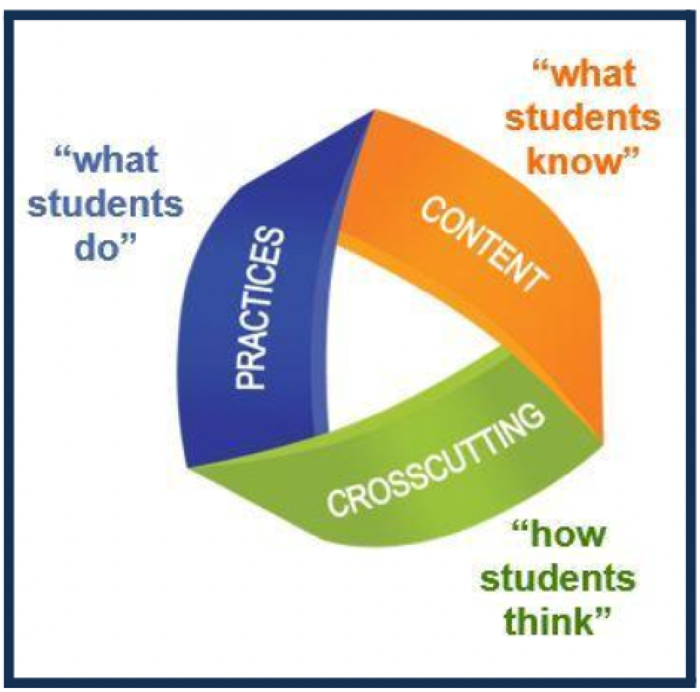
Ledyard Public Schools

Ledyard High School

NGSS Science Curriculum

<u>Marine Science</u>



Course Title	Marine Science I (1455)
Department and Curriculum Writing Team Members	David Bednarz
Course Overview	Marine Science I is an introduction to the marine environment Marine Science including marine biology and oceanography. Aquarium studies and field investigations, including Project Oceanology field trips, supplement classroom work that allows students to explore aspects of marine life and conditions, especially related to Long Island Sound and Coastal Southeastern Connecticut.
Length of Course	☐ Full year ☑ Semester
Type of Course	☐ Humanities Required Credit ☐ STEM Required Credit ☐ Humanities Elective Credit ☑ STEM Elective Credit ☐ PE/Health Required Credit ☐ Other
Grade Level	☐ 9 ☐ 10 ☑ 11 ☑ 12
Prerequisites	None
Ledyard High School Vision of the Graduate	Ledyard High School is a learning community dedicated to the cultivation of skills essential for our students' success in a rapidly-evolving society. At Ledyard High School, we believe our graduates should demonstrate the following: ☑ Collaboration - Colonel Graduates will demonstrate an ability to work effectively with others, sharing ideas, acknowledging one another's strengths, and collaborating to produce presentations, projects, performances, or events. ☑ Communication- Colonel Graduates will demonstrate an ability to communicate information clearly and effectively through a variety of media, including written, oral, visual, musical, and/or video productions. ☑ Problem-Solving- Colonel Graduates will demonstrate an ability to solve problems of varying complexity across a variety of content areas. ☑ Critical Thinking - Colonel Graduates will demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas. ☑ Perseverance - Colonel Graduates will demonstrate perseverance in academic and extracurricular settings by working through and past obstacles in pursuit of goals. ☑ Creativity - Colonel Graduates will demonstrate creativity through their participation in fine arts courses as well as through their inventive approaches to learning activities in a variety of settings.
VOG Portfolio Component	Seal Population Data Analysis Critical Thinking

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District Philosophy

Ledyard's vision for K-12 inquiry based science is to engage students in scientific and engineering practices as they apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

A New Vision for Science Education

Implications of the Vision of the Framework for K-12 Science Education and the Next Generation Science Standards

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Rote memorization of facts and terminology.	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning.
Learning of ideas disconnected from questions about phenomena.	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned.
Teachers providing information to the whole class.	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance.
Teachers posing questions with only one right answer.	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims.
Students reading textbooks and answering questions at the end of the chapter.	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students developing summaries of information.
Pre-planned outcome for "cookbook" laboratories or hands-on activities.	Multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas.
Worksheets.	Student writing of journals, reports, posters, and media presentations that explain and argue.
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Provision of supports so that all students can engage in sophisticated science and engineering practices

Source: National Research Council. (2015). *Guide to Implementing the Next Generation Science Standards* (pp. 8-9). Washington, DC: National Academies Press. http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards

Three Dimensions of the *Next Generation Science Standards*: Practices of Science and Engineering:

Scientific and Engineering Practices Matrix - SEP (appendix F)

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.
Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

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Three Dimensions of the *Next Generation Science Standards*: Disciplinary Core Ideas:

Disciplinary Core Ideas Matrix - DCI (appendix E)			
Physical Science	**Life Science**	**Earth and Space Science**	**Engineering, Technology, and the Application of Science**
PS1: Matter and Its Interactions PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes **PS2: Motion and Stability: Forces and Interactions** PS2.A: Forces and Motion PS2.B: Types of Interactions PS2.C: Stability and Instability in Physical Systems **PS3: Energy** PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes and Everyday Life **PS4: Waves and Their Applications in Technologies for Information Transfer** PS4.A: Wave Properties PS4.B: Electromagnetic Radiation PS4.C: Information Technologies and Instrumentation	**LS1: From Molecules to Organisms: Structures and Processes** LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS1.C: Organization for Matter and Energy Flow in Organisms LS1.D: Information Processing **LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS2.D: Social Interactions and Group Behavior **LS3: Heredity: Inheritance and Variation of Traits** LS3.A: Inheritance of Traits LS3.B: Variation of Traits **LS4: Biological Evolution: Unity and Diversity** LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection LS4.C: Adaptation LS4.D: Biodiversity and Humans	**ESS1: Earth's Place in the Universe** ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System ESS1.C: The History of Planet Earth **ESS2: Earth's Systems** ESS2.A: Earth Materials and Systems ESS2.B: Plate Tectonics and Large-Scale System Interactions ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS2.E: Biogeology **ESS3: Earth and Human Activity** ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change	**ETS1: Engineering Design** ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution **ETS2: Links Among Engineering, Technology, Science, and Society** ETS2.A: Interdependence of Science, Engineering, and Technology ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Three Dimensions of the *Next Generation Science Standards*: Crosscutting Concepts:

Crosscutting Concepts Matrix - CCC (appendix G)		
Patterns Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. **Cause and Effect: Mechanism and Explanation** Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	**Scale, Proportion, and Quantity** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. **Systems and System Models** Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.	**Energy and Matter: Flows, Cycles, and Conservation** Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. **Structure and Function** The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. **Stability and Change** For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Connections to the Nature of Science

Nature of Science Practices	Nature of Science Crosscutting Concepts
These understandings about the nature of science are closely associated with the science and engineering practices, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.	These understandings about the nature of science are closely associated with the crosscutting concepts, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.
Scientific Investigations Use a Variety of Methods	Science is a Way of Knowing
Science Knowledge is Based on Empirical Evidence	Scientific Knowledge Assumes and Order and Consistency in Natural Systems
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is a Human Endeavor
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena.	Science Addresses Questions About the Natural and Material World

How does Ledyard Define Inquiry?

Inquiry is defined as a way of seeking information, knowledge, or truth through questioning. Inquiry is a way for a learner to acquire new information and data and turn it into useful knowledge. Inquiry involves asking good questions and developing robust investigations from them. Inquiry also involves considering possible solutions and consequences. A third component of inquiry is separating evidence based claims from common opinion, and communicating claims with others, and acting upon these claims when appropriate. Questions lead to gathering information through research, study, experimentation, observation, or interviews. During this time, the original question may be revised, a line of research refined, or an entirely new path may be pursued. As more information is gathered, it becomes possible to make connections and allows individuals to construct their own understanding to form new knowledge. Sharing this knowledge with others develops the relevance of the learning for both the student and a greater community. Sharing is followed by reflection and potentially more questions, bringing the inquiry process full circle.

Inquiry 5 Science Teaching Model

Engagement	Object, event or question used to engage students. Connections facilitated between what students know and can do.
Exploration	Objects and phenomena are explored. Hands-on activities, with guidance.
Explanation	Students explain their understanding of concepts and processes. New concepts and skills are introduced as conceptual clarity and cohesion are sought.
Elaboration	Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

Grade Level: 11-12	Timeline: approx 4 classes
Unit 1: Introduction to the Long Island Sound Estuary & Glacial History of Long Island Sound	
Essential Question(s):	• What physical and geographical factors help to define Long Island Sound as an estuary? • How did the late Wisconsin glaciation modify the landform, leading to the current day?
Standards: HS-ESS2-1:Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. HS-ESS2-2:Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems results in changes in climate.	
Crosscutting Concepts: Stability and Change: Feedback (negative or positive) can stabilize or destabilize a system (HS-ESS2-2).	
Science and Engineering Practices: Developing and Using Models: Use a model to provide mechanistic accounts of phenomena (HS-ESS2-4).	
Content & Vocabulary:	• Understand relationships between the geography of the Long Island Sound basin and physical factors such as tides, temperatures and salinity. • Identify and apply knowledge to explain formation of terminal vs. recessional moraines. • Describe how glaciation and change in sea level modified the landform to create the current day Long Island Sound basin.
Suggested Activities:	• Long Island Sound map activity. • Glaciers and Ice Cores activity and scale model • Students enrolled in fall semester class will spend approximately two periods setting up fish tanks as environments (ie. rocky intertidal zone, marsh, beach, etc.) that they will be responsible for during the class and for their Pine Island Ecology Project at the end of the semester. • Students read a primary source article on the creation of Long Island sound, complete reading quiz.
Suggested Assessments:	• Quiz on Long Island Sound as an estuary (includes selected map locations).

Grade Level: 11-12	Timeline: approx 4 classes
Unit 2: Shoreline Features and Processes	
Essential Question(s):	● How do physical processes act to shape the coast? ● How do biological processes further modify shorelines (in concert or against the physical factors)? ● Identify and describe the major shoreline types found in Long Island Sound.
Standards: 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-ESS2-4:Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	
Crosscutting 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 (HS-ESS2-1)	
Science and Engineering Practices: Developing and Using Models: Develop a model based on evidence to illustrate the relationships between systems or between components in a system (HS-ESS2-1) Developing and Using Models: Use a model to provide mechanistic accounts of phenomena (HS-ESS2-4)	
Content & Vocabulary:	● Understand how tides, winds and waves modified and continue to modify the coast left by the late Wisconsin glaciation event. ● Explain the role of biological processes (ie. marsh formation, mangrove coasts, dune grass) in further modification of the shoreline (in concert with or antagonistically to the physical processes). ● Identify and justify the location of the major shoreline types (headlands, beaches, marshes, mudflats) found in Long Island Sound.
Suggested Activities:	● Shoreline resilience activity. ● Sediment sorting and settling rate activity. ● Students read primary source material on seal level rise and coastal forest destruction, complete reading quiz.
Suggested Assessments:	● Quiz on glacial history of Long Island Sound and Shoreline Features and Processes.

Grade Level: 11-12	Timeline: approx 4-5 classes
Unit 3: The Benthos	
Essential Question(s):	What are the characteristics of organisms that live on and within the seafloor?
Standards: HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. HS-LS4-5: Evaluate the evidence of supporting claims that changes in environmental conditions may result in (1) increases in the number of some species, (2) emergence of new species over time, (3) the extinction of other species.	
Crosscutting Concepts: Systems and System Models: Models can be used to simulate systems and interactions- including energy, matter and information flows- within and between systems at different scales. (HS-LS1-2).	
Science and Engineering Practices: Using Mathematics and Computational Thinking: Use mathematical and/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1).	
Content & Vocabulary:	•Benthic community groupings: a. epibenthic (epiflora, epifauna) vs. inflora, inflauna b. size classes (macro-, meio-, micro-) c. sessile vs. mobile d. feeding types (filter, carnivore, herbivore, deposit) •Roles of bottom type & temperature in benthic community diversity.
Suggested Activities:	• Students read primary source material on benthic habitat destruction, complete reading quiz. • Identify specimens of benthic organisms provided in class, match the organism to their respective feeding style, size, habitat and geographic range. • Data Set Analysis: Identify hypothesis, variables in sci. simulation. Analyze symbiotic relationship between urchins and corals, resolve a data set, draw a conclusion. • Benthic Diversity Activity: Assess and justify the differences in species diversity of sandy vs. rocky subtidal habitats. Use mathematics (diversity index) to provide evidence of differences in diversity.
Suggested Assessments:	• Quiz on benthos unit. • Test on LIS as an estuary, glaciers, coasts, benthos, production and life

Grade Level: 11-12	Timeline: approx 4 classes
Unit 4: Mollusks	
Essential Question(s):	• What are the physical characteristics of organisms in the phylum Mollusca and what morphological differences exist within the three major classes? • How do these differences in morphology allow individuals to exploit different habitats?
Standards: HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	
Crosscutting Concepts: Systems and System Models: Models can be used to simulate systems and interactions- including energy, matter and information flows- within and between systems at different scales. (HS-LS1-2).	
Science and Engineering Practices: Using Mathematics and Computational Thinking: Use mathematical and/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1).	
Content & Vocabulary:	• What specific adaptations allow mollusks to inhabit various habitats (ie. rocky intertidal or subtidal zones vs. subtidal sand or mud) ? • What anatomical adaptations (ie. radula, gills, beak) allow for the variety of feeding styles found in mollusks? • What is the economic importance of mollusks?
Suggested Activities:	• Students read primary source material on oyster reefs as a method to decrease coastal erosion, complete reading quiz. • Identify specimens of mollusks provided in class, match the organism to their respective feeding style, size, habitat and geographic range. • Data Set Analysis: Identify hypothesis, variables in sci. simulation. Analyze suitability of substrate type for mollusk colonization, resolve a data set, draw a conclusion. • Mollusks and ocean acidification lab
Suggested Assessments:	• Quiz on mollusks unit.

Grade Level: 11-12	Timeline: approx 4 classes
Unit 5: Crustaceans	
Essential Question(s):	What types of crustaceans live in Long Island Sound and what are their ecological roles and economic importance?
Standards: HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS4-5: Evaluate the evidence of supporting claims that changes in environmental conditions may result in (1) increases in the number of some species, (2) emergence of new species over time, (3) the extinction of other species.	
Crosscutting Concepts: Systems and System Models: Models can be used to simulate systems and interactions- including energy, matter and information flows- within and between systems at different scales. (HS-LS1-2). Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects (HS-LS4-5).	
Science and Engineering Practices: Using Mathematics and Computational Thinking: Use mathematical and/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1). Engaging in Argument from Evidence: Evaluate the evidence behind currently accepted explanations or solutions to determine the merit of arguments (HS-LS4-5).	
Content & Vocabulary:	• What habitats are inhabited by crustaceans? • What strategies do crustaceans employ to gain food and energy? • What is the economic importance of crustaceans (with focus on the American lobster) ?
Suggested Activities:	• Students read primary source material on negative effects from shrimp farming practices in Asia, complete reading quiz. • Identify specimens of crustaceans provided in class, match the organism to their respective feeding style, size, habitat and geographic range. • Data Set Analysis: Identify hypothesis, variables in sci. simulation. Analyze effect of El Niño events on zooplankton populations,resolve a data set, draw a conclusion.
Suggested Assessments:	• Quiz on crustaceans unit.

Grade Level: 11-12	Timeline: approx 4 classes
Unit 6: Fish	
Essential Question(s):	How do body styles, habitats, and reproductive strategies affect the success of marine and anadromous fish?
Standards: HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS4-5: Evaluate the evidence of supporting claims that changes in environmental conditions may result in: (1) increases in the number of some species, (2) emergence of new species over time, (3) the extinction of other species.	
Crosscutting Concepts: Systems and System Models: Models can be used to simulate systems and interactions- including energy, matter and information flows- within and between systems at different scales (HS-LS1-2). Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-7).	
Science and Engineering Practices: Developing and Using Models: Develop and use a model based on evidence to illustrate the relationship between systems or between components of a system (HS-LS1-2).	
Content & Vocabulary:	● Compare marine fishes to anadromous and catadromous fishes. ● What habitats in Long Island Sound are utilized by which species of fish? ● What are the economic values (sport, commercial) of various fish found in Long Island Sound? ● How has river health and damming affected anadromous fish populations? What solutions have been proposed/ implemented? ● How has overfishing and bycatch negatively affected fish species?
Suggested Activities:	● Students read primary source material on the importance of Menhaden to food webs and human sustainability, complete reading quiz. ● Data Set Analysis: Identify hypothesis, variables in sci. simulation. Analyze the effect of overfishing on marine ecosystems, resolve a data set, draw a conclusion. ● "Tragedy of the Commons" activity with goldfish.
Suggested Assessments:	● Quiz on fish unit.

Grade Level: 11-12	Timeline: approx 4 classes
Unit 7: Production and Life	
Essential Question(s):	• What role do seals play in a Long Island Sound food web? • What types of seals might be found in Long Island Sound and why?
Standards 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-LS2-5: 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-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	
Crosscutting Concepts: Stability and Change: much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-6), (HS-LS2-7). 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 (HS-LS1-5), (HS-LS1-6).	
Science and Engineering Practices: Using Mathematics and Computational Thinking: Use mathematical and/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1).	
Content & Vocabulary:	• Track energy flow through an ecosystem from producers to consumers. • Understand the difference between a food chain and a food web. • Use results of a light/ dark bottle experiment to measure primary productivity • Demonstrate an understanding of ecological efficiency using a trophic pyramid • What anatomical and behavioral adaptations to pinnipeds possess? • What ecological role do pinnipeds (specifically harbor seals) play in Long Island Sound?
Suggested Activities:	• Students read primary source material on bioaccumulation of a persistent manmade toxic compound within seals, complete reading quiz. • Project Oceanology field trip to assess seal population in selected locations within Fishers Island Sound. • Mammalian Dive Response Lab
Suggested Assessments:	• Data analysis project from data collected on seal field trip. This project can be given as an on paper or online format.

Grade Level: 11-12	Timeline: approx 4 classes
Unit 8: Vegetation	
EssentialQuestion(s):	What abiotic conditions are present in the rocky intertidal zone, marsh, eelgrass beds, beach and upland environments? How do macroalgae and plants take advantage of each set of conditions?
Standards: 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 on climate. HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	
Crosscutting 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 (HS-LS1-5), (HS-LS1-6).	
Science and Engineering Practices: Using Mathematics and Computational Thinking: Use mathematical and/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1).	
Content & Vocabulary:	• How does light intensity and wavelength affect the vertical zonation of macroalgae in the intertidal community? • How does salinity affect species composition and vertical zonation on a salt marsh? • Describe the different seasonal roles of the eelgrass community on the ecosystem as a whole. • What adaptations does dune vegetation possess to deal with the shifting sands and low nutrients of a beach? • What stressor(s) do plants of the upland community have to occasionally face?
Suggested Activities:	• Students read primary source material on cooperativity between eelgrass beds and shellfish aquaculture, complete reading quiz. • Identify specimens of plants and algae provided in class, match the organism to their size, habitat and geographic range. • Data Set Analysis: Identify hypothesis, variables in sci. simulation. Analyze effect of eutrophication on mud snail populations in mudflat community, resolve data set, draw a conclusion.
Suggested Assessments:	• Quiz on vegetation unit. • Test on Mollusks, Crustaceans, Fish and Vegetation units.

Grade Level: 11-12	Timeline: approx 4-6 classes
Unit 9: Pine Island Ecology Project	

Essential Question(s):	What conditions (abiotic and biotic) are present in a selected ecosystem (subtidal rocky, subtidal sandy, eelgrass bed, salt marsh, beach, rocky intertidal zone) within the Long Island Sound estuary?

Standards:

HS-LS2-1: Use mathematical and/ or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem

Crosscutting Concepts:

Scale, Proportion and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs (HS-LS2-1)

Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-6)

Science and Engineering Practices:

Using Mathematics and Computational Thinking: Use mathematical an/or computational representations of phenomena or design solutions to support explanations (HS-LS2-1)

Using Mathematics and Computational Thinking: Use mathematical representations of phenomena or design solutions to support and revise explanations (HS-LS2-2)

Content & Vocabulary:	• What physical conditions (ie. elevation or water quality exist in the selected ecosystem? • How do the physical conditions found in that ecosystem affect species composition?
Suggested Activities:	Students keep an aquarium for the duration of the course of a selected ecosystem as defined above. A full day field trip to Pine Island is utilized to record real time physical and biological data.
Suggested Assessments:	Student teams generate a scientific poster (introduction, materials & methods, graphs, results, discussion, sources cited) to demonstrate their understanding of the ecosystem as a whole and the interactions present between the physical environment and the organisms that inhabit that environment. Students are also provided with an example for this project.

Pacing Guide: Due to scheduling of field experiences with Project Oceanology, availability of live plant specimens, unit order differs if course is taught in fall semester vs. spring semester.

Approved by Instructional Council on May 10, 2023

Semester 1 (fall)	Semester 2 (spring)
Quarter 1: Unit 1 (Intro. To LIS, Glaciers), Unit 2 (Shorelines & Coastal Processes), Unit 9 (Pine Island Ecology), Unit 8 (Vegetation) **[Test]**	**Quarter 3:** Unit 1 (Intro. To LIS, Glaciers), Unit 2 (Shorelines & Coastal Processes), Unit 3 (Benthos), Unit 7 (Production & Life) **[Test]**
Quarter 2: Unit 3 (Benthos), Unit 4 (Mollusks), Unit 7 (Production & Life), Unit 5 (Crustaceans), Unit 6 (Fish) **[Test]**	**Quarter 4:** Unit 4 (Mollusks), Unit 5 (Crustaceans), Unit 6 (Fish), Unit 8 (Vegetation), Unit 9 (Pine Island Ecology) **[Test]**