ESL
SCIENCE
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BILINGUAL
PRESCHOOL
MATHEMATICS
LIBRARY MEDIA
SOCIAL STUDIES
WORLD LANGUAGES
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TECHNOLOGY EDUCATION
ENGLISH LANGUAGE ARTS
FINE & PERFORMING ARTS
FAMILY & CONSUMER SCIENCE
HEALTH & PHYSICAL EDUCATION

RAHWAY PUBLIC SCHOOLS

CURRICULUM & INSTRUCTION

Content Area: Science

Course: Marine Science

Grade Level: 11-12

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Jeffery Kurczeski,

Program Supervisor of 7-12 Math & Science and 9-12 Business & Technology Education

The Board acknowledges the following who contributed to the preparation of this curriculum.

Adrienne Savard, Science Teacher

Dr. Tiffany A. Beer, Director of Curriculum and Instruction

Subject/Course Title:
Marine Science
Grades 11-12

Date of Board Adoption:
August 26, 2025

RAHWAY PUBLIC SCHOOLS CURRICULUM

Marine Science: Grades 11-12

PACING GUIDE

Unit	Title	Pacing
1	Introduction to Marine Science	2 weeks
2	The Ocean Seafloor	3 weeks
3	Properties and Chemistry of the Ocean	3 weeks
4	Marine Physics and Energy	3 weeks
5	Biodiversity of Ocean Ecosystems	5 weeks
6	Human Impact on Oceans and Climate Change	4 weeks

ACCOMMODATIONS

504 Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Provide extra visual and verbal cues and prompts.
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages).
- Provide study sheets and teacher outlines prior to assessments.
- Quiet corner or room to calm down and relax when anxious.
- Reduction of distractions.
- Permit answers to be dictated.
- Hands-on activities.
- Use of manipulatives.
- Assign preferential seating.
- No penalty for spelling errors or sloppy handwriting.
- Follow a routine/schedule.
- Provide student with rest breaks.
- Use verbal and visual cues regarding directions and staying on task.
- Assist in maintaining agenda book.

IEP Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Differentiate reading levels of texts (e.g., Newsela).
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide extra visual and verbal cues and prompts.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Provide students with additional information to supplement notes.
- Modify questioning techniques and provide a reduced number of questions or items on tests.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Provide study sheets and teacher outlines prior to assessments.
- Use of manipulatives.
- Have students work with partners or in groups for reading, presentations, assignments, and analyses.
- Assign appropriate roles in collaborative work.
- Assign preferential seating.
- Follow a routine/schedule.

Gifted and Talented Accommodations:

- Differentiate reading levels of texts (e.g., Newsela).
- Offer students additional texts with higher lexile levels.
- Provide more challenging and/or more supplemental readings and/or activities to deepen understanding.
- Allow for independent reading, research, and projects.
- Accelerate or compact the curriculum.
- Offer higher-level thinking questions for deeper analysis.
- Offer more rigorous materials/tasks/prompts.
- Increase number and complexity of sources.
- Assign group research and presentations to teach the class.
- Assign/allow for leadership roles during collaborative work and in other learning activities.

ELL Accommodations:

- Provide extended time.
- Assign preferential seating.
- Assign peer buddy who the student can work with.
- Check for understanding frequently.
- Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc…).
- Have student repeat directions.
- Make vocabulary words available during classwork and exams.
- Use study guides/checklists to organize information.
- Repeat directions.
- Increase one-on-one conferencing.
- Allow student to listen to an audio version of the text.
- Give directions in small, distinct steps.
- Allow copying from paper/book.
- Give student a copy of the class notes.

	● Provide written and oral instructions. ● Differentiate reading levels of texts (e.g., Newsela). ● Shorten assignments. ● Read directions aloud to student. ● Give oral clues or prompts. ● Record or type assignments. ● Adapt worksheets/packets. ● Create alternate assignments. ● Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted. ● Allow student to resubmit assignments. ● Use small group instruction. ● Simplify language. ● Provide scaffolded vocabulary and vocabulary lists. ● Demonstrate concepts possibly through the use of visuals. ● Use manipulatives. ● Emphasize critical information by highlighting it for the student. ● Use graphic organizers. ● Pre-teach or pre-view vocabulary. ● Provide student with a list of prompts or sentence starters that they can use when completing a written assignment. ● Provide audio versions of the textbooks. ● Highlight textbooks/study guides. ● Use supplementary materials. ● Give assistance in note taking ● Use adapted/modified textbooks. ● Allow use of computer/word processor. ● Allow student to answer orally, give extended time (time-and-a-half). ● Allow tests to be given in a separate location (with the ESL teacher). ● Allow additional time to complete assignments and/or assessments. ● Read question to student to clarify. ● Provide a definition or synonym for words on a test that do not impact the validity of the exam. ● Modify the format of assessments. ● Shorten test length or require only selected test items. ● Create alternative assessments. ● On an exam other than a spelling test, don’t take points off for spelling errors.

UNIT 1 OVERVIEW

Content Area: Science

Unit Title: Introduction to Marine Science

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: The first two weeks of this course will be dedicated to students activating their prior knowledge of ecology and biology. With this knowledge, we will discuss how marine science is a very specific branch of ecology, biology, geology, chemistry, and other aspects of environmental science coming together in our oceans and waterways. This is extremely important because the oceans connect the entire Earth. Students will also evaluate and explore different ways that humans rely on the oceans. To further engage students, we will discuss our local waterways and their importance (Atlantic Ocean, Rahway River, and the Hudson River). This unit is meant to get the students engaged in the course, activate prior knowledge, and bring the importance of marine science into their everyday lives.

Approximate Length of Unit: 2 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-LS2-6 Evaluate 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-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Science & Engineering Practices:

Constructing Explanations and Designing Solutions

- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Engaging in Argument from Evidence

- Construct an oral and written argument or counter-arguments based on data and evidence.

Disciplinary Core Ideas:

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

HS-ESS1.C: The History of Planet Earth

- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.

HS-ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

HS-ESS2.E: Biogeology

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Cross-Cutting Concepts:

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.IML.3 Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Unit Understandings:

Students will understand that…

- The ocean is changing throughout time naturally and with human impact.
- Different events throughout time have changed Earth's oceans.
- Marine ecosystems are different from each other depending on where they are located on Earth.
- Marine science is a collection of different sciences focused on the ocean.

Unit Essential Questions:

- What is marine science?
- How has the ocean changed throughout time?
- Which events have changed the Earth's oceans?
- Where are different marine ecosystems located on Earth?
- How are marine ecosystems different from each other?

Knowledge and Skills:
Students will know…

- The location of the oceans on Earth.
- The location of varying marine ecosystems on Earth.
- The timeline of events that have happened on Earth and how they have impacted the oceans.
- How humans use the ocean.
- The history behind the Rahway River and the Hudson River.

Students will be able to …

- Activate prior knowledge about ecosystems (biotic and abiotic factors)
- Ask questions about marine science.
- Research information about a marine ecosystem.
- Locate marine ecosystems on a global map.
- Explain why marine ecosystems are important.
- Evaluate how humans use and impact the ocean.
- Construct a timeline of the history of Earth's oceans.
- Explain the importance of our local waterways to our lives.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- Do now questions
- Exit ticket questions
- Claim, Evidence, Reasoning Activities
- Prior knowledge pre-assessment
- Students' collaboration with each other
- Review questions

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Individual research with teacher feedback
- Class and individual diagramming
- Peer-to-peer presentations
- Using maps as a class and individually
- Experiments and analysis of data
- Marine Ecosystem Research Project
- Locating different ecosystems on a world map
- Ocean Timeline Activity
- Map and History of the Local Waterways
- Exploring Biodiversity in Marine Ecosystems

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Large world map
- Classroom computer and projector
- Student Chromebooks
- Local waterways map

UNIT 2 OVERVIEW

Content Area: Science

Unit Title: Exploring the Seafloor

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: Within this unit, students will explore different topographical features of the ocean floor. Students will create and evaluate models of the seafloor and learn how scientists figure out these features with measurements and sonar technology. The geological aspects of the ocean will be investigated with learning in depth about the different boundaries or Earth's crust and how plate tectonics plays a role in the past and future of Earth's oceans. Evidence for plate tectonics will also be used to make diagrams and predict movement of these plates throughout time. Students will also begin to see how different aspects of the ocean interconnect by looking at how populations respond to the seafloor formations to guide migration patterns.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

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-ESS2-3 Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

Science & Engineering Practices:

Engaging in Argument from Evidence

- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas:

HS-ESS1.C: The History of Planet Earth

- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.

HS-ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a

model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.

HS-ESS2.B: Plate Tectonics and Large Scale System Interactions

- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.

HS-ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space.

Cross-Cutting Concepts:

Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.IML.3 Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Unit Understandings:

Students will understand that…

- The Earth is made up of different layers.
- The crust of the Earth is made up of different separate plates that move toward each other, away from each other, and slide against each other.
- How to read an oceanic topographic map called a bathymetry.
- Plate tectonics is forever changing the geology of the Earth's land and oceans.
- The ocean floor is made up of different geological features, just like the land is.
- Scientists can estimate the sizes and shapes of these features by using different technologies.
- We can estimate how far certain areas of land are going to move by observing plate tectonics.

- Different populations rely on the features of the seafloor for survival.

Unit Essential Questions:

- How do the Earth's layers interact with each other?
- What is the evidence for plate tectonics?
- What happens when two different plates move toward or away from each other?
- How does plate tectonics change the Earth's land and oceans?
- How do the different features of the seafloor influence marine life?
- How do scientists measure and observe the features of the seafloor?

Knowledge and Skills:

Students will know…

- Different features of the seafloor, like trenches, ridges, and shelves.
- How to model the features of the seafloor.
- How scientists use sonar to measure the seafloor.
- The different plates of the Earth's crust and where they are located on Earth.
- The three boundaries of plates (transform, divergent, and convergent).
- Which plates are moving toward or away from each other.
- Seals, penguins, and whales are some of the populations that use the seafloor for survival.

Students will be able to …

- Evaluate topographical maps.
- Explain different features of the seafloor and how scientists view these features.
- Differentiate between the features of the seafloor.
- Model different features of the seafloor.
- Use evidence from measurements to conclude different features of a seafloor.
- Graph seafloor features.
- Explain how sonar is used to measure various features of the ocean.
- Use evidence to explain plate tectonics.
- Explain the three different plate boundaries and the consequences of these interactions.
- Compare how marine populations use the seafloor for survival.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- Do Now questions
- Discussion questions
- Claim, Evidence, Reasoning Activities
- Review questions

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Notes and diagrams of the seafloor features
- Modeling seafloor features with peers
- Using evidence from models with peers

- Using equations
- Experiments and analysis of data
- Full class discussions and small group discussions
- Analyzing data from graphs
- Mapping and Diagramming Plate Tectonics
- Measuring and Graphing the Seafloor Features
- Models of the Seafloor
- Sonar calculations
- Seafloor Quiz
- Calculating the Rates of Movement of Plates
- Marine mammal diving diagramming questions

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Classroom computer and projector
- Student Chromebooks

UNIT 3 OVERVIEW

Content Area: Science

Unit Title: The Properties and Chemistry of the Ocean

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: Within this unit students will explore the different properties of the ocean, specifically salinity, temperature, transparency, density, and pressure. They will begin by investigating the structure and chemistry of the water molecule. Students will then begin to question what else we find in the oceans' water besides just water? Salts and salinity of the ocean has a relationship with the life within those ecosystems as well as the density of salt water versus fresh water. We find many other elements within the ocean that help sustain life like oxygen, carbon, nitrogen, and phosphorus. Students will experiment with different concentrations of dissolved oxygen and carbon within salt water, and analyze how those amounts affect life. We will begin to delve into ocean acidification and human impacts on the oceans.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-LS1-6 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

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-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Science & Engineering Practices:

Constructing Explanations and Designing Solutions

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or components of a system.
- Use a model to provide mechanistic accounts of phenomena.

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Obtaining, Evaluating, and Communicating Information

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Disciplinary Core Ideas:

HS-LS1.C: Organization for Matter and Energy Flow in Organisms

- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

HS-LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

HS-ESS2.A: Earth Materials and Systems

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

HS-ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

HS-ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

HS-PS1.B: Chemical Reactions

- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

HS-PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Cross-Cutting Concepts:

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- The total amount of energy and matter in closed systems is conserved.

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.
- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.IML.3 Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Unit Understandings:

Students will understand that…

- The properties of a water molecule.
- Other elements are commonly found within the ocean.
- Water has different densities at different phases.
- Salt impacts the density of water.
- The ocean is the lowest point on the Earth; therefore, salt in the ocean comes from the land.
- Saltwater impacts the temperature of the ocean.
- Dissolved oxygen in the ocean is essential for life.

- The ocean is a carbon sink, and high amounts of carbon dioxide in the ocean lead to ocean acidification.

Unit Essential Questions:

- What is in ocean water?
- What are the different properties of the ocean?
- Where does the salt come from?
- Which elements are mostly found in oceans to support life?
- How do organisms breathe underwater?
- How is salinity and temperature related?
- How much dissolved oxygen do different ocean ecosystems need to sustain life?
- What makes the ocean more acidic?
- How does ocean acidification affect life and the properties of the ocean?

Knowledge and Skills:

Students will know...

- The ocean is not just water molecules; it contains salts, oxygen, carbon, and many other elements to support life.
- Scientists study salinity, density, temperature, and other factors of the ocean.
- Salt comes from the land, and the deeper the ocean is, the saltier it is.
- Organisms that breathe underwater must have a certain amount of dissolved oxygen in the water to live. Not all organisms metabolize oxygen.
- The ocean is a carbon sink, and as the levels of carbon dioxide increase in the atmosphere, they increase in the oceans, causing ocean acidification, which is negatively affecting many ecosystems.

Students will be able to…

- Compare and contrast the heating and cooling of freshwater and saltwater.
- Analyze the different properties of the ocean and explain how they impact each other and marine organisms.
- Determine whether substances will float or sink in water, based on their densities.
- Describe the relationship between water temperature and dissolved oxygen.
- Analyze evidence about the amounts of dissolved oxygen and marine life.
- Observe how carbon dioxide sinks into the ocean from the atmosphere.
- Explain how carbon dioxide in water impacts the pH of water (ocean acidification).
- Collect and analyze data to explain ocean acidification.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- Do Now questions
- Discussion questions
- Claim, Evidence, Reasoning Activities
- Review questions

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Notes and diagrams
- Using evidence from models with peers
- Using equations
- Experiments and analysis of data
- Full class discussions and small group discussions
- Analyzing data from experimentation & graphs
- Temperature of the Ocean Experiment - data collected and analysis
- Density of the Ocean Experiment - data collection and analysis
- Dissolved Oxygen Experiment - data collection and analysis
- pH of Water and the Ocean Experiment - data collection and analysis
- Ocean Acidification Experiment - data collection and analysis

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Classroom computer and projector
- Student Chromebooks

UNIT 4 OVERVIEW

Content Area: Science

Unit Title: Marine Physics and Energy

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: This unit will focus on the different types of energy that deal with the ocean and marine ecosystems. Students will begin by exploring the sun and how solar radiation makes its way to the Earth to give this planet energy. The energy from the sun is distributed unequally due to the tilt of the Earth, which creates differences in sea surface temperatures. Ocean currents move different temperature water around the Earth, which could explain the movement of marine animals. Students will consider their own experiences with water's high heat capacity and compare heat capacities of land and water through experimentation. Students will also learn about the conservation of energy and analyze the transfer of energy within a system. Waves are another aspect of the ocean that has to do with energy. Students will explore the physics behind waves and use their knowledge to predict tsunamis.

Approximate Length of Unit: 3 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS4-1 Use mathematical representation to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.

Science & Engineering Practices:

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system.
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas:

HS-PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually

transferred from one object to another and between its various possible forms.

HS-PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.

HS-PS4.A: Wave Properties

- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

HS-ESS1.A: The Universe and Its Stars

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.

Cross-Cutting Concepts:

Systems and System Models

- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.IML.3 Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Unit Understandings:

Students will understand that…

- There are many different forms of energy, and they all allow things to happen (do work). The polar regions receive less solar radiation than the equatorial region of the Earth due to the tilt of the Earth, which is called differential heating.
- The electromagnetic spectrum includes many different types of waves from the sun.
- Marine mammals base their lives around differential heating of the oceans.
- Warm water is less dense than cold water.
- Currents in the ocean cause different temperatures of water to move around the Earth.
- It takes a lot more energy to heat up the ocean than it does the land, but once the ocean is heated, it takes a long time to lose its energy.

- The major parts of a wave.
- The ratio of a wave's height to wavelength can tell us information about a wave, like when it's going to break.
- There are different types of waves.
- A tsunami is a shallow water wave triggered by displacements of a large amount of water.
- Wave physics can help scientists predict tsunamis and their location.

Unit Essential Questions:

- What different types of energy come from the sun?
- Which sections of the Earth receive the most sun?
- How do the different types of energy from the electromagnetic spectrum compare to each other?
- How do marine animals use the ocean's heat for survival?
- How do currents impact the temperature of the ocean in different locations?
- What are the different features of a wave?
- How do scientists predict tsunamis?

Knowledge and Skills:

Students will know…

- Warmer water is at the equator, and cooler water is at the poles due to the tilt of the Earth and how the sun hits it.
- The Sun's radiation travels to Earth through Space in the form of waves.
- The electromagnetic spectrum includes Gamma Rays, X-rays, UV, Visible light, Infrared Red, Microwaves, and Radio waves.
- The major parts of a wave are the crest, trough, height, wavelength, and period.
- The ratio of a wave's height to wavelength can tell us information about a wave, like when it's going to break.
- There are shallow and deep water waves.
- A tsunami is a shallow water wave triggered by displacements of a large amount of water.
- Wave physics can help scientists predict tsunamis and their location.

Students will be able to…

- Model how the angle of isolation from the sun relates to differential heating of the Earth's surface.
- Give examples of how marine animals respond to seasonal cues.
- Differentiate between types of incoming solar radiation.
- Indicate that energy in the ocean is distributed through currents.
- Identify sea surface temperature (SST) and ocean currents from satellite imagery.
- Explain the concept of heat capacity and the role of the ocean in moderating Earth's climate.
- Demonstrate the Law of Conservation of Energy in various scenarios of energy transformation.
- Define a wave and the terminology commonly used to describe the anatomy and movement of a wave.
- Differentiate between shallow and deep water waves.
- Predict when tsunamis originating at specific locations will affect nearby areas.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- Do Now questions
- Discussion questions
- Claim, Evidence, Reasoning Activities
- Review questions

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Notes and diagrams
- Using evidence from models with peers
- Using equations
- Experiments and analysis of data
- Full class discussions and small group discussions
- Analyzing data from experimentation & graphs
- Solar Radiation Graphing
- Sea surface temperature maps
- Investigating Warm and Cold water experiment & analysis
- The Ocean Helps Earth Support Life Experiment
- Wavelength Calculations
- Can You Outrun a Tsunami? Activity

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Teacher computer and Newline Board
- Student Chromebooks

UNIT 5 OVERVIEW

Content Area: Science

Unit Title: Biodiversity of Marine Ecosystems

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: The biodiversity of organisms in ecosystems is the key to a healthy environment. Populations naturally change over time, but we are seeing more and more evidence that humans are impacting populations as well. Organisms have specialized adaptations to survive in these changing environments. Due to these changing environments, organisms with the best adaptations survive to reproduce. These organisms also rely on the abiotic and biotic factors within their habitat. The base of these ecosystems is the producers, specifically phytoplankton in the oceans. The health of the ecosystems relies on these microscopic organisms. Students will use Earth imagery to predict where marine animals will feed, and if algal blooms are becoming dangerous. Students will also explore the invertebrates of the ocean, which consist of 97% of the animal species on Earth. Students will begin to work on their final projects during this unit, which will entail a presentation component during their final exam. For their final projects, students will identify a problem within marine science that they would like to investigate.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

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.

HS-LS2-6 Evaluate 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-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices:

Developing and Using Models

- Use a model based on evidence to illustrate the relationships between systems or between components of a system.

Using Mathematics and Computational Thinking

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations.

Asking Questions and Defining Problems

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions.

Constructing Explanations and Designing Solutions

- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Ideas:

HS-LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

HS-LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

HS-LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

Delimiting Engineering Problems:

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

HS-ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Cross-Cutting Concepts:

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

Energy and Matter

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Influence of Science, Engineering, and Technology on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Career Readiness, Life Literacies, and Key Skills:

9.1.12.CFR.2 Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions.

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.GCA.1 Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.5 Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6 Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Unit Understandings:

Students will understand that…

- Producers and consumers have a relationship within food webs.
- Phytoplankton is the base of marine food webs.
- Different populations have different trends of growth depending on environmental factors.
- Certain populations need human protection.

- Abiotic and biotic factors could influence population size.
- Populations change over time as their environment changes.
- Only individuals with favorable adaptations will survive to reproduce, passing on those favorable traits to offspring.
- Different marine ecosystems cater to different adaptations of organisms.
- Invertebrates are an important part of every marine ecosystem
- Invertebrates are extremely diverse, consisting of 97% of animals on Earth.

Unit Essential Questions:

- Which factors impact marine populations?
- What is the Endangered Species Act?
- How do populations change with a changing environment?
- Which adaptations are best for which marine ecosystems?
- In which ways is phytoplankton important to ocean life?
- How can scientists look at chlorophyll maps to predict marine life feedings?
- How does structure relate to function in invertebrates?

Knowledge and Skills:

Students will know….

- Factors like food availability, reproduction rate, protection, predation, etc., influence marine populations.
- Marine populations have unique adaptations through natural selection based on which marine ecosystem they live in.
- The Endangered Species Act protects biodiversity in the oceans and the land.
- Invasive species tend to outcompete native species, leading toa loss of biodiversity.
- Phytoplankton populations have to be healthy in order for the rest of the food web to be healthy.
- Marine life follows phytoplankton populations.
- Marine invertebrates have specialized internal and external structures to support hunting and transportation.

Students will be able to …

- Identify the factors that increase or decrease population sizes and analyze changes in animal populations.
- Describe the importance of the Endangered Species Act and give examples of species that are listed under the Act.
- Explain how the process of natural selection influences the evolution of species.
- Determine how invasive species can result in biodiversity loss.
- Give examples of adaptations in diverse marine ecosystems.
- Construct a marine food web.
- Describe how phytoplankton influence marine food webs.
- Model how nutrient cycling is essential to the ocean system.
- Identify organisms classified into the major invertebrate phyla.
- Explain how the structure of marine invertebrates relates to their function.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

- End of Unit Common Assessment - See folder for assessment links.
- Do Now questions
- Discussion questions
- Claim, Evidence, Reasoning Activities
- Formative assessment quizzes
- Review questions

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Notes and diagrams
- Using evidence from models with peers
- Using equations
- Experiments and analysis of data
- Full class discussions and small group discussions
- Analyzing data from experimentation & graphs
- Food Web Analysis
- Photosynthesis and Carbon Cycle Activity
- Virtual Plankton Lab Activity
- Local plankton field & lab experiment
- Marine Population Analysis
- Endangered Species Project

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Teacher computer and Newline Board
- Student Chromebooks

UNIT 6 OVERVIEW

Content Area: Science

Unit Title: Human Impact on the Ocean and Climate Change

Target Course/Grade Level: Marine Science/Grades 11-12

Unit Summary: Students will begin this unit by exploring what happens to a marine ecosystem when too many nutrients get into the water from the land. Phytoplankton blooms are common at the mouth of the Mississippi, which leads to dead zones directly related to nutrients coming off farm land in the Midwest. Students will analyze these problems, along with being introduced to other marine nonpoint and point pollution. Polluting our waters is not the only way humans are impacting oceans. We are also directly impacting coastlines, marine ecosystems, and biodiversity populations by overfishing and changing the climate. Scientists have the technology to predict how a hurricane will impact the coastline, how much land will be underwater in the next 50 years with rising sea levels, and the future of biodiversity for these marine ecosystems.

Approximate Length of Unit: 4 weeks

LEARNING TARGETS

NJ Student Learning Standards:

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices:

Constructing Explanations and Designing Solutions

- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Analyzing and Interpreting Data

- Analyze data using computational models in order to make valid and reliable scientific claims.

Asking Questions and Defining Problems

- Analyze complex real-world problems by specifying criteria and constraints for successful

solutions.

Disciplinary Core Ideas:

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

HS-ESS3.C: Human Impacts on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

HS-ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

HS-ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Cross-Cutting Concepts:

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Feedback (negative or positive) can stabilize or destabilize a system.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Influence of Science, Engineering, and Technology on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Career Readiness, Life Literacies, and Key Skills:

9.1.12.CFR.2 Summarize causes important to you and compare organizations you seek to support to other organizations with similar missions.

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.GCA.1 Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.5 Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6 Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

9.4.12.IML.8 Evaluate media sources for point of view, bias, and motivations.

Interdisciplinary Connections and Standards:

ELA

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.SE.11–12.6 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Mathematics

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Social Studies

6.1.12.GeoHE.16.a Explain why natural resources (i.e., fossil fuels, food, and water) continue to be a source of conflict and analyze how the United States and other nations have addressed issues concerning the distribution and sustainability of natural resources and climate change.

Unit Understandings:

Students will understand that…

- Extra nutrients in the ocean from human activity disrupt ecosystems.
- There is a difference between nonpoint and point pollutants.
- Oil spills in oceans can be cleaned up with innovative engineering.
- Using renewable energy sources eliminates oil spills.
- Wetlands provide natural benefits for the oceans and land.
- Fisheries can be more sustainable if policies follow the tragedy of the commons.
- Climate change impacts marine ecosystems negatively.
- Communities and governments are protecting marine ecosystems around the world.

Unit Essential Questions:

- Why do extra nutrients in the water negatively affect marine ecosystems?
- What is the difference between nonpoint and point pollutants?
- How do scientists use satellite imagery to identify algal blooms?
- How do we clean up oil spills?
- How do oil spills affect marine organisms? (specifically sea turtles, birds, seals, whales, and dolphins)
- What benefits do wetlands provide?
- How can fisheries be more sustainable?
- What evidence do we have for climate change impacting marine ecosystems?
- How are humans protecting marine ecosystems?

Knowledge and Skills:

Students will know…..

- Phytoplankton require carbon dioxide, water, nutrients (nitrogen), sunlight, and oxygen for survival, but too many nutrients cause blooms, which wind up depleting the water of oxygen through eutrophication.
- Point pollutants are harmful pollutants where we know exactly where they come from, like an oil spill or sewage leaks.
- Nonpoint pollutants are things that cannot be directly identified, like how we may use fertilizers on our lawns, but these fertilizers wind up in our waterways far away from the source.
- Wetlands provide natural filters for pollutants, habitats for diverse organisms, and reduce flooding.
- If policies were put in place to allow fisheries to make money and leave fish to reproduce in a healthy way, the fishing industry could be sustainable.
- Factors of climate change, like rising sea levels, ocean acidification, and harsher storms, are impacting marine ecosystems.

- Scientists work with communities, companies, and governments to establish policies to protect marine ecosystems.

Students will be able to …

- Explain human impacts on the ocean and how they are detected by satellite imagery.
- Illustrate the process of eutrophication and its influences on marine ecosystems, relating to human activities.
- Identify sources of marine pollution and their impacts on marine organisms.
- Make connections between local pollution and marine pollution.
- Identify examples of nonpoint and point pollutants.
- Compare and contrast methods of cleaning up oil spills.
- Explain the impacts of point pollutants on ecosystems.
- Identify the properties of wetland ecosystems.
- Explain the function of wetlands for the community.
- Analyze the costs and benefits associated with coastal development.
- Explain the impacts of the fishing and crabbing industries on the stability of populations in marine ecosystems.
- Give examples of ways in which fisheries can be more sustainable.
- Use evidence to support climate change.
- Analyze the impacts of climate change on marine ecosystems.
- Describe the functions of Marine Protected Areas (MPAs).
- Use scientific evidence to design new MPAs.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- Final Summative Assessment Project
    - Students will be working on this for the last few weeks of the course. The last couple of classes will consist of students presenting their projects.
- Do Now questions
- Discussion questions
- Claim, Evidence, Reasoning Activities
- Formative assessment quizzes
- Review questions

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Notes and diagrams
- Using evidence from models with peers
- Modeling ecosystems
- Experiments and analysis of data
- Full class discussions and small group discussions
- Analyzing data from experimentation & graphs
- Light and Nutrients Experiment and Analysis
- Oil Spill Engineering Activity
- Modeling Wetlands Activity

- Global Climate Change Evidence Analysis
- Rising Sea Levels Experiment
- New Marine Protected Areas Design

RESOURCES

Teacher Resources:

- Marine Science- The Dynamic Ocean by Meghan E. Marrero, Ed.D. and Glen Schuster, M.S.
- Teacher designed worksheets and notes

Equipment Needed:

- Teacher computer and Newline Board
- Student Chromebooks