Fairfield Public Schools
Science Curriculum

Draft

Marine Science of
Long Island Sound

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Marine Science of Long Island Sound: Description

Marine Science of Long Island Sound is a one-semester course designed to expose students to this great natural resource that is in their own local area. Students will apply knowledge and experiences both inside and outside the classroom. The topics that are discussed are: Intertidal Ecology, the Continental Shelf, and Human impacts of the Sound. This course involves many field trips to various locations.

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:

Disciplinary Core Ideas (DCIs): Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

Science and Engineering Practices (SEP): These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

Crosscutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

Marine Science of Long Island Sound

Enduring Understandings

Scientific inquiry is a thoughtful and coordinated attempt, through a continuous process of questioning, data collection, analysis and interpretation, to describe, explain, and predict natural phenomena.
The environment is a complex assemblage of interacting and evolving chemical, physical and biological processes.
Changes in any of the interacting processes will impact the current state of the environment.

Course Essential Questions

- How have humans impacted the diversity of life in the marine environment?
- How do populations interact with each other and their marine environment?
- How does climate change impact in New England's coastline?

Marine Science of Long Island Sound: Semester-at-a-Glance

Unit	Title	Unit Essential Questions
1	LIS Intertidal Ecology	• How do the tides affect the biodiversity of LIS? • How do species' adaptations help them live in the intertidal zone? • How do you humans manage the coastline? • How is data collected and analyzed in the field?
2	Continental Shelf	• How do fish adaptations all for increase success rate in their habitat? • How does energy flow through an ecosystem and how is it altered? • How have humans impacted the diversity of life in marine fisheries?
3	Humans Impact on the Ocean	• How does climate change impact on the ocean and New England's coastline? • How does climate change (temp and CO_2) affect marine organisms? • How can humans model, predict and manage current and future impacts of global climate change? • How do humans and marine mammals interact?

Unit 1: LIS Intertidal Ecology

Overview

Our Fairfield students live directly on the coast of Long Island Sound. We work, play and have our economy based on life on the Sound. Humans have a direct impact in how we use, manage and harvest the ecosystem and habitats. An understanding of the make-up of the intertidal ecosystem allows us to properly manage this important resource.

Performance Expectations

At the conclusion of this unit, students will be able to:

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

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

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Unit Essential Questions

- How do the tides affect the biodiversity of LIS?
- How do species' adaptations help them live in the intertidal zone?
- How do you humans manage the coastline?
- How is data collected and analyzed in the field?

Crosscutting Concepts

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.
  (HS-LS2-4)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HSLS2-7)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2),(HS-LS4-4),(HS-LS4-5),(HS-LS4-6)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS:

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),(HSLS2-2)

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)

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 HS-LS4-6.)

Adaptation

- 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. (HS-LS4-5),(HS-LS4-6)

Corresponding CT Core Standards:

ELA/Literacy – RST.9-10.8, RST.11-12.1, RST.11-12.8,

Mathematics – MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSS-ID.A.1, HSS-IC.A.1, HSS-IC.B.6

Unit 2: Continental Shelf

Overview

Life over the Continental Shelf is unique and an important ecosystem for humans. Marine organisms have unique physical characteristics that allow them to survive and interact with other organisms in their environment. How we alter and manage life over the shelf is critical to the survival of the different species of organisms.

Performance Expectations

At the conclusion of this unit, students will be able to:

- **HS-LS 2-1.** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
- **HSLS 2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

Unit Essential Questions

- How do fish adaptations all for increase success rate in their habitat?
- How does energy flow through an ecosystem and how is it altered?
- How have humans impacted the diversity of life in marine fisheries?

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)

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. (HS-LS2-4)

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. (HSESS3- 3),(HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HSESS3-4)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

Using Mathematics and Computational Thinking

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)
- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HSESS3-3)

Constructing Explanations and Designing Solutions

- Construct 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. (HS-ESS3-1)
- 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. (HS-ESS3-4)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Scale, Proportion, and Quantity

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

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. (HS-LS2-4)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

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. (HSESS3- 3),(HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HSESS3-4)

Corresponding CT Core Standards:

ELA/Literacy – RST.11-12.1, WHST.9-12.2,

Mathematics – Mp.4, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3

Unit 3: Human Impacts on the Ocean

Overview

Climate change is altering the physical and biological components of Long Island Sound. With the changing planet, marine organisms are under increased pressures to evolve or become extinct. All humans have the choice to impact the marine environment positively or negatively.

Performance Expectations

At the conclusion of this unit, students will be able to:

- **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-LS 2-6:** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- **HS-LS2-7:** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-ESS 2-4:** 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-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 systems.
- **HS-ESS3-6:** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Unit Essential Questions

- How does climate change impact on the ocean and New England's coastline?
- How does climate change (temp and CO_2) affect marine organisms?
- How can humans model, predict and manage current and future impacts of global climate change?
- How do humans and marine mammals interact?

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Scale, Proportion, and Quantity

- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HSLS2-7)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HSESS3- 3),(HS-ESS3-5)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

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),(HSLS2-2)

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)

Earth and the Solar System

- Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

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-ESS2-4)

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 re-radiation into space. (HS-ESS2-2),(HS-ESS2-4)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4)
- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6)

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. (HS-ESS3-5)
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

Constructing Explanations and Designing Solutions

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Developing and Using Models

- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Analyzing and Interpreting Data

- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Corresponding CT Core Standards:

ELA/Literacy – SL.2.5

Mathematics – MP.4, 2.MD.D.10