MARINE BIOLOGY

CURRICULUM

Middle Township Public Schools

216 S. Main Street

Cape May Court House, NJ 08210

Born on May 14, 2020

Marine Biology
Unit 1: Introduction to Marine Biology
Time Frame: 10 Days

NGSS Disciplinary Core Ideas

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.

LEARNING STATEMENTS (NGSS Performance Expectations):

*** HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.**

[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will explain different areas that encompass the marine science field.
- Students will communicate what skills, strategies, and equipment are used to gather, analyze, and interpret data in the marine science field.
- Students will explain how data is gathered, analyzed, and applied in the field and classroom environment.
- Students will explain how scientific contributions from various cultures throughout history affected our understanding of the ocean.
- Students will communicate the benefits of understanding the marine environment.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Midterm & final exams
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
ESS2-5 Rutgers University Marine Science COOL Classroom WebQuest. Students will embark on three adventures: "Hudson River Plume", "Spatial Literacy", and "Fish Migration" in a quest to learn more about types of water sources, human impacts, and ocean life. http://coolclassroom.org/adventures **ESS2-5** Ocean Floor Mapping Activity. Students will use basic materials (shoe box, clay, skewers, etc.) to simulate how scientists map deep ocean floors using hydrographic surveying. https://www.noaa.gov/sites/default/files/atoms/files/HydrographicSurveying.pdf	• Reduce group size and pair with positive peer model. • Simplify directions by modeling lab activity. • Address moon phase misconceptions prior to the start of the activity. • Assist students as necessary in order to achieve correct phases. • Provide template for students to record data. • Reinforce concepts via notes/videos/follow up manipulative activity. • Simplify/explain the wording of lab simulation questions. • Provide written directions that correspond to online directions. • Provide each student with an individual computer. • Assist students as necessary to avoid misconceptions. • Reinforce concepts via notes/videos/follow up	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Additional Resources Nova Southeastern University Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/	manipulative activity.		

Marine Biology
Unit 2: Interdependence in the Oceans
Time Frame: 10 Days

NGSS Disciplinary Core Ideas

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-LS2-1), (HS-LS2-2)

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

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
- 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-LS2-4)
- 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-LS2-5)

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-LS2-2), (HS-LS2-6)
- 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-LS2-7)

LEARNING STATEMENTS (NGSS Performance Expectations):

*** HS-LS2-1. 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**. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

*** HS-LS2-1. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will explain how humans impact the ocean.
- Students will communicate how plants and animals are interconnected within the marine ecosystems.
- Students will investigate how human activities have drastic effects on the ocean and its inhabitants.
- Students will describe the components of the oceanic food web.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
LS2-1 Carrying Capacity Activity. Students will be broken up into even groups of animals, and asked to send one member to the front to grab a piece of food then return to the herd. Eventually food will run out, and students will be asked to brainstorm different strategies to maintain their numbers. https://clic.cengage.com/uploads/8c398c438ab0854e03ad36975064907d_2_7586.pdf **LS2-1** National Geographic "Human Impacts on Marine Ecosystems" Web Activity. Students will review a map, listen to a NPR podcast, view a NOAA animation, and view images of human impacts on marine ecosystems in conjunction with thought-provoking and discussion-starting worksheets. https://www.nationalgeographic.org/activity/human-impacts-	• Simplify/explain the wording of lab simulation questions. • Provide written directions that correspond to online directions. • Provide each student with an individual computer. • Reduce group size and pair with positive peer model. • Assist students as necessary to avoid misconceptions. • Reinforce concepts via notes/videos/follow up manipulative activity. • Emphasize concept over calculations.	**Scale, Proportion, and Quantity** • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). ***Connections to Engineering, Technology, and Applications of Science*** **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.	**Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical or computational representations of phenomena to describe explanations.

on-marine-ecosystems/ **Additional Resources** Nova Southeastern University Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/			

Marine Biology
Unit 3: Waves, Currents, and Tides
Time Frame: 15 Days

NGSS Disciplinary Core Ideas

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-LS2-1), (HS-LS2-2)

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-LS2-2), (HS-LS2-6)
- 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-LS2-7)

LEARNING STATEMENTS (NGSS Performance Expectations):

*** HS-LS2-1. 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.** [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

*** HS-LS2-1. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will identify the general flow patterns of currents throughout the world's oceans.
- Students will explain which forces are responsible for causing ocean currents.
- Students will communicate how major ocean currents circulate around the world and affect climate and weather of certain regions.
- Students will explain how ocean circulation, weather, and current flow patterns affect biological processes.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects/presentation

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
HS-LS2-1 Ocean Explorer Multimedia Discovery Missions (NOAA). Students will investigate how waves are formed, tsunami warning systems, and how oceanic events affect sea life in this interactive activity that encompasses critical thinking activities. https://oceanexplorer.noaa.gov/edu/learning/player/lesson09.html	• Provide a presentation rubric to promote student success. • Allow students to present work to teacher individually if needed. • Emphasize content over creativity/format. • Provide visual examples that correspond to actual presentation format. • Reduce group size and pair with positive peer model.	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific reasoning to link evidence to the claims to assess the extent

HS-LS2-1 Scientific American Seawater Science Model Ocean Currents in Your Kitchen. Students will create and learn about ocean currents using common science laboratory materials. Students will also be asked to think critically and experiment with other materials as an extension. https://www.scientificamerican.com/article/seawater-science-model-ocean-currents-in-your-kitchen/ **Additional Resources** Nova Southeastern University Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/	• Allow for rough draft revisions if needed. • Reinforce concepts via notes/videos/follow up manipulative activity. • Assist students will scaling calculations for the model. • Provide additional visual aides to represent the planets. (colored beads or colored pencils) • Use graph paper to assist in scaled distances.		to which the reasoning and data support the explanation or conclusion. **Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that

			the theory does not accommodate, the theory is generally modified in light of this new evidence. ● Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. **Scientific Knowledge is Based on Empirical Evidence** ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Marine Biology
Unit 4: Marine Ecosystems
Time Frame: 20 Days

NGSS Disciplinary Core Ideas

LS2.D: Social Interactions and Group Behavior

- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

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-LS2-2), (HS-LS2-6)
- 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-LS2-7)

LEARNING STATEMENTS (NGSS Performance Expectations):

***HS-LS2-1. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

***HS-LS2-1. 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.** [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

***HS-LS2-1. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will differentiate life zones that exist at different depths and coastal formations.
- Students will communicate the effects of human activities on marine ecosystems and marine resources.
- Students will identify which characteristics and adaptations exist in flora and fauna found in marine environments.
- Students will explain what resources are available for human use from marine ecosystems.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Benchmark Assessment
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
HS-LS2-1 Rutgers University COOL Classroom Seagrass Activity. Students will use a matrix to investigate how scientists can predict where and how much seagrass will grow in a given area. http://coolclassroom.org/discoveries/view/map-algebra	• Simplify wording lab questions • Rephrase/explain directions orally that correspond to written directions. • Simplify the amount of data required to graph and/or provide a partially completed graph. • Allow students to use online graphing programs if needed. • Group with positive peer models	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Energy and Matter** • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes,	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

HS-LS2-1 National Geographic Mapping Marine Ecosystems. Students investigate types of marine ecosystems, identify examples of these ecosystems and their characteristics, and locate the ecosystems on a map of the world's oceans. https://www.nationalgeographic.org/activity/mapping-marine-ecosystems/ **Additional Resources** Nova Southeastern University Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/		atoms are not conserved, but the total number of protons plus neutrons is conserved. ***Connections to Engineering, Technology, and Applications of Science*** **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. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

		● Science assumes the universe is a vast single system in which basic laws are consistent.	● Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Marine Biology
Unit 5: Creatures
Time Frame: 20 Days

NGSS Disciplinary Core Ideas

LS4.B: Natural Selection

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HSLS4-3)

LS4.C: Adaptation

- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)
- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HSLS4-5), (HS-LS4-6)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

LEARNING STATEMENTS (NGSS Performance Expectations):

***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.** [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of

organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

***HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading 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. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will define the characteristics of marine invertebrates and vertebrates.
- Students will explain the roles marine invertebrates and vertebrates play in the ecosystem.
- Students will identify how humans have impacted marine invertebrates and vertebrates.
- Students will explain how marine vertebrates and invertebrates have evolved due to natural changes in their ecosystems.
- Students will identify how marine vertebrates and invertebrates have evolved due to human impacts on their ecosystems.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects/presentation

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
HS-LS4-4 Investigating Natural Selection Activity. This inquiry-based learning activity on natural selection will help students establish a basic understanding of natural selection. Discussion of current happenings involving the concepts of natural selection and evolution will illustrate the importance of Darwin's theory in today's society. https://www.nku.edu/~bowlingb2/NaturalSelectionActivity/LP_1.pdf **HS-LS4-2** WHSH Whale Evolution WebQuest. In this WebQuest, students will investigate how whales have evolved over centuries as a result of human and natural impacts on their environment. https://wshsscience.edublogs.org/biology/evolution-resources/whale-evolution-webquest/	• Simplify wording lab questions • Rephrase/explain directions orally that correspond to written directions. • Simplify the amount of calculations required. • Provide calculators • Group with positive peer models • Extended time as needed • Utilize colored pencils to aid visualization	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Energy and Matter** • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D).	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own

Additional Resources Nova Southeastern University Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. ● Science assumes the universe is a vast single system in which basic laws are consistent.	investigations, 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. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ● Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain**

			Natural Phenomena • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Marine Biology
Unit 6: Pollution
Time Frame: 10 Days

NGSS Disciplinary Core Ideas

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-LS2-2), (HS-LS2-6)
- 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-LS2-7)

LS4.D: Biodiversity and Humans

- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HSLS4-6.) Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)

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-ESS3-4)

LEARNING STATEMENTS (NGSS Performance Expectations):

***HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. [Clarification Statement: Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

***HS-LS2-1. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students will define what marine pollution is.
- Students will identify sources of marine pollution.
- Students will explain the differences between point and non-point pollution, and provide examples.
- Students will communicate how marine pollution affect the flora and fauna in marine ecosystems.
- Students will present examples of how to personally help or remedy the problem of marine pollution.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects/presentation

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
HS-LS2-1 "Labster Marine Biology: Investigate a Massive Fish Death". In this computer activity, students will essentially perform a "fish autopsy" to determine the cause of death. Aspects will include investigating the lungs and searching/identifying pollutants. https://www.labster.com/simulations/marine-biology/ **HS-ESS3-4** SDWF (Safe Drinking Water Foundation) Concept Map Development. Students will research current strategies for reducing marine pollution, and collaboratively create a concept map ultimately leading to adding personal creative new ways of reducing marine pollution. https://www.safewater.org/operation-water-pollution-1/2017/2/2/lesson-1-water-pollution **Additional Resources** Nova Southeastern University	• Simplify wording lab questions • Rephrase/explain directions orally that correspond to written directions. • Simplify the amount of calculations required. • Provide calculators • Group with positive peer models • Extended time as needed • Utilize colored pencils to aid visualization	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Energy and Matter** • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D).	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own

Marine Biology Resources K-12 https://nsufl.libguides.com/marinebioresources/k12 COSEE Networked Ocean World https://coseenow.net/education-resources/other-resources/marine-biology-resources/		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. ● Science assumes the universe is a vast single system in which basic laws are consistent.	investigations, 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. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ● Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain**

			Natural Phenomena • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.