, sensory details, linking or transitional words, words to indicate tone, or domain-specific vocabulary.	--The student response is underdeveloped and therefore inappropriate to the task, purpose, and/or audience. --The student response demonstrates a lack of coherence, clarity and cohesion. --The student response has an inappropriate style. The student writing shows little to no awareness of the norms of the discipline. The response includes little to no precise language.

PARCC – GRADE 6-11 LAL Condensed Scoring Rubric for Prose Constructed Response Items (cont'd)

[Type here]

Writing Knowledge of Language and Conventions	The student response demonstrates command of the conventions of standard English consistent with effectively edited writing. Though there may be a few minor errors in grammar and usage, meaning is clear throughout the response.	The student response demonstrates command of the conventions of standard English consistent with edited writing. There may be a few distracting errors in grammar and usage, but meaning is clear.	The student response demonstrates inconsistent command of the conventions of standard English. There are a few patterns of errors in grammar and usage that may occasionally impede understanding	The student response demonstrates limited command of the conventions of standard English. There are multiple errors in grammar and usage demonstrating minimal control over language. There are multiple distracting errors in grammar and usage that sometimes impede understanding	The student response demonstrates little to no command of the conventions of standard English. There are frequent and varied errors in grammar and usage, demonstrating little or no control over language. There are frequent distracting errors in grammar and usage that often impede understanding.

NOTE:

- The reading dimension is not scored for elicited narrative stories.
- The elements of coherence, clarity, and cohesion to be assessed are expressed in the grade-level standards 1-4 for writing and elucidated in the scoring guide for each PCR.
- Tone is not assessed in grade 6.
- Per the CCSS, narrative elements in grades 3-5 may include: establishing a situation, organizing a logical event sequence, describing scenes, objects or people, developing characters personalities, and using dialogue as appropriate. In grades 6-8, narrative elements may include, in addition to the grades 3-5 elements, establishing a context, situating events in a time and place, developing a point of view, developing characters' motives. In grades 9-11, narrative elements may include, in addition to the grades 3-8 elements, outlining step-by-step procedures, creating one or more points of view, and constructing event models of what happened. The elements to be assessed are expressed in grade-level standards 3 for writing and elucidated in the scoring guide for each PCR.

Coded Responses: (All coded responses are scored with a 0 on the rubric)

A=No response
B=Response is unintelligible or undecipherable
C=Response is not written in English
D=Response is too limited to evaluate

Note—additional codes may be added after the tryout or piloting of tasks

Writing Forms for Prose Constructed Response (PCR) Items:

The PARCC Summative Assessments in Grades 3-11 will measure writing using three prose constructed response (PCR) items. In the classroom writing can take many forms, including both informal and formal. Since each PCR is designed to measure both written expression and knowledge of language and conventions, the audience and form for each PCR will necessitate that students use a formal register. In addition, PARCC seeks to create items that elicit writing that is authentic for the students to be assessed. The list below represents a sample of the forms which may be elicited from students in response to PARCC Summative Assessment PCRs. This list is not designed to be exhaustive either for the PARCC assessments or the classroom. Item writers will not use the list as the definitive list of forms that can be elicited on PCRs, and teachers should not plan to use the list as a checklist of forms to be taught. Instead, the list is provided to demonstrate the wealth of forms for writing that may be used to elicit authentic student writing.
In grades 3-5, students may be asked to produce:

- Adventure stories
- Autobiography
- Biography
- Book reviews
- Brochures
- Character Sketches
- Descriptions
- Diaries
- Encyclopedia or Wiki entries
- Endings
- Essays
- Explanations
- Fables
- Fantasy stories
- Fiction
- How-to-do-it articles
- Humorous stories
- Legends
- Letters
- Magazine articles
- Myths
- News articles
- Pamphlets
- Persuasive letters
- Reports
- Reviews
- Scenes (from a play)
- Short stories
- Science articles
- Science fiction stories
- Sequels
- Speeches

In addition to those forms listed for grades 3-5, students in grades 6-8 may be asked to produce:

- Anecdotes
- Apologies
- Complaints
- Editorials
- Interviews

In addition to those forms listed for grades 3-8, students in grades 9-11 may be asked to produce:

- Satires
- Spoofs
- Testimonials

THE COMMON CORE STATE STANDARDS – ENGLISH LANGUAGE ARTS

Key Shifts in English Language Arts

Introduction

The Common Core State Standards for English Language Arts and Literacy build on the best of existing standards and reflect the skills and knowledge students will need to succeed in college, career, and life. Understanding how the standards differ from previous standards—and the necessary shifts they call for—is essential to implementing the standards well.

The following are key shifts called for by the Common Core:

1. Regular practice with complex texts and their academic language

   Rather than focusing solely on the skills of reading and writing, the ELA/literacy standards highlight the growing complexity of the texts students must read to be ready for the demands of college, career, and life. The standards call for a staircase of increasing complexity so that all students are ready for the demands of college- and career-level reading no later than the end of high school. The standards also outline a progressive development of reading comprehension so that students advancing through the grades are able to gain more from what they read.

   Closely related to text complexity and inextricably connected to reading comprehension is a focus on academic vocabulary: words that appear in a variety of content areas (such as *ignite* and *commit*). The standards call for students to grow their vocabularies through a mix of conversation, direct instruction, and reading. They ask students to determine word meanings, appreciate the nuances of words, and steadily expand their range of words and phrases. Vocabulary and conventions are treated in their own strand not because skills in these areas should be handled in isolation, but because their use extends across reading, writing, speaking, and listening.

   Because the standards are the roadmap for successful classrooms, and recognizing that teachers, school districts, and states need to decide on the journey to the destination, they intentionally do not include a required reading list. Instead, they include numerous sample texts to help teachers prepare for the school year and allow parents and students to know what to expect during the year.

   The standards include certain critical types of content for all students, including classic myths and stories from around the world, foundational U.S. documents, seminal works of American literature, and the writings of Shakespeare. The standards appropriately defer the majority of decisions about what and how to teach to states, districts, schools, and teachers.

2. Reading, writing, and speaking grounded in evidence from texts, both literary and informational

   The Common Core emphasizes using evidence from texts to present careful analyses, well-defended claims, and clear information. Rather than asking students questions they can answer

solely from their prior knowledge and experience, the standards call for students to answer questions that depend on their having read the texts with care.

The reading standards focus on students' ability to read carefully and grasp information, arguments, ideas, and details based on evidence in the text. Students should be able to answer a range of *text-dependent* questions, whose answers require inferences based on careful attention to the text.

Frequently, forms of writing in K–12 have drawn heavily from student experience and opinion, which alone will not prepare students for the demands of college, career, and life. Though the standards still expect narrative writing throughout the grades, they also expect a command of sequence and detail that are essential for effective argumentative and informative writing. The standards' focus on evidence-based writing along with the ability to inform and persuade is a significant shift from current practice.

3. Building knowledge through content-rich nonfiction

Students must be immersed in information about the world around them if they are to develop the strong general knowledge and vocabulary they need to become successful readers and be prepared for college, career, and life. Informational texts play an important part in building students' content knowledge. Further, it is vital for students to have extensive opportunities to build knowledge through texts so they can learn independently.

In K-5, fulfilling the standards requires a 50-50 balance between informational and literary reading. Informational reading includes content-rich nonfiction in history/social studies, sciences, technical studies, and the arts. The K-5 standards strongly recommend that texts—both within and across grades—be selected to support students in systematically developing knowledge about the world.

In grades 6-12, there is much greater attention on the specific category of literary nonfiction, which is a shift from traditional standards. To be clear, the standards pay substantial attention to literature throughout K-12, as it constitutes half of the reading in K-5 and is the core of the work of 6-12 ELA teachers. Also in grades 6-12, the standards for literacy in history/social studies, science, and technical subjects ensure that students can independently build knowledge in these disciplines through reading and writing. Reading, writing, speaking, and listening should span the school day from K-12 as integral parts of every subject.

THE COMMON CORE STATE STANDARDS – ENGLISH LANGUAGE ARTS

Key Design Consideration

CCR and grade-specific standards

The CCR standards anchor the document and define general, cross-disciplinary literacy expectations that must be met for students to be prepared to enter college and workforce training programs ready to succeed. The K-12 grade-specific standards define end-of-year expectations and a cumulative progression designed to enable students to meet college and career readiness expectations no later than the end of high school. The CCR and high school (grades 9-12) standards work in tandem to define the college and career readiness line—the former providing broad standards, the latter providing additional specificity. Hence, both should be considered when developing college and career readiness assessments.

Students advancing through the grades are expected to meet each year's grade-specific standards, retain or further develop skills and understandings mastered in preceding grades, and work steadily toward meeting the more general expectations described by the CCR standards.

Grade levels for K-8; grade bands for 9-10 and 11-12

The Standards use individual grade levels in kindergarten through grade 8 to provide useful specificity; the Standards use two-year bands in grades 9-12 to allow schools, districts, and states flexibility in high school course design.

A focus on results rather than means

By emphasizing required achievements, the Standards leave room for teachers, curriculum developers, and states to determine how those goals should be reached and what additional topics should be addressed. Thus, the Standards do not mandate such things as a particular writing process or the full range of metacognitive strategies that students may need to monitor and direct their thinking and learning. Teachers are thus free to provide students with whatever tools and knowledge their professional judgment and experience identify as most helpful for meeting the goals set out in the Standards.

An integrated model of literacy

Although the Standards are divided into Reading, Writing, Speaking and Listening, and Language strands for conceptual clarity, the processes of communication are closely connected, as reflected throughout this document. For example, Writing standard 9 requires that students be able to write about what they read. Likewise, Speaking and Listening standard 4 sets the expectation that students will share findings from their research.

Research and media skills blended into the Standards as a whole

To be ready for college, workforce training, and life in a technological society, students need the ability to gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and nonprint texts in media forms old and new. The need to conduct research and to produce and consume media is embedded into every aspect of today's curriculum. In like fashion, research and media skills and understandings are embedded throughout the Standards rather than treated in a separate section.

Shared responsibility for students' literacy development

The Standards insist that instruction in reading, writing, speaking, listening, and language be a shared responsibility within the school. The K-5 standards include expectations for reading, writing, speaking, listening, and language applicable to a range of subjects, including but not limited to ELA. The grades 6-12 standards are divided into two sections, one for ELA and the other for history/social studies, science, and technical subjects. This division reflects the unique, time-honored place of ELA teachers in developing students' literacy skills while at the same time recognizing that teachers in other areas must have a role in this development as well.

Part of the motivation behind the interdisciplinary approach to literacy promulgated by the Standards is extensive research establishing the need for college and career ready students to be proficient in reading complex informational text independently in a variety of content areas. Most of the required reading in college and workforce training programs is informational in structure and challenging in content; postsecondary education programs typically provide students with both a higher volume of such reading than is generally required in K-12 schools and comparatively little scaffolding.

The Standards are not alone in calling for a special emphasis on informational text. The 2009 reading framework of the National Assessment of Educational Progress (NAEP) requires a high and increasing proportion of informational text on its assessment as students advance through the grades.

Distribution of Literary and Informational Passages by Grade in the 2009 NAEP Reading Framework

Grade	Literary	Information
4	50%	50%
8	45%	55%
12	30%	70%

(2008). Reading framework for the 2009 National Assessment of Educational Progress. Washington, DC: U.S. Government Printing Office.

The Standards aim to align instruction with this framework so that many more students than at present can meet the requirements of college and career readiness. In K-5, the Standards follow NAEP's lead in balancing the reading of literature with the reading of informational texts, including

texts in history/social studies, science, and technical subjects. In accord with NAEP's growing emphasis on informational texts in the higher grades, the Standards demand that a significant amount of reading of informational texts take place in and outside the ELA classroom. Fulfilling the Standards for 6-12 ELA requires much greater attention to a specific category of informational text—literary nonfiction—than has been traditional. Because the ELA classroom must focus on literature (stories, drama, and poetry) as well as literary nonfiction, a great deal of informational reading in grades 6-12 must take place in other classes if the NAEP assessment framework is to be matched instructionally.[1] To measure students' growth toward college and career readiness, assessments aligned with the Standards should adhere to the distribution of texts across grades cited in the NAEP framework.

NAEP likewise outlines a distribution across the grades of the core purposes and types of student writing. The 2011 NAEP framework, like the Standards, cultivates the development of three mutually reinforcing writing capacities: writing to persuade, to explain, and to convey real or imagined experience. Evidence concerning the demands of college and career readiness gathered during development of the Standards concurs with NAEP's shifting emphases: standards for grades 9-12 describe writing in all three forms, but, consistent with NAEP, the overwhelming focus of writing throughout high school should be on arguments and informative/explanatory texts.[2]

Distribution of Communicative Purposes by Grade in the 2011 NAEP Writing Framework

Grade	To Persuade	To Explain	To Convey Experience
4	30%	35%	35%
8	35%	35%	30%
12	40%	40%	20%

Source: National Assessment Governing Board. (2007). Writing framework for the 2011 National Assessment of Educational Progress, pre-publication edition. Iowa City, IA: ACT, Inc.

It follows that writing assessments aligned with the Standards should adhere to the distribution of writing purposes across grades outlined by NAEP.

Focus and coherence in instruction and assessment

While the Standards delineate specific expectations in reading, writing, speaking, listening, and language, each standard need not be a separate focus for instruction and assessment. Often, several standards can be addressed by a single rich task. For example, when editing writing, students address Writing standard 5 ("Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach") as well as Language standards 1-3 (which deal with conventions of standard English and knowledge of language). When drawing evidence from literary and informational texts per Writing standard 9, students are also demonstrating their comprehension skill in relation to specific standards in Reading. When discussing something they have read or written, students are also demonstrating their speaking and listening skills. The CCR anchor standards themselves provide another source of focus and coherence.

The same ten CCR anchor standards for Reading apply to both literary and informational texts, including texts in history/social studies, science, and technical subjects. The ten CCR anchor standards for Writing cover numerous text types and subject areas. This means that students can develop mutually reinforcing skills and exhibit mastery of standards for reading and writing across a range of texts and classrooms.

What is not covered by the Standards

The Standards should be recognized for what they are not as well as what they are. The most important intentional design limitations are as follows:

1. The Standards define what all students are expected to know and be able to do, not how teachers should teach. For instance, the use of play with young children is not specified by the Standards, but it is welcome as a valuable activity in its own right and as a way to help students meet the expectations in this document. Furthermore, while the Standards make references to some particular forms of content, including mythology, foundational U.S. documents, and Shakespeare, they do not—indeed, cannot—enumerate all or even most of the content that students should learn. The Standards must therefore be complemented by a well-developed, content-rich curriculum consistent with the expectations laid out in this document.

2. While the Standards focus on what is most essential, they do not describe all that can or should be taught. A great deal is left to the discretion of teachers and curriculum developers. The aim of the Standards is to articulate the fundamentals, not to set out an exhaustive list or a set of restrictions that limits what can be taught beyond what is specified herein.

3. The Standards do not define the nature of advanced work for students who meet the Standards prior to the end of high school. For those students, advanced work in such areas as literature, composition, language, and journalism should be available. This work should provide the next logical step up from the college and career readiness baseline established here.

4. The Standards set grade-specific standards but do not define the intervention methods or materials necessary to support students who are well below or well above grade-level expectations. No set of grade-specific standards can fully reflect the great variety in abilities, needs, learning rates, and achievement levels of students in any given classroom. However, the Standards do provide clear signposts along the way to the goal of college and career readiness for all students.

5. It is also beyond the scope of the Standards to define the full range of supports appropriate for English language learners and for students with special needs. At the same time, all students must have the opportunity to learn and meet the same high standards if they are to access the knowledge and skills necessary in their post-high school lives.

   Each grade will include students who are still acquiring English. For those students, it is possible to meet the standards in reading, writing, speaking, and listening without displaying native-like control of conventions and vocabulary.

   The Standards should also be read as allowing for the widest possible range of students to participate fully from the outset and as permitting appropriate accommodations to ensure maximum participation of students with special education needs. For example, for students with

disabilities *reading* should allow for the use of Braille, screen-reader technology, or other assistive devices, while *writing* should include the use of a scribe, computer, or speech-to-text technology. In a similar vein, *speaking* and *listening* should be interpreted broadly to include sign language.

6. While the ELA and content area literacy components described herein are critical to college and career readiness, they do not define the whole of such readiness. Students require a wide-ranging, rigorous academic preparation and, particularly in the early grades, attention to such matters as social, emotional, and physical development and approaches to learning. Similarly, the Standards define literacy expectations in history/social studies, science, and technical subjects, but literacy standards in other areas, such as mathematics and health education, modeled on those in this document are strongly encouraged to facilitate a comprehensive, school wide literacy program.

Quality science education is based on standards that are rich in content and practice, with aligned curricula, pedagogy, assessment, and teacher preparation and development. It has been nearly 15 years since the National Research Council and the American Association for Advancement in Science produced the seminal documents on which most state standards are based. Since that time, major advances in science and our understanding of how students learn science have taken place and need to be reflected in state standards. The time is right to advance toward *Next Generation Science Standards*.

Next Generation Science Standards for Today's Students and Tomorrow's Workforce: Through a collaborative, state-led process managed by Achieve, new K–12 science standards have been developed that are rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education. The NGSS is based on the *Framework for K-12 Science Education* developed by the National Research Council.

The National Research Council (NRC) of the National Academy of Sciences managed the first of two steps in the creation of the *Next Generation Science Standards* by developing the *A Framework for K-12 Science Education*, which was released July 2011.

The *Framework* provides a sound, evidence-based foundation for standards by drawing on current scientific research—including research on the ways students learn science effectively—and identifies the science all K–12 students should know.

To undertake this effort, the NRC convened a committee of 18 individuals who are nationally and internationally known in their respective fields. The committee included practicing scientists, including two Nobel laureates, cognitive scientists, science education researchers, and science education standards and policy experts. In addition, the NRC used four design teams to develop the *Framework*. These four design teams, in physical science, life science, earth/space science, and engineering, developed the *Framework* sections for their respective disciplinary area.

After releasing a public draft in July of 2010, the NRC reviewed comments and considered all feedback prior to releasing the final *Framework*. The *Framework* is now being used as the foundation for the *Next Generation Science Standards* in a collaborative, state-led process that is managed by Achieve.

The Ocean Literacy Standards – Version 2 (March 2013)

What is Ocean Literacy?

Ocean literacy is an understanding of the ocean's influence on you—and your influence on the ocean. An ocean-literate person:

- **Understands the essential Principles and Fundamental concepts about the ocean;**
- **Can communicate about the ocean in a meaningful way; and**
- **Is able to make informed and responsible decisions regarding the ocean and its resources.**

This definition, the Essential Principles, and supporting Fundamental Concepts were developed through a community-wide consensus-building process. This effort built on previous work to define ocean literacy, assess what the public knows about the ocean, and redress the lack of ocean-related content in state and national science education standards, instructional materials,
and assessments.
The Essential Principles and Fundamental Concepts outlined in this guide (inside) represent content that does not always fall neatly within particular disciplines. As a result, many Fundamental Concepts illustrate more than one Essential Principle. For example, Essential Principle 4 lists only three Fundamental Concepts; however, several others could be listed as well. This demonstrates the interdisciplinary nature of ocean sciences. Educators can use these Fundamental Concepts to fulfill and go beyond the Next Generation Science Standards. They provide coordination, consistency, and coherence for ocean sciences education and are transforming the vision
of ocean literacy into reality.

The Ocean Literacy Campaign is an ongoing process. We encourage you to join in this open, participative process by signing up at **www.oceanliteracy.net** to be kept informed; following us on Twitter @4oceanliteracy and Facebook at www.facebook.com/oceanliteracy; and joining the National Marine Educators Association (www.marine-ed.org).

The Ocean is the defining feature on our blue planet. Five great, interconnected ocean basins, the Atlantic, Pacific, Indian, Arctic and Southern, make up the only ocean in our solar system, and contain 97 percent of Earth's water. The vapor released into the atmosphere returns as rain, sleet and snow, ever replenishing the planet with freshwater. All life, including our own, exists because
of the ocean. Our lives depend, now and forever, on the health of the ocean. Understanding the ocean is essential to comprehending and protecting this planet on which we live.

This guide presents a vision of an ocean-literate society. Along with the more detailed *Ocean Literacy Scope and Sequence for Grades K-12,* it outlines the knowledge required to be considered ocean literate. These two documents are a practical resource that educators and policymakers use to influence teaching and learning about the ocean throughout our schools, museums, aquariums, science centers, parks, and other informal learning environments. Several hundred leading scientists and educators contributed to the development of these consensus documents. They were used to ensure that ocean concepts are well-represented in *A Framework for K-12 Science Education* (National Academy of Sciences, 2012) and the "Next Generation Science Standards" (Achieve, Inc., 2013).

- **Using the Ocean as a Teaching Tool**

The ocean covers most of our planet, is the source of most life on Earth, regulates our weather and climate, provides most of our oxygen, and feeds much of the human population. After decades of pollution, habitat degradation and overfishing, now climate change and ocean acidification threaten the health of the ocean in unprecedented ways.

Better public understanding of the ocean is an important part of resolving these complex and critical issues. While the public generally has limited understanding of the ocean (The Ocean Project, 2009), the more people know, the more they are willing to support policies to keep the ocean healthy (Steel *et al.,* 2005). Understanding complex systems like the ocean is difficult. However, the use of models, computer simulations, and first-hand experiences strongly enhance learning and teaching (Tran, 2009). Engaging learners in experiences focused on the ocean helps them build personal connections to the ocean, coasts, and Great Lakes that motivate them to become ocean literate and to act on behalf of the ocean.

Curriculum content, instruction, and assessment all derive from accepted standards. By ensuring that ocean sciences concepts are more prominent in science standards at the national, state, and local levels, we can make certain of their incorporation throughout K–12 instructional materials, assessments, and teacher professional development.

Those who are concerned about science education
and about the future health of our ocean planet must actively promote the implementation of high quality science standards by local educational agencies, such
as school districts, state departments of education, and professional societies and associations. In order to be effective, we must agree upon and codify the essential disciplinary core ideas and practices of science related
to the ocean, coasts and Great Lakes.

- **Ocean Literacy Framework**

The Ocean Literacy Framework comprises this guide
and the more detailed *Ocean Literacy Scope and Sequence for Grades K–12*. This guide describes the 7 most important ideas, or Essential Principles, about the ocean that all students should understand by the end of high school. The Essential Principles are supported and explained by 45 Fundamental Concepts. The Scope and Sequence then provides educators with guidance as to what students need to comprehend in Grades K–2, Grades 3–5, Grades 6–8, and Grades 9–12 in order to achieve
full understanding of the Essential Principles. These progressions show how students' thinking about the ocean may develop in ever more complex ways across many years of thoughtful, coherent science instruction. The Scope and Sequence, represented in a series of conceptual flow diagrams that include cross-references, also shows how concepts about the ocean are interconnected.

The Ocean Literacy Scope and Sequence for Grades K–12 was developed through an extensive, iterative process from 2006-2010, led by the Center for Ocean Sciences Education Excellence (COSEE) California with additional support from COSEE West at University of Southern California. Over 150 members of the ocean sciences education community contributed to the final document. The Scope and Sequence was published by the National Marine Educators Association (NMEA) in March 2010 as *NMEA Special Report #3 on the Ocean Literacy Campaign*. Please see the "Honor Roll" at **www.oceanliteracy.net** for names of individuals who contributed to the development and review processes.

Development of the Ocean Literacy Framework was informed by current research on learning and teaching

science, including Learning Science in Informal Environments (National Academy of Sciences [NAS], 2009), *Taking Science to School* (NAS, 2007), and *How People Learn* (NAS, 2000). Subsequently, it was used to inform *A Framework for K-12 Science Education* (NAS, 2012) and the Next Generation Science Standards. The Ocean Literacy Framework can and has been used to guide the work of standards committees, curriculum developers, teachers, informal science educators, assessment developers, professional development providers, communications experts, and scientists engaged in education and outreach.

- **About the Ocean Literacy Campaign**

The Ocean Literacy Campaign is a wide-ranging, collaborative, and decentralized effort by hundreds of scientists and educators to create a more ocean literate society. An important component of the Campaign is the education of our K–12 students in ocean sciences through development of the Ocean Literacy Framework. These consensus documents provide formal and informal educators and curriculum and program developers with a "roadmap" that helps them build coherent and conceptually sound learning experiences for students from Kindergarten through 12th grade. Over the years, the efforts of the Campaign have been, and continue to be, supported by many organizations and the dedicated individuals within them. We continue to seek input from colleagues to expand the consensus on what is essential for students to understand about our ocean planet. This effort is only the beginning.

- **Impacts of the Campaign to Date**

Since its first publication in 2005, this guide has made a significant impact in both the scientific and education communities. Most notably, it served as a model and inspiration for other science literacy guides (e.g., climate and energy), changed guidelines for federal funding opportunities, and provided a framework for designing exhibits, courses, and instructional materials. Look up "Impacts of the Ocean Literacy Principles" on the ocean literacy website for more information. In 2013, this guide was revised to reflect continued advances in ocean sciences and in science education. Members of the original team plus several additional educators and scientists participated in the revision (see Acknowledgments on last page).

- **International Developments**

While this guide was developed for use in the United States, it has inspired several other countries and geographic regions to engage in similar processes to develop their own approaches to achieve ocean literacy. Portugal was one of the first, with Ciencia Viva leading a process to engage scientists and educators to create a similar document. The Portuguese culture and language translate "ocean literacy" into "Conhecer o Oceano" ("Knowing the Ocean") (http:// www.cienciaviva.pt/oceano/home/). Marine educators in Europe have begun a process to define ocean literacy for the European Union (http://www.emsea.eu); while in Chile, they have translated the first version of this guide into Spanish. The first version has also been translated into Chinese and Japanese.

1 The Earth has One Big Ocean with Many Features

a The ocean is the defining physical feature on our planet Earth—covering approximately 70% of the planet's surface. There is one ocean with many ocean basins, such as the North Pacific, South Pacific, North Atlantic, South Atlantic, Indian, Southern, and Arctic.

b Ocean basins are composed of the seafloor and all of its geological features (such as islands, trenches, mid-ocean ridges, and rift valleys) and vary in size, shape and features due to the movement of Earth's crust (lithosphere). Earth's highest peaks, deepest valleys and flattest plains are all in the ocean.

c Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of Earth's rotation (Coriolis effect), the Sun and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation. This "global ocean conveyor belt" moves water throughout all of the ocean basins, transporting energy (heat), matter, and organisms around the ocean. Changes in ocean circulation have a large impact on the climate and cause changes in ecosystems.

d Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.

e Most of Earth's water (97%) is in the ocean. Seawater has unique properties. It is salty, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. Balance of pH is vital for the health of marine ecosystems, and important in controlling the rate at which the ocean will absorb and buffer changes in atmospheric carbon dioxide.

F The ocean is an integral part of the water cycle and is connected to all of Earth's water reservoirs via evaporation and precipitation processes.

g The ocean is connected to major lakes, watersheds, and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments, and pollutants from watersheds to coastal estuaries and to the ocean.

h Although the ocean is large, it is finite, and resources are limited.

2 The Ocean and Life in the Ocean Shape the Features of Earth

a Many earth materials and biogeochemical cycles originate in the ocean. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.

b Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.

c Erosion—the wearing away of rock, soil and other biotic and abiotic earth materials—occurs in coastal areas as wind, waves, and currents in rivers and the ocean, and the processes associated with plate tectonics move sediments. Most beach sand (tiny bits of animals, plants, rocks, and minerals) is eroded from land sources and carried to the coast by rivers; sand is also eroded from coastal sources by surf. Sand is redistributed seasonally by waves and coastal currents.

d The ocean is the largest reservoir of rapidly cycling carbon on Earth. Many organisms use carbon dissolved in the ocean to form shells, other skeletal parts, and coral reefs.

e Tectonic activity, sea level changes, and the force of waves influence the physical structure and landforms of the coast.

3 The Ocean is a Major Influence on Weather and Climate

a The interaction of oceanic and atmospheric processes controls weather and climate by dominating the Earth's energy, water, and carbon systems.

b The ocean moderates global weather and climate by absorbing most of the solar radiation reaching Earth. Heat exchange between the ocean and atmosphere drives the water cycle and oceanic and atmospheric circulation.

c Heat exchange between the ocean and atmosphere can result in dramatic global and regional weather phenomena, impacting patterns of rain and drought. Significant examples include the El Niño Southern Oscillation and La Niña, which cause important changes in global weather patterns because they alter the sea surface temperature patterns in the Pacific.

d Condensation of water that evaporated from warm seas provides the energy for hurricanes and cyclones. Most rain that falls on land originally evaporated from the tropical ocean.

e The ocean dominates Earth's carbon cycle. Half of the primary productivity on Earth takes place in the sunlit layers of the ocean. The ocean absorbs roughly half of all carbon dioxide and methane that are added to the atmosphere.

F The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon, and water. Changes in the ocean's circulation have produced large, abrupt changes in climate during the last 50,000 years.

g Changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences.

4 The Ocean made Earth Habitable

a Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean. This accumulation of oxygen in Earth's atmosphere was necessary for life to develop and be sustained on land.

b The ocean is the cradle of life; the earliest evidence of life is found in the ocean. The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.

c The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for life to exist on Earth (Essential Principles 1, 3, and 5).

5 The Ocean Supports a Great Diversity of Life and Ecosystems

a Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.

b Most of the organisms and biomass in the ocean are microbes, which are the basis of all ocean food webs. Microbes are the most important primary producers in the ocean. They have extremely fast growth rates and life cycles, and produce a huge amount of the carbon and oxygen on Earth.

c Most of the major groups that exist on Earth are found exclusively in the ocean and the diversity of major groups of organisms is much greater in the ocean than on land.

d Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.

e The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.

F Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life.

g There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps, rely

only on chemical energy and chemosynthetic organisms to support life.

h Tides, waves, predation, substrate, and/or other factors cause vertical zonation patterns along the coast; density, pressure, and light levels cause vertical zonation patterns in the open ocean. Zonation patterns influence organisms' distribution and diversity.

i Estuaries provide important and productive nursery areas for many marine and aquatic species.

6 The Ocean and Humans are Inextricably Interconnected

a The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. The ocean moderates the Earth's climate, influences our weather, and affects human health.

b The ocean provides food, medicines, and mineral and energy resources. It supports jobs and national economies, serves as a highway for transportation of goods and people, and plays a role in national security.

c The ocean is a source of inspiration, recreation, rejuvenation, and discovery. It is also an important element in the heritage of many cultures.

d Humans affect the ocean in a variety of ways. Laws, regulations, and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non- point source, and noise pollution), changes to ocean chemistry (ocean acidification), and physical modifications (changes to beaches, shores, and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

e Changes in ocean temperature and pH due to human activities can affect the survival of some organisms and impact biological diversity (coral bleaching due to increased temperature and inhibition of shell formation due to ocean acidification).

F Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).

g Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

7 The Ocean is Largely Unexplored

a The ocean is the largest unexplored place on Earth—less than 5% of it has been explored. The next generation of explorers and researchers will find great opportunities for discovery, innovation, and investigation.

b Understanding the ocean is more than a matter of curiosity. Exploration, experimentation, and discovery are required to better understand ocean systems and processes. Our very survival hinges upon it.

c Over the last 50 years, use of ocean resources has increased significantly; the future sustainability of ocean resources depends on our understanding of those resources and their potential.

d New technologies, sensors, and tools are expanding our ability to explore the ocean. Scientists are relying more and more on satellites, drifters, buoys, subsea observatories, and unmanned submersibles.

e Use of mathematical models is an essential part of understanding the ocean system. Models help us understand the complexity of the ocean and its interactions with Earth's interior, atmosphere, climate, and land masses.

F Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.