TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

ACP MARINE SCIENCE
Grade 12
Science Department

2016

(Last revision date: 2007)

Curriculum Writing Team

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ACP Marine Science
Grade 12
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The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES AND BELIEFS

The Trumbull High School community engages in an environment conducive to learning which believes that all students will **read and write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

The ACP Marine Science elective is offered to students who have successfully completed three years of college-preparatory science. Through this field-based course, Marine Science students will be challenged to apply concepts introduced in previous science courses to extend their understanding of Earth's systems through focused study of the marine environment. Upon successful completion of the course, the student will receive 0.625 Science credit toward graduation.

The connection between healthy marine ecosystems and human health cannot be over-exaggerated, nor can the stresses placed on Earth's oceans be denied, given that the world's human population now exceeds 7.2 billion, with predictions of many more before 2100. Oceans provide food, absorb and distribute energy, sequester carbon, are reservoirs of water, and are home to organisms that generate much of oxygen produced on Earth. The alteration of Earth's ocean systems due to non-sustainable practices by humans has the potential to do significant economic, social, and environmental harm. Reports of increased pressure on global fisheries, declining fish stocks, and subsequent price increases have increased since the mid-20th century. The removal or alteration of coastal barriers has resulted in increased storm damage in coastal communities; predictions of warming ocean temperatures, increased sea levels, and increased storm strength have the potential for even more damage to less protected areas.

The United States has been a leading advocate for sustainable use and has passed and implemented significant legislation to protect and improve water quality and biological diversity. International agreements in support of sustainable use have also been ratified by many nations, but challenges remain. As we move toward the next century, it is essential that students leave school scientifically literate and have an understanding of the interactions between Earth's systems and consequences of human actions and decisions. Through this course, students will become literate regarding the essential role oceans play in maintaining the global environment.

The general organization of this course is similar to that outlined in the prior curriculum guide (2006) with some exceptions. The first marking period remains focused on coastal ecosystems of Long Island Sound and the organisms found in each. A strong emphasis is placed on understanding the challenges posed by abiotic conditions and the adaptations observed in organisms that allow them to survive despite these challenges. During the second marking period, there is now an increased emphasis on analysis of abiotic data sets (temperature, pH, nitrogen) and biotic data (fish populations). The use of case studies to evaluate marine-related

legislative effectiveness has been added, as has a unit on shark biology, distribution, and biodiversity.

COURSE GOALS

The following course goals derive from the 2010 Connecticut Core Standards.

CCSS.ELA-Literacy.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-Literacy.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-Literacy.WHST.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-Literacy.SL.11-12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-Literacy.SL.11-12.4	Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
CCSS.ELA-Literacy.SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

The following standards derive from the 2016 International Society for Technology in Education Standards.

ISTE Knowledge Constructor (Standard 3)	Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others.

ISTE Creative Communicator (Standard 6)	Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals.
ISTE Global Collaborator (Standard 7)	Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

The following standards derive from the 2013 Next-Generation Science Standards.

NGSS.HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
NGSS.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
NGSS.HS.LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
NGSS.HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow or energy among organisms in an ecosystem.
NGSS.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.
NGSS.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the ecosystem and biodiversity.
NGSS.HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
NGSS.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.
NGSS.HS.LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
NGSS.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.

NGSS.HS.ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
NGSS.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.
NGSS.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.
NGSS.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.
NGSS.HS.ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- life on Earth exists in the Biosphere, wherein portions of the Earth's atmosphere, lithosphere (Earth's Crust), and hydrosphere (waters of the Earth's surface) come together to create Earth's unique environment.
- all species depend on certain environmental conditions in order to thrive, and that Earth's varied climates and ecosystems provide conditions and essential nutrients, thus supporting biological diversity.
- changes in one environmental component can stimulate responses in another; much of the time, small adjustments allow life to go on as before via a system of checks and balances.
- significant changes in one or more component(s) can drastically alter conditions within the Biosphere, thus affecting biodiversity.
- human actions, including those occurring well-removed from coastlines, directly and indirectly affect the marine environment, with economic, environmental, public health, and social implications.
- human population growth, in conjunction with technological advancements, has resulted in dramatic decreases in global fish stocks and significantly affected marine food webs.
- scientific research, in conjunction with legislative and social actions, can (a) increase public awareness of essential services provided by marine ecosystems and (b) develop measures to be taken to protect vital marine resources.

COURSE ESSENTIAL QUESTIONS

- What essential roles do marine environments play in maintaining the global environment?
- How are complex marine ecosystems, including abiotic and biotic components, a model for terrestrial ecosystems?

- How and why does the Long Island Sound affect the greater social, economic, and environmental community?
- What does current data indicate about the state of the marine environment, both locally and globally, and how can humans effectively address negative trends?

COURSE KNOWLEDGE & SKILLS

Students will understand . . .

- the interactions among the lithosphere, hydrosphere, and atmosphere, and their effects on living things.
- how marine systems transport energy and moderate climate, and the potential effects of warming average ocean temperatures.
- the supplies and biotic and abiotic conditions required to establish and maintain a marine aquarium, with a specific focus on the nitrogen biogeochemical cycle.
- marine species common to three Long Island Sound habitats (Sandy Beach, Salt Marsh, and Rocky Shore), and their roles in the local marine food webs and economy.
- significant ecosystem services provided to humans by aquatic ecosystems with complex food webs.
- the threat to long-term environmental sustainability caused by current and projected regional and global patterns of population growth vs. regional and global resource consumption rates, and the indicated need for development and implementation and sustainable practices.
- historic and current marine exploration technology and findings, and the importance of recent discoveries to our understanding of the marine environment.

Students will be able to . . .

- identify, with oral and/or written support, current events reported in the press illustrating concepts and principles discussed in class.
- determine key themes and concepts presented in course readings.
- write clear and informed responses to marine science-related questions, and summarize in writing, incorporating supporting data, key factors of an marine science issue.
- work collaboratively with others using digital tools to broaden perspective, gain understanding of environmental issues, and share knowledge.
- create models, including drawings, tests, and mechanical simulations, to illustrate scientific concepts.
- collaborate with others to follow complex laboratory procedures, analyze and evaluate data, and individually explain in a clear, concise manner consistent with the scientific writing approach.

COURSE SYLLABUS

Course Name

Marine Science

Level

Advanced College-Preparatory

Prerequisites

A course grade of B or higher in ACP Biology and ACP Chemistry, or permission of the Department Chair.

Materials Required

None

General Description of the Course

This course includes a wide-ranging study of the earth's marine environment, emphasizing the oceans and Long Island Sound. Field trips are taken during laboratory periods to Lordship salt marsh, beaches, and other selected sites. Several all-day field trips include the Museum of Natural History and South Street Seaport in New York, and the Mystic Marine Life Aquarium. Students should be expected to carry out independent projects as well as set up and maintain a saltwater aquarium in the classroom. Students enrolling in Marine Science must enroll in Environmental Science for the spring semester.

Assured Assessments

Formative Assessments:

- Vocabulary quiz on components/structure of marine aquarium (Unit 1)
- Field Study #1: Overview of the Long Island Sound Shoreline (Unit 2)
- Bathymetric mapping (Unit 3)
- Group and individual shark identification (Unit 4)
- "I've Got the Law . . ." (Unit 5)

Summative Assessments:

- Graph and summary related to nitrogen cycling in the classroom aquarium (Unit 1)
- Aquarium Lab Practicum (Unit 2)
- Unit test on physical ocean (Unit 3)
- Comparative Anatomy Practicum (Unit 4)
- U.S. National Marine Sanctuaries Project: presentation and sanctuary summary (Unit 5)

Core Text

Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.

UNIT 1
The Classroom Aquarium as a Model for the Marine Environment

Unit Goals

At the completion of this unit, students will:

CCSS.ELA-Literacy.RST.11-12.3	Follow precisely complex multistep procedures to monitor the chemical composition of the classroom aquarium and samples collected through field investigation, and interpret findings based on knowledge gained in the classroom.
CCSS.ELA-Literacy.SL.11-12.4	Interpret and present findings related to aquarium chemistry data, convincingly conveying evidence as to the status of aquarium conditions in relation to supporting marine organisms.
ISTE Knowledge Constructor (Standard 3)	Use digital tools to support data analysis relative to aquarium conditions, thus providing a meaningful learning experience for themselves and their research partners.
NGSS.HS.PS1-5	Assess oxygenation levels in tide pools, observing variation resulting from biotic and abiotic factors including temperature (molecular collisions), wave action, and biological oxygen demand.
NGSS.HS.LS2-4	Quantitatively assess the presence and concentration of various nitrogen compounds cycling in classroom aquariums as an indicator of tank readiness for sustaining marine organisms.

Unit Essential Questions

- What is a biogeochemical cycle, and how do nitrogen and phosphorous cycle in the marine environment?
- What levels of salinity, nitrogen, and phosphorous are typically observed in the near shore habitats of Long Island Sound, and what patterns of oxygenation are observed?
- What conditions are optimal for sustaining a classroom marine aquarium, and why are they essential?
- What equipment and components are required to create and maintain optimal marine aquarium conditions?

Scope and Sequence

- Classroom aquarium
  - Functions and configurations of components

    - Set-up and maintenance
- Characteristics of sea water: oxygenation, salinity/density, micro-components, temperature, pH, turbidity
- Nutrient cycling: extended focus on nitrogen in the classroom aquarium in preparation for introduction of collected specimens

Assured Assessments

Formative Assessment:
Component/Structure Vocabulary Quiz:
Sustaining a marine aquarium requires relatively narrow parameters for oxygen, nitrogen, and pH, among other things. Specific equipment supports these conditions. Students will use a guide document to set up their group aquarium, with instructor oversight. Following set-up, students will complete a vocabulary quiz that will be evaluated to determine each student's level of understanding of the components and structure of the physical system that will be maintained for the remainder of the course. Results will be used to inform subsequent instruction and scores will be entered into the Formative Assessments category of the gradebook.

Summative Assessment:
Nitrogen Cycling in the Classroom Aquarium:
Students will use digital tools to graphically represent nitrogen aquarium data collected over approximately 30 days; subsequently, students will prepare a written summary (a) explaining the process of nitrogen cycling; (b) interpreting the conditions found within the tank; and (c) discussing the readiness of the tank to introduce marine organisms. The THS school-wide writing rubric will be the basis for assessing levels of comprehension, with an added component for assessing the data presentation section. Scores will be recorded in the Laboratory category of the gradebook.

Resources

<u>Core</u>

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.
- Classroom Aquarium handouts
- Dissolved Oxygen Test procedures
- Tank Preparation – Nitrogen Cycle
- Nitrogen Compound Test Procedures

<u>Supplemental</u>

- A Simple Guide to Establishing and Maintaining a Reef Aquarium
- There's Something Fishy cycling handout

Time Allotment

- Approximately 5 weeks, overlapping with Unit 2

UNIT 2
Shore to Shallows: Estuarine Communities of Long Island Sound

Unit Goals

At the completion of this unit, students will:

CCSS.ELA-Literacy.WHST.11-12.4	Produce clear and coherent field study summaries in a scientific style appropriate to the course and task.
CCSS.ELA-Literacy.SL.11-12.1	Initiate and participate effectively in lab group and full-class discussions connecting classroom content to laboratory and field study findings, building on others' ideas and expressing their own clearly and persuasively.
NGSS.HS.LS4-2	Construct an evidence-based explanation, including morphology, distribution, tolerance, and abundance, of evolution based on evidence of the potential for various marine crab species and barnacle species to increase, variation within the species as a result of mutation and breeding, competition for resources, and the survival of those most fit.
NGSS.HS.LS4-4	Construct an evidence-based explanation for how natural selection leads to adaptation of marine populations, with observation and collection in the laboratory of multiple shore habitats.
NGSS.HS.LS4-5	Evaluate the evidence supporting claims that changes in marine conditions (anthropogenic and non-anthropogenic), such as temperature, nitrogen levels, and acidity, may result in increases in the number of individuals of some species and the extinction of other species.

Unit Essential Questions

- Why are estuaries important, and what ecosystems are present in the Long Island Sound estuary?
- What are the general abiotic characteristics of the Sandy Beach, Salt Marsh, and Rocky Shore intertidal zones, and what are the specific features found in these shore habitats of Long Island Sound?
- What organisms are commonly found in the Long Island Sound estuary, and what physical and behavioral adaptations are present that affect their "fitness" for the conditions to which they are exposed?
- How has human activity affected the biological diversity and geography of Long Island Sound?

- How does Long Island Sound affect the local Connecticut economy and society, past and present, and what organizations and regulations are in place or proposed to protect the Sound?
- What role does Long Island Sound play in local climate regulation?

Scope and Sequence

1. Long Island Sound
    a. Formation
    b. Water supply and challenges
    c. Economics, past and present
2. Currents and tides in the Long Island Sound estuary
    a. Coastal currents
    b. Tides
3. Interdependence of organisms
    a. Habitat vs. niche
    b. Adaptations
        i. Structural: shell, claws, shape, gills, etc.
        ii. Behavioral: burrowing, schooling, etc.
4. Ecosystems and food webs of the Long Island Sound estuary
    a. Sandy Beach: characteristics, challenges to survival, food web, invasive species
    b. Salt Marsh: characteristics, challenges to survival, food web, invasive species
    c. Rocky Shore: characteristics, challenges to survival, food web, invasive species

Field Studies

- Beach overview
- Sandy Beach: profile, collection, speciation, water temperature, salinity
- Salt Marsh: profile, collection, speciation, water temperature, salinity
- Rocky Shore: tide pool study (oxygenation and salinity), collection, speciation

Assured Assessments

Formative Assessment:
Field Study #1: Overview of the Long Island Sound Shoreline:
Student groups will be assigned tasks for each field study and share data on the following day. Field Study #1 is the Beach overview during which groups observe obvious human impact on the beach (refuse, structures, shipping, and airports), shore birds, boundaries, and general beach configuration. One group will develop and project in front of the classroom a map that will subsequently be used by all groups to share data.
Students will then write a brief summary of the shared findings and their interpretation of the quality of the beach. For this ambiguous question, they must provide support for their response. This summary is an introduction to more elaborate field studies and is used as an instructional aid to guide students toward future success. Written summaries will be evaluated using the THS school-wide writing rubric and be entered into the Formative Assessments category of the gradebook.

Summative Assessment:
Aquarium Lab Practicum:
Student knowledge of the organisms of the three major Long Island Sound habitats will be evaluated in a lab practicum setting at the conclusion of the Shore to Shallows unit. Specimens and images will be placed at stations in the laboratory; related questions as to habitat, diet, adaptations for survival, and common and scientific names must be completed. The level of proficiency will be determined by the number of correct responses. The score on this practicum will be entered into the Test/Quiz category of the gradebook.

Resources

Core

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.

Supplemental

- "Estuaries." NOAA's National Ocean Service Education. NOAA, 25 Sept. 2007. Web. http://oceanservice.noaa.gov/education/kits/estuaries/estuaries01_whatis.html.
- Lerman, Matthew. *Marine Biology: Environment, Diversity, and Ecology.* Menlo Park, CA: Benjamin/Cummings, 1986. Print.
- "Long Island Sound Formation." YouTube. YouTube, 05 March 2012. Web. https://www.youtube.com/watch?v=eeeIgDs4SdY.
- Maritime Aquarium. "Long Island Sound – Conservation." YouTube. Maritime Aquarium Norwalk, 14 July 2016. Web. https://www.youtube.com/watch?v=XLnAuaHpNeo.
- NURTECUCONN. "ROV Exploration of Long Island Sound 2013." YouTube. YouTube, 20 Jan. 2014. Web. https://www.youtube.com/watch?v=tz_QX4R2hg0.
- "Oyster Fishing on Long Island Sound." Vimeo. Bruce Museum, 2014. Web. https://vimeo.com/83979515.
- Tavee, Tom, & H. Bruce Franklin. *Discover* Sept. 2001: n.p. Web. http://discovermagazine.com/2001/sep/featfish.

Time Allotment

- Approximately 7 weeks, partially overlapping with Unit 1

UNIT 3
Beyond the Beach: The Physical Ocean: Exploration and Discovery

Unit Goals

At the completion of this unit, students will:

CCSS.ELA-Literacy.RST.11-12.3	Follow precisely complex multistep procedures when carrying out investigations related to plate tectonics, currents, and bathymetry, gaining an understanding of geology and fluid dynamics in the marine environment.
CCSS.ELA-Literacy.RST.11-12.7	Integrate and evaluate multiple sources of information presented in print, audio, and video formats to understand the theory of plate tectonics, the use of technology in marine exploration, and the implications of recent bathymetric findings.
CCSS.ELA-Literacy.SL.11-12.1	Initiate and participate effectively in lab group and full-class discussions connecting classroom content in collaborative conversations related to the physical ocean, building on others' ideas and expressing their own clearly and persuasively.
ISTE Knowledge Constructor (Standard 3)	Explain the formation of and describe characteristics of the physical ocean (water column and sea floor) by critically curating resources using digital tools, and effectively create artifacts to demonstrate understanding.
NGSS.HS.LS2-7	Investigate plastic accumulation in major ocean gyres and the effects on marine species; discuss and design options for addressing this issue.
NGSS.HS.ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
NGSS.HS.ESS2-1	Develop a physical model of the sea floor to illustrate the effects of Earth's internal processes, creating the features visible on Earth's surface and below the ocean, clearly identifying regions of new crust formation, subduction of older crust, and the convective forces involved.
NGSS.HS.ESS2-2	Analyze geoscience data related to CO_2 in the atmosphere and pH levels in the ocean; discuss the positive feedback loop involving increasing atmospheric temperatures, melting snow and ice

(exposing darker surfaces that absorb energy and increase the rate of melting ice), and the potential for increased coastal damage resulting from rising seas, increased coastal storms, and elimination of natural barriers such as salt marshes, coral reefs, and mangrove forests.

Unit Essential Questions

- What major features are present on the sea floor, and what forces have contributed to their formation?
- By what means, and by whom, has sea floor bathymetry been studied, both past and present, and why is this study important?
- What causes the formation of surface and deep ocean currents?
- How do ocean currents affect climate and biological diversity in terrestrial and marine ecosystems?
- How might changing atmospheric temperatures affect marine currents, and what effects might changes in currents have on terrestrial and marine ecosystems?

Scope and Sequence

1. History of marine exploration
    a. Missions and explorers
    b. Methods
2. Discoveries
    a. Abyssal plain, sea mounts, ridges, rifts, trenches, volcanoes
    b. Hydrothermal vents
3. Plate tectonics – mechanism for change
    a. Earthquake mapping lab
    b. Convection – the driving force
    c. Sea floor map interpretation and bathymetric mapping
4. Currents
    a. Heat distribution
    b. Deep ocean currents & thermohaline conveyor – convection lab
    c. Surface currents
        i. Coriolis and wind
        ii. Modeling the Gulf Stream – gyres, eddies, currents
        iii. *The Great Pacific Garbage Patch*
5. Zonation
    a. Provinces
        i. Naming systems
        ii. Characteristics
    b. Thermocline
6. Climate
    a. Effects of changing ocean temperatures on ocean currents

b. Positive feedback loops and sea level rise
c. Severe storms, rising seas, and loss of natural barriers: high potential for coastal damage

Assured Assessments

Formative Assessment:
Bathymetric Mapping:
Students will work collaboratively in lab groups to create a bathymetric map of a specific feature of the sea floor, following a procedure provided. Students will display the map to the full class for interpretation, and then lead classmates in a brief discussion as to where this type of feature would likely be found relative to various types of plate boundaries. This activity will precede the unit assessment, and provide the instructor an opportunity to clarify and correct misconceptions regarding features of the sea floor. Focused participation in the mapping and presentation segments will be entered into the gradebook as a Formative Assessment.

Summative Assessment:
Students will complete a unit test covering the major aspects of the physical ocean, which will be graded using a point-value approach. Free-response questions will be included, and graded based on inclusion of key vocabulary and clear explanation of concepts. Mastery will be indicated through percentage of correct responses to multiple-choice questions and accuracy of information provided in the free-response section. Scores will be incorporated into the Test/Quiz category of the gradebook.

Resources

Core

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.

Supplemental

- Lerman, Matthew. *Marine Biology: Environment, Diversity, and Ecology.* Menlo Park, CA: Benjamin/Cummings, 1986. Print.
- *How the Earth Was Made*. Dir. Peter Chinn. Perf. Edward Herrmann. A&E Television Networks, 2009. DVD.
- Molnar, William. *Environmental Science Laboratory Investigations.* Saddle Brook, NJ: Peoples, 2005. Print.
- *The Weather.* Dir. John Maguire and Ben Fox. Perf. Donal McIntyre. BBC, 2003. DVD.

Time Allotment

- Approximately 3 weeks

UNIT 4

Beyond the Beach: Ecosystems and Adaptations of Organisms in the Oceanic Province

Unit Goals

At the completion of this unit, students will:

CCSS.ELA-Literacy.RST.11-12.3	Follow precisely complex multistep procedures to dissect clam, squid, and shark specimens, remaining aware of lab safety practice while observing and identifying structures using resources provided.
CCSS.ELA-Literacy.RST.11-12.7	Integrate and evaluate print, digital, and video formats to gain knowledge as to why the integrity of coral reefs is declining globally.
NGSS.HS.LS1-2 NGSS.HS.LS2-3	Analyze global fish population data for various species, formulating and revising explanations for observed decreases, increases, and fluctuations of various species.
NGSS.HS.LS2-8	Evaluate the evidence for the role of group behavior, such as schooling in many fish species, shared nutrients between coral polyps, and group hunting among cetaceans, in increasing the chances of species survival and reproduction.
NGSS.HS.LS4-4	Construct an evidence-based explanation for how abiotic and biotic factors such as temperature, acidity, geographic barriers, and food availability can affect natural selection (including reproduction) and ultimately change gene frequency over time within populations.

Unit Essential Questions

- What are the major marine ecosystems identified around the globe, and how are they similar and different, both in biotic and abiotic terms?
- By what mechanism do coral reefs form, what unique ecosystem services do they provide, and why should they be a priority to conserve?
- How do organisms within the same marine phylum differ, and how do these adaptations indicate a common evolutionary past and facilitate survival?
- How do marine animal phyla differ, and what adaptations, generally, facilitate survival in the environments they inhabit?
- What factors potentially limit population growth in the marine environment, and what adaptations for survival, both behavioral and structural, are observed in marine organisms?
- How has human activity affected biological diversity in the Oceanic Province?

Scope and Sequence

1. Marine ecosystem overview
    - Antarctic, arctic, mangrove forest, coral reef, kelp forest, abyssal plain, deep sea (water column), open ocean (surface)
    - Review of Sandy Beach, Salt Marsh, Rocky Shore
2. Interdependence and diversity of organisms
    - Overview of marine phyla
    - Food webs
        - Antarctic – krill as keystone species
        - Arctic – odontocete
        - Deep Sea – Georges Bank
    - Niches – Shark feature
        - Diversity – structure, geography, niche
        - Research
        - Status
    - Adaptations – comparison to the neritic organisms of Long Island Sound
        - Structural
        - Behavioral
    - Comparative anatomy
        - Dissection – clam, squid, shark
        - Coelacanth – evidence of evolution
3. Coral reef
    - Formation
    - Characteristics
    - Zonation
    - Ecosystem services
    - Threats and current research
4. The effects of human activity in the Oceanic Province

Assured Assessments

Formative Assessment:
Shark Identification, Group and Individual:
Students will use a taxonomic key to determine the species of shark they will be dissecting. This requires familiarity with shark anatomy gained in earlier lessons. Students will track the choices they make, thus allowing the instructor to follow their path or reasoning and identify incorrect interpretations. This will reinforce vocabulary and reasoning skills essential in the dissection to follow. The teacher will confirm or correct as needed. When finished, students will complete a brief shark dissection pre-quiz to confirm understanding. Results will be used to inform instruction prior to dissection and scores will be entered into the Formative Assessments category of the gradebook.

Summative Assessment:
Comparative Anatomy Practicum:
At the conclusion of the comparative anatomy segment of the course, student learning will be assessed using a lab practicum format. Clam, squid and shark specimens will be placed at stations in the laboratory; questions will include structural identification, function, adaptations, and interspecific comparisons. The level of proficiency will be determined by the number of correct responses, and scores on this practicum will be entered into the Test/Quiz category of the gradebook.

Resources

Core

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.

Supplemental

- Lerman, Matthew. *Marine Biology: Environment, Diversity, and Ecology.* Menlo Park, CA: Benjamin/Cummings, 1986. Print.

Time Allotment

- Approximately 3 weeks

UNIT 5
The Future of Oceans

Unit Goals

At the completion of this unit, students will:

CCSS.ELA-Literacy.RST.11-12.7 NGSS.HS.ESS3-6	Integrate and evaluate quantitative data, video, and multimedia digital information related to the U.S. National Marine Sanctuaries to understand the unique aspects of this sanctuary and the need for its protection.
CCSS.ELA-Literacy.WHST.11-12.4 NGSS.HS.ETS1-1	Produce a clear and coherent summary of a marine related problem and potential solution, with development, organization, and style appropriate to course expectations.
CCSS.ELA-Literacy.SL.11-12.4	Present information, findings, and supporting evidence regarding marine sanctuaries and marine protection legislation, conveying a clear and distinct perspective appropriate to the audience.
CCSS.ELA-Literacy.SL.11-12.5	Make strategic use of textual, graphical, audio, visual, and/or interactive digital elements in marine sanctuary presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
ISTE Creative Communicator (Standard 6)	Communicate clearly within working groups and during presentations to express themselves creatively using platforms, tools, styles, formats, and digital media appropriate to task.
ISTE Global Collaborator (Standard 7)	Use digital tools to collaborate within working groups to address research questions and broaden their perspective.
NGSS.HS.LS1-2 NGSS.HS.LS2-3	Analyze data sets such as shark research data, sanctuaries' biodiversity data and cetacean data, and associated legislation to describe factors affecting biodiversity and current trends.
NGSS.HS.LS2-6	Evaluate the claims, evidence, and reasoning supporting that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, and create a food web of a given sanctuary to support findings. Explain how changing conditions, both natural and those caused by humans, such as overfishing, volcanic

eruption, or resource extraction, may result in creation of a new ecosystem.

Unit Essential Questions

- How has the human population affected global oceans?
- What actions have been taken in the United States and internationally to assure long-term sustainability of critical marine species and habitats, and how were these actions accomplished?
- What progress, if any, has resulted from the national and international actions taken to assure long-term sustainability of critical marine species and habitats?
- How are the U.S. National Marine Sanctuaries similar and different, and why are they important culturally, economically, and environmentally?
- What can be done, nationally and internationally, to further protect marine biological diversity and sustain healthy, abundant biodiversity for future generations, and what barriers to such actions exist?

Scope and Sequence

- Legislation aimed at protecting the marine environment
  - United States: Magnuson-Stevens Fishery Conservation and Management Act; Endangered Species Act; Marine Mammal Protection Act; Antiquities Act; National Marine Sanctuaries Act; National Environmental Protection Act; Lacey Act; Pelly Amendment; Packwood-Magnuson Amendment; Prevent Pollution from Ships; Marine Debris Research, Prevention, and Reduction Act; Shore Protection Act (SPA)
  - International: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); United Nations Convention on the Law of the Sea (UNCLOS); International Whaling Convention
- Effectiveness of national and international conservation efforts – Shark Case Study
  - Diversity – structure, geography, niche
  - Research
  - Legislation – U.S. and CITES
  - Challenges
  - Status
- United States National Marine Sanctuaries Project
  - Mission and overview
  - Process for establishing NMS
  - Group projects

Assured Assessments

Formative Assessment:
"I've Got the Law . . .":
Students will work with two color-coded sets of cards, one with the name of a regulation and one describing its major provisions or purpose. Half of the class will have law cards and half

provision cards. Each student with a provision cards will read his/her card. A student who believes he/she has the corresponding law card will stand. Full class input will be solicited before a match is made. Once all are paired and confirmed by the teacher, students will switch roles and use remaining cards to repeat the activity. Results of this activity will inform follow-up instruction and clarification. This is a non-graded assessment; however, participation is required and will contributes to the overall participation grade included in the Formative Assessments section of the gradebook.

Summative Assessment:
Two-Part U.S. National Marine Sanctuaries Project:
(1) Presentation:
Student groups will prepare and present an oral presentation featuring one of the U.S. National Marine Sanctuaries (NMS). Detailed content requirements will be provided in a project handout. Student will work collaboratively to access digital resources and learn about the natural history of their sanctuary and the efforts taken to set it aside, including applicable legislative efforts. Students will research species common to the area and create a food web illustrating biodiversity and feeding relationships. Students must include one shark species in the food web and one marine mammal common to this area. Presentations will also include a profile of a marine mammal native to the sanctuary. Students will describe characteristics, adaptations for survival, breeding patterns, threats, and status. Finally, presentations should include an environmental quality update of the sanctuary and cite threats to maintaining the sanctuary. This presentation should include many visual images that support findings; however, the specific format will be up to the discretion and creativity of the group. Presentations may include student videos, slide presentations, Prezi, demonstrations, or simulations. Presentations will be evaluated utilizing the project rubric, the THS school-wide independent learning and thinking rubric, and the THS school-wide critical thinking rubric, and scores will count as a summative assessment in the gradebook.
(2) Sanctuary Summary:
Student groups will prepare and submit a written sanctuary summary with essential information outlined in the project handout and including a Works Cited page in MLA format. Summaries will be evaluated using the THS school-wide writing rubric, and scores will count as a summative assessment in the gradebook.

Resources

Core

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.
- "NOAA National Marine Sanctuaries." *NOAA National Marine Sanctuaries.* NOAA, 2016. Web. http://sanctuaries.noaa.gov/.

Supplemental

- "Investing in Your National Marine Sanctuaries." *National Marine Sanctuaries.* NOAA, 20 June 2014. Web. http://sanctuaries.noaa.gov/videos/investment/welcome.html.
- "NOAA Fisheries: Laws and Policies." *NOAA Fisheries.* NOAA, Dec. 2015. Web. http://www.nmfs.noaa.gov/pr/laws/.

Time Allotment

- Approximately 2 weeks

COURSE CREDIT

0.625 credit in Science
One class period daily for a half year

PREREQUISITES

A course grade of B or higher in ACP Biology and ACP Chemistry, or permission of the Department Chair.

TEXT

Greene, Thomas F. *Marine Science: Marine Biology and Oceanography.* 2nd ed. New York: Amsco, 2004. Print.

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric
- Trumbull High School School-Wide Critical Thinking Rubric
- Trumbull High School School-Wide Independent Learning and Thinking Rubric

SCHOOL-WIDE RUBRICS

Rubric 2: Write Effectively

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_____	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_____	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_____	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_____	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors. Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Rubric 3: Problem Solving through Critical Thinking

Category/Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X_____	Student demonstrates clear understanding of the problem and the complexities of the task	Student demonstrates sufficient understanding of the problem and most of the complexities of the task	Student demonstrates some understanding of the problem but requires assistance to complete the task	Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_____	Student gathers compelling information from multiple sources including digital, print, and interpersonal	Student gathers sufficient information from multiple sources including digital, print, and interpersonal	Student gathers some information from few sources including digital, print, and interpersonal	Student gathers limited or no information
Reasoning and Strategies X_____	Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	Student demonstrates some critical thinking skills to develop a plan integrating some strategies	Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_____	Solution shows deep understanding of the problem and its components. Solution shows extensive use of 21st Century Technology Skills.	Solution shows sufficient understanding of the problem and its components. Solution shows sufficient use of 21st Century Technology Skills.	Solution shows some understanding of the problem and its components. Solution shows some use of 21st Century Technology Skills.	Solution shows limited or no understanding of the problem and its components. Solution shows limited or no use of 21st Century Technology Skills.

Rubric 5: Independent Learners And Thinkers

Category/Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X_____	Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work.	Student demonstrates initiative by generating appropriate questions, creating original projects/work.	Student demonstrates some initiative by generating questions, creating appropriate projects/work.	Student demonstrates limited or no initiative by generating few questions and creating projects/work.
Independent Research & Development X_____	Student is analytical, insightful, and works independently to reach a solution.	Student is analytical, and works productively to reach a solution.	Student reaches a solution with direction.	Student is unable to reach a solution without consistent assistance.
Presentation of Finished Product X_____	Presentation shows compelling evidence of an independent learner and thinker. Solution shows deep understanding of the problem and its components. Solution shows extensive and appropriate application of 21st Century Skills.	Presentation shows clear evidence of an independent learner and thinker. Solution shows adequate understanding of the problem and its components. Solution shows adequate application of 21st Century Skills.	Presentation shows some evidence of an independent learner and thinker. Solution shows some understanding of the problem and its components. Solution shows some application of 21st Century Skills.	Presentation shows limited or no evidence of an independent learner and thinker. Solution shows limited or no understanding of the problem. Solution shows limited or no application of 21st Century Skills.