

TRUMBULL PUBLIC SCHOOLS
Trumbull, Connecticut

ACP Marine Science & Environmental Science
Grade 12

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(Last Revised 2016)

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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

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 processes and systems through focused study of the marine environment.

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 7.8 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 organization of this course is similar to that outlined in the prior curriculum guide (2016) with updates to materials and assessments.

COURSE GOALS

The following course goals 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 of 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-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.

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

CCSS.ELA-LITERACY.RI.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.RI.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 course goals derive from the 2016 International Society for Technology in Education Standards.

ISTE Knowledge Constructor

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

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

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

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 know . . .
 - 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

ACP

Prerequisites

Grade of B or better in ACP Biology and ACP Chemistry, or with permission of the department chairperson.

General Description of the Course

ACP Marine Science is a field-based elective that provides students with an introduction to the marine environment, emphasizing the ocean and Long Island Sound. Students will take a hands-on approach by exploring and investigating the marine environment by taking field trips during laboratory periods to Lordship salt marsh, beaches, and other local selected sites. Several all-day fields trips include the Museum of Natural History and South Street Seaport in New York, and the Mystic Marine Life Aquarium. Students will also be expected to carry out independent projects as well as set up and maintain a saltwater aquarium in the classroom. Student work will be evaluated using a variety of techniques in order to accommodate and recognize the different learning styles. Students enrolling in Marine Science must enroll in Environmental Science for the spring semester.

Assured Assessments

Formative Assessments:

- Weekly classroom aquarium data (pH, temperature, salinity, nitrogen cycling)
- Vocabulary quiz on components of marine aquarium (Unit 1)
- Field Studies: Long Island Sound shoreline (Unit 2)
- Bathymetric mapping (Unit 3)
- Shark identification (Unit 4)
- Ecosystem Conservation Campaign (Unit 5)

Summative Assessments:

- Graphs and summary of aquarium data (Unit 1)
- Long Island Sound test (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

Green, 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:

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.
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	Use digital tools to support data analysis relative to aquarium conditions. thus providing a meaningful learning experience for themselves and their research partners.

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?

Unit Scope and Sequence

- Classroom Aquarium
 - Functions & configurations of components
 - Set-up and maintenance
- Characteristics of sea water: oxygenation, salinity/density, micro-components, temperature, pH, turbidity

Unit 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 Practice and Preparation 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

Core

- Green, Thomas F. Marine Science: Marine Biology and Oceanography. 2nd ed. New York: Amsco, 2004. Print.
- Classroom Aquarium handouts
- Tank Preparation
- Water Quality handout and test procedures

Supplemental

- The Nitrogen Cycle and "New Tank Syndrome"
- "There's Something Fishy" The Nitrogen Cycle

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:

NGSS.HS-PS4-2

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 nonanthropogenic), 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.

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.

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?

Unit Scope and Sequence

- Long Island Sound Estuary
 - Formation
 - Water supply & challenges
 - Economics, past and present
- Currents and tides in Long Island Sound
 - Coastal currents
 - Tides
- Interdependence of organisms
 - Habitat versus niche
 - Adaptations
 - Structural: shell, claws, shape, gills, etc.
 - Behavioral: burrowing, schooling, etc.
- Ecosystems & food webs of Long Island Sound
 - Characteristics, challenges to survival, food web, invasive species of:
 - Sandy Beach
 - Salt Marsh
 - Rocky Shore

Unit Assured Assessments

Formative Assessment:

Field Studies: Overview of the Long Island Sound Shoreline - Sandy Beach, Salt Marsh and Rocky Shore.

Student groups will be assigned tasks for each field study and share in the lab. Tasks include observations of human impact on the beach (refuse, structures, shipping, and airports), flora and fauna observed (macroalgae, vascular plants, invertebrates, and vertebrates), boundaries, general beach configuration, and water quality 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. These summaries are used as an instructional aid to guide student understanding of changes in marine environments. Written summaries will be evaluated using the THS school-wide writing rubric and be entered into the Lab category of the gradebook.

Summative Assessment:

Student knowledge of the organisms biotic and abiotic characteristics of Long Island Sound habitats will be assessed 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 with related multiple choice and free response questions as to habitat, diet, and adaptations for survival must be completed.

Resources

Core

- Green, Thomas F. *Marine Science: Marine Biology and Oceanography*. 2nd ed. New York: Amsco, 2004. Print.
- Connecticut Sea Grant Long Island Sound Resource Guide
- Long Island Sound Study
- Know Your Shells handout
- Seine Net Procedure and Data

Supplemental

- “A Student’s Guide to the Phytoplankton of Long Island Sound.” University of Connecticut Sea Grant, 29 Mar. 2012. Web.
https://seagrant.uconn.edu/wp-content/uploads/sites/1985/2021/10/Phytoplankton_Guide.pdf
- “Estuary Habitat.” NOAA’s Office of Habitat Conservation. NOAA, 27 July 2022. Web.
<https://www.fisheries.noaa.gov/national/habitat-conservation/estuary-habitat>.
- Van Patten, Margaret. *Seaweeds of Long Island Sound*. 2nd ed. Connecticut: Sea Grant and College Arboretum, 2009. Print.
- Van Patten, M. Moore, M. O’Muin, E. *Sound facts: fun facts about Long Island Sound*. 2nd ed. Connecticut: Sea Grant, 2009. Print.
- Warren, R. Barrett, J. Van Patten, M. *Salt Marsh Plants of Long Island Sound*. Revised 2nd ed. Connecticut: Sea Grant and College Arboretum, 2009. Print.

Time Allotment

- Approximately 7 Weeks, overlapping with Unit 1

UNIT 3

The Physical Ocean: Exploration and Discovery

Unit Goals

At the completion of this unit, students will:

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.
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 fullclass 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	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.

Unit Essential Questions

- What major features are present on the sea floor, and what forces have contributed to their formation?
- In an era of environmental degradation, how does bathymetry play a pivotal role?
- 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?

Unit Scope and Sequence

- History of marine exploration
 - Missions, explorers and methods
- Discoveries
 - Abyssal plain, sea mounts, ridges, rifts, trenches, volcanoes
 - Hydrothermal vents
- Tectonism - mechanism for change
 - Earthquake mapping
 - Convection - the driving force
 - Sea floor map interpretation and bathymetric mapping
- Currents
 - Heat distribution
 - Deep ocean currents & thermohaline circulation
 - *The Great Pacific Garbage Patch*
- Zonation
 - Provinces
 - Naming systems and characteristics
 - Thermocline
- Climate
 - Effects of changing ocean temperatures on ocean currents
 - Positive feedback loops and sea level rise
 - Coastal damage: severe storms, rising seas, and loss of natural barriers

Unit Assured Assessments

Formative Assessment:

Bathymetric Mapping:

Students will work collaboratively in groups to create a bathymetric map of a specific feature of the sea floor, following a procedure provided. Students will present the map to the 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. Scores will be incorporated into the Preparation and Practice category of the gradebook.

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 Application and Assessment category of the gradebook.

Resources

Core

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

Supplemental

- “Long Island Sound Habitat Mapping.” Long Island Sound Study. University of Connecticut, Mar. 2018. Web. <https://lismap.uconn.edu/story-map-overview/>.
- “Long Island Sound Formation.” YouTube. YouTube, 05 March 2012. Web. <https://www.youtube.com/watch?v=eeeIgDs4SdY>.
- NURTECUCONN. “ROV Exploration of Long Island Sound 2013.” YouTube. YouTube, 20 Jan. 2014. Web. https://www.youtube.com/watch?v=tz_QX4R2hg0.
- Ocean Voyages Institute - Project Kaisei. “LARGEST OPEN OCEAN CLEAN-UP IN HISTORY.” YouTube. YouTube, 25 Jun 2020. Web. <https://www.youtube.com/watch?v=U7Ka0stsTO0>.
- “Seabed 2030: Map the Gaps.” NOAA’s National Centers for Environmental Information. NOAA, 29 July 2022. Web. <https://www.ncei.noaa.gov/news/seabed-2030-map-gaps>.
- The Ocean Cleanup. “This Is The Largest Cleanup in History | The Ocean Cleanup.” YouTube. YouTube, 06 Apr. 2022. Web. <https://www.youtube.com/watch?v=Pv1Otdg4fok>.

Time Allotment

- Approximately 3 Weeks

UNIT 4

Ecosystems and Adaptations of Organisms in the Oceanic Province

Unit Goals

At the completion of this unit, students will:

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.
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.

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?

Unit Scope and Sequence

- Marine Ecosystems overview
 - Antarctic, arctic, mangrove forest, coral reef, kelp forest, abyssal plain, deep sea (water column), open ocean (surface)
 - Review of Sandy Beach, Salt Marsh, and Rocky Shore
- 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
- Coral reef
 - Formation & characteristics
 - Zonation
 - Ecosystem services
 - Threats and current research
- The effects of human activity in the Oceanic Province

Unit Assured Assessments

Formative Assessment:

Shark Identification:

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-check to confirm understanding. Results will be used to inform

instruction prior to dissection and scores will be entered into the Preparation and Practice 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. 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 Application and Assessment category of the gradebook.

Resources

Core

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

Supplemental

- Netflix. “Chasing Coral | Full Feature | Netflix.” YouTube. YouTube, 17 Apr. 2020. Web. <https://www.youtube.com/watch?v=aGGBGcjdjXA>.

Time Allotment

- Approximately 3 Weeks

UNIT 5

The Future of the Ocean

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS3-6 CCSS.ELA-LITERACY.RST.11-12.7	Integrate and evaluate quantitative data, video, and multimedia digital information related to the U.S. National Marine Sancturaries to understand the unique aspects of this sanctuary and the need for its protection.
NGSS.HS-ETS1-1	Produce a clear and coherent summary of a marine related problem and potential solution(s), with development, organization, and style appropriate to course expectations.
NGSS.HS-LS1-2 NGSS.HS-LS2-3	Analysze data sets such as 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.
CCSS.ELA-LITERACY.RST.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.RST.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	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

Use digital tools to collaborate within working groups to address research questions and broaden their perspective.

Unit Essential Questions

- 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?

Unit 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; 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; Marine Pollution Prevention from Ships (MARPOL)
- Effectiveness of national and international conservation efforts – Shark Case Study
 - Diversity – structure, geography, niche
 - Research o Legislation – U.S. and CITES
 - Challenges
 - Status
- United States National Marine Sanctuaries Project
 - Mission and overview
 - Process for establishing NMS
 - Group projects

Unit Assured Assessments

Formative Assessment:

Conserve or Develop?

Students will be divided into groups and given a task to designate a part of the ocean for various forms of development. Groups must then decide whether to conserve or develop. Each location has a different set of characteristics that make it unique and important to the health of the ecosystem. Students need to determine what impacts their decision may have on the environment, the species in the surrounding area, and the local community. Student explanations will be scored using the THS school-wide critical thinking rubric and recorded as Preparation and Practice in 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, efforts taken to set it aside, including applicable legislative efforts, research species common to the area and create a food web illustrating biodiversity and feeding relationships. 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. Presentations may include brief videos, slides, 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 Application and Assessment in the gradebook.
- (2) Sanctuary Summary: Student groups will submit a written sanctuary summary with essential information outlined in the project handout. Summaries will be evaluated using the THS school-wide writing rubric will count as towards the Application and Assessment category in the gradebook.

Resources

Core

- Green, Thomas F. *Marine Science: Marine Biology and Oceanography*. 2nd ed. New York: Amsco, 2004. Print.
- “Investing in Your National Marine Sanctuaries.” National Marine Sanctuaries. NOAA, 20 June 2014. Web. <http://sanctuaries.noaa.gov/videos/investment/welcome.html>.

Supplemental

- “NOAA Fisheries: Laws and Policies.” NOAA Fisheries. NOAA, Dec. 2015. Web. <http://www.nmfs.noaa.gov/pr/laws/>.

Time Allotment

- Approximately 3 Weeks

ACP Environmental Science

Grade 12

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INTRODUCTION & PHILOSOPHY

ACP Environmental Science is designed for students to explore the natural world and the impact humans have on the environment. This course uses earth science, biology, physics, chemistry, and social sciences to understand how the world works and ultimately, the influence humans have on the natural processes and systems. Students will construct, analyze, and evaluate designs for sustainability through current events and sources from within and outside this curriculum document.

The lab component of this course will involve field study, wet labs, and case studies to enhance student mastery. This course provides students with the opportunity to extend their knowledge through field and classroom studies, and integrate their knowledge of social issues as they explore environmental issues and subsequent solutions ultimately needed for a sustainable future.

COURSE GOALS

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

NGSS.HS-LS2-1	Use mathematical and/or computational representations to support explanation of factors that affect carrying capacity of ecosystems at different scales.
NGSS.HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
NGSS.HS-LS2-6	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
NGSS.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
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-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.
NGSS.HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
NGSS.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.
NGSS.HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
NGSS.HS-ESS3-5	Analyze geoscience data and results from global climate models to make evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's 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-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

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

CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
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.W.11-12.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY.WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
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.

The following course goals derive from the revised 2016 International Society for Technology in Education Student Standards.

1.3 Knowledge Constructor	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.
1.5 Computational Thinker	Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

COURSE ENDURING UNDERSTANDINGS

Students will understand that...

- science is a process that is a method of learning more about the world and is constantly changing the way we understand the world.
- the Earth itself is one big interconnected system in which natural systems change over time and space, and biogeochemical systems vary in ability to recover from disturbances.
- humans alter natural systems and impact the environment. Technology and population growth have enabled humans to increase both the rate and scale of their impact.
- Human survival depends on developing practices that will achieve sustainable systems in that a suitable combination of conservation and development is required, and management of common resources is essential.

COURSE ESSENTIAL QUESTIONS

- What processes allow for Earth to maintain its overarching equilibrium and homeostasis?
- How have living organisms added to or subtracted from Earth's ability to maintain homeostasis?
- How has human presence altered these processes, and what impact will it have?
- How can humans alter behavior and practices to mitigate these impacts?

COURSE KNOWLEDGE & SKILLS

- Students will know . . .
 - the composition and major processes that occur in Earth's geosphere, atmosphere, biosphere and hydrosphere.
 - the atmosphere's composition, structure, weather and climate, atmospheric circulation, and El Niño-Southern Oscillation.
 - the greenhouse effect.
 - major reservoirs and fluxes of the major biogeochemical cycles.
 - how biotic and abiotic factors affect an ecosystem.
 - how life is organized in an ecosystem.
 - the process of evolution by natural selection.
 - the concept of adaptation.
 - the differences among food chains, food webs, trophic levels, and ecological pyramids and energy flows.
 - how species contribute to ecological succession.
 - what a keystone species is.
 - what factors contribute to biodiversity and its importance to ecological health.
 - characteristics of each major biome and examples.
 - what ecosystem services are.

- how biotic potential, limiting factors, and carrying capacity play a role in population ecology.
- what an invasive species is, characteristics that make an organism prone to becoming invasive, and the impacts invasive species may cause.
- the characteristics (total fertility, birth rate, death rate) of a population and examples of countries or regions in each stage.
- strategies for sustainability as population size continues to increase.
- problems caused by rapid human population growth.
- relevant laws and treaties associated with the loss of biodiversity.
- the distribution of Earth's water resources.
- the relationship between groundwater and surface water in a watershed.
- the difference between point- and nonpoint- source pollution.
- primary air pollutants and sources of each.
- effects of air pollution on human health.
- the impact of noise and light pollution on humans and the environment.
- how acid precipitation affects plants, soils, and aquatic ecosystems.
- how the ozone layer shields Earth from harmful radiation and the impact chlorofluorocarbons have on it.
- how urban sprawl has affected the environment.
- how the federal highway system, canals and channels, and transportation systems have fragmented wildlife and the increase in wildlife corridors as a solution.
- the differences and functions of national parks and wilderness areas.
- the concept of ecosystem services.
- benefits and environmental impacts of pesticide use.
- use of genetic engineering in agriculture.
- the current role of aquaculture in providing seafood.
- the manner in which mining companies explore and collect new mineral deposits.
- examples of national policies that relate to mining and reclaiming mined land.
- factors that influence the value of a fuel.
- differences between renewable and nonrenewable energy, forms of energy, and their efficiency.
- how nuclear waste is stored and the challenge behind storing it.
- the difference between run of river and stored hydroelectric power.
- process involved and the target pollutant of each step of drinking water treatment.
- the relevant laws and treaties associated with clean water.
- the major types and the treatment/disposal of hazardous waste.
- relevant laws and treaties associated with hazardous waste.
- human activities are impacting the climate system.
- relevant laws and treaties associated with climate change.
- examples of national policies that have been implemented for sustainability.

- Students will be able to . . .
 - Describe the processes that shape each layer of the Earth
 - Describe the challenges that are faced by organisms around the world to access the resource of water.
 - Evaluate the effects of the removal of a keystone species on a given ecosystem.
 - Identify threats to biodiversity.
 - Identify risk factors for each biome based on human desired resources in each.
 - Describe the importance of photosynthesis and cellular respiration in a food chain.
 - Use the rule of 10 to explain why an energy pyramid is an accurate representation of energy flow in an ecosystem.
 - Utilize food chains, food webs, trophic levels, and ecological pyramids in order to evaluate ecological relationships.
 - Identify selection pressures driving the evolution of a given species.
 - Describe the importance of ecosystem services to human kind as well as global ecological health.
 - Describe the stages of succession after a disturbance.
 - Analyze the impacts humans have had on the major biogeochemical cycles.
 - Describe how environmental change will influence an ecosystem's carrying capacity.
 - Plot a given data set to determine which reproductive strategy and survivorship curve has evolved in that species.
 - Design ways to prevent the spread of invasive species.
 - Make predictions about a population's growth using information derived from age-structured data.
 - Identify the benefits and flaws with different types of agriculture.
 - Discuss the costs and benefits of pesticide use.
 - Utilize data regarding global reserves from each fossil fuel and the projected demand to determine when each resource may be exhausted.
 - Identify patterns of energy consumption and production in the world and in the United States.
 - Compare the advantages and disadvantages of fossil fuel use.
 - Identify ways to reduce exposure to indoor air pollutants.
 - Identify the sources, impacts and measures to mitigate noise pollution.
 - Describe how bioaccumulation and biomagnification occurs in food webs.
 - Identify the costs and benefits of septic systems compared to wastewater treatment plants.
 - Identify Superfund sites and discuss what types of cleanup efforts are being put in place to remediate the pollution.
 - Identify factors that determine climate.
 - Identify threats to stratospheric ozone and the consequences to human and ecological health.
 - Analyze and predict what a warmer Earth would look like globally.
 - Design solutions to each human impact of habitat loss, overuse, pollution, introduced species, endangered species, and extinct species.

COURSE SYLLABUS

Course Name

Environmental Science

Level

ACP

Prerequisites

Grade of B or better in ACP Biology and ACP Chemistry, or with permission of the department chairperson.

General Description of the Course

ACP Environmental Science is offered to students to explore the environment and the impacts humans have on it. As an interdisciplinary study, Environmental Science offers students the opportunity to extend their scientific knowledge through field and classroom studies, integrate social issues and government processes, and investigate current environmental issues and potential solutions. Students will collaborate and develop presentations on global environmental issues and solutions and also complete independent research on current environmental issues and policies locally and globally. Student work will be evaluated using a variety of techniques in order to accommodate and recognize different learning styles. Class participation will be an important part of the course. Students are expected to complete all work required for the course and come to class prepared and motivated. An Environmental News Journal and Final Project will be a comprehensive culmination to the course and will be representative of all the work a student does throughout the entire course of study.

Assured Assessments

Formative Assessments:

- Weekly Environmental News analysis (All Units)
- Weekly brief check-in on content (All Units)
- Osteoporosis of the Sea Lab (Unit 1)
- Mark & Recapture Lab (Unit 2)
- Acid Precipitation Lab (Unit 3)
- Renewable versus Nonrenewable Chart (Unit 4)
- Reduce Your Environmental Impact Proposal (Unit 5)

Summative Assessments:

- Test on the Dynamic Earth: Geosphere, Atmosphere, Hydrosphere and Biosphere (Unit 1)
- Biome Project (Unit 2)
- Water Filtration Project (Unit 3)
- Genetically Modified Organisms Discussion (Unit 3)
- Energy Resource Profile (Unit 4)
- Environmental Disaster Final Project

Core Text

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

UNIT 1

Introduction to Environmental Science

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS2-3	Develop a model by observing fault movements to describe the cycling of matter by thermal convection.
NGSS.HS-ESS2-4	Use a model to describe how variations in the flow or energy into and out of Earth's systems result in changes in climate.
NGSS.HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects of Earth materials and surface processes in a sugar cube model lab.
NGSS.HS-ESS3-5	Use ocean acidification lab to illustrate the relationship among Earth systems and how those relationships are being modified due to human activity.
CCSS.ELA-LITERACY.RST.11-12.3	Conduct a tragedy of the commons lab to understand what happens when resources are public.

Unit Essential Questions

- What is the study of environmental science and why is it important?
- How and why have humans altered the environment?
- How can we evaluate the health of the Earth?
- What is the relationship between geographic features of the Earth's crust and its internal processes?

Unit Scope and Sequence

- The Lorax Clip and Reading
- Tragedy of the Commons Lab Activity
- Ecological Footprint Calculator
- The Geosphere
 - Review of Earth's layers, tectonism, earthquakes, volcanoes, weathering & erosion
- The Atmosphere
 - Layers
 - Review of Radiation, Conduction, Convection
 - Greenhouse effect

- The Hydrosphere & Biosphere
 - Hydrologic cycle
 - Thermal regulation
 - Life in the biosphere

Unit Assured Assessments

Formative Assessments:

- Students will work in groups to complete the Osteoporsis of the Sea lab. Free-response questions will be included and graded based on inclusion of key vocabulary and explanation of concepts. Students will evaluate their responses for self-reflection and growth.
- Students will collect environmental news weekly and write a brief analysis. News can be in the form of a print, broadcast, or internet media.
- Weekly brief check-in based on each week's content.

Summative Assessments:

- Students will complete an assessment covering the interacting components of Earth's integrate system. Multiple choice and free-response questions will be included, and graded based on inclusion of key vocabulary and clean explanation of concepts.

Resources

Core

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

Supplemental

- Annenberg Learner. "Dynamic Earth Interactive." *Annenberg Learner*, 27 Nov. 2019. Web. www.learner.org/series/interactive-dynamic-earth.
- "The Lost Worlds of Planet Earth." *Cosmos A Spacetime Odyssey*, created by Ann Druyan and Steven Soter, episode 9, Cosmos Studios, 2014.
- Seuss. *The Lorax (Classic Seuss)*. Random House Books for Young Readers, 1971.
- Student selected environmental weekly news
- Teacher selected articles and multimedia

Time Allotment

- Approximately 2 Weeks

UNIT 2

Ecology: Populations and Communities

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS2-1	Use mathematical and/or computational representations to support explanation of factors that affect carrying capacity of ecosystems at different scales.
NGSS.HS-LS2-4	Develop models to demonstrate the flow of energy, nitrogen, carbon, phosphorus and water.
NGSS.HS-LS2-6	Analyze populations of lynx and hares in order to understand the balance that exists between predator, prey and biomass.
NGSS.HS-LS4-4	Use a computer simulation to understand the process of natural selection, using peppered moths as the organism of study.
NGSS.HS-LS4-5	Use the case of human adaptation on the Tibetan Plateau to understand how changes in the environment may lead to emergence of new traits.
NGSS.HS-ESS3-6	Use a computational representation to illustrate the relationship among Earth systems and how those relationships are being modified due to human activity.
CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
CCSS.ELA-LITERACY.RST.11-12.7	Collect data on human survivorship in order to derive patterns.
1.3 Knowledge Constructor	Critically curate a variety of resources using digital tools to construct knowledge and produce a creative depiction of their biome.

Unit Essential Questions

- How does location influence living organisms?
- What components make up biotic and abiotic factors?

- How do heritable characteristics help organisms survive and reproduce?
- How have humans used artificial selection to cause evolution?
- What factors affect population size and how does overpopulation impact the environment?
- How do changes impact the stability and diversity of an ecosystem?

Unit Scope and Sequence

- Biomes
- Ecosystems are interconnected
 - Biotic and abiotic factors
 - Habitats vs. niches
- Evolution
 - Natural selection
 - Artificial selection
 - Resistance
 - Genetically modified organisms
- Populations
 - Carrying capacity
 - Competition
 - Symbiotic relationships
 - Human population growth
- Biodiversity
 - Keystone species
 - Invasive species
 - Endangered and threatened species
 - Future of biodiversity

Unit Assured Assessments

Formative Assessments:

- Students will complete a mark and recapture lab to communicate their understanding of how population studies can help communities maintain healthy populations.
- Students will collect environmental news weekly and write a brief analysis. It can be in the form of a print, broadcast, or internet media.
- Weekly check-in based on each week's content.

Summative Assessments:

- Student groups will be given a biome to research and develop a presentation on throughout the unit. This will include the type of biome, species adaptations and energy flow, threats to native species and the environment, and conservation efforts. Detailed content requirements will be provided in a handout. Presentations will be evaluated utilizing the project rubric, the THS school-wide independent learning and thinking rubric, and the THS school-wide problem solving through critical thinking rubric. Scores will count as Application and Assessment.

Resources

Core

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

Supplemental

- “DON’T PANIC - Hans Rosling showing the facts about population.” YouTube. YouTube, 15 Dec. 2015. Web. <https://www.youtube.com/watch?v=FACK2knC08E>.
- “Planet Earth: From Pole to Pole” *Planet Earth*, created by Alastair Fothergill and Mark Linfield, episode 1, BBC Natural History Unit, 2006.
- Student selected environmental weekly news
- Sustainable Human. “How Wolves Change Rivers.” YouTube. YouTube, 02 Feb. 2014. Web. <https://www.youtube.com/watch?v=ysa5OBhXz-Q>.
- Teacher selected articles and multimedia

Time Allotment

- Approximately 5 weeks

UNIT 3

Water, Air, and Land

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS2-6	Evaluate evidence that the complex interactions in ecosystems maintain equilibrium and homeostasis, but changing conditions may result in a new ecosystem.
NGSS.HS-LS2-7	Evaluate the environmental impacts of various water and land management practices. Identify sources of air pollution in developing nations and strategies to reduce them.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources has influence human activity.
CCSS.ELA-LITERACY.RST.11-12.3	Conduct an investigation to see how acid deposition forms, the impact it has on aquatic and terrestrial systems, as well as mitigation strategies.

Unit Essential Questions

- What are ecosystem services and how does the United States compare to other nations?
- How are water and land used and managed?
- How are dams and water diversion projects used to manage freshwater resources?
- What are the major sources of ocean pollution and what effect do they have on ecosystems?
- What are primary air pollutants and their sources?
- How does thermal inversion trap air pollution?
- What are the impacts and solutions of light and noise pollution on human health?
- What is the urban crisis and how does urban sprawl affect the environment?
- What are the benefits of preserving farmland and how can they be managed sustainably?

Unit Scope and Sequence

- Water
 - Resources
 - Usage and management
 - The Three Gorges Dam
 - Water scarcity
- Air
 - Pollution - primary air pollutants

- Short-term and long-term health effects
- Noise & light pollution
- Acid Precipitation
- Smog
- Land
 - Usage and management
 - Urban sprawl
 - Ecosystem services
 - Agriculture
 - Food scarcity
 - Soil and pest management
 - Livestock
- Waste
 - Bioaccumulation and biomagnification
 - Hazardous waste management and laws
 - Superfund sites

Unit Assured Assessments

Formative Assessments:

- Students will work in groups to complete the Acid Deposition Lab.
- Students will collect environmental news weekly and write a brief analysis. It can be in the form of a print, broadcast, or internet media.
- Weekly check-in based on each week's content.

Summative Assessments:

- Students will design a water filtration system using various materials. Students will be evaluated on their effort and effectiveness of their filtration system.
- Students will participate in a discussion on the genetically modified organisms (GMOs) as a solution to food security. Students will be evaluated utilizing the THS school-wide Problem Solving Through Critical Thinking rubric. Scores will count as Application and Assessment.

Resources

Core

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

Supplemental

- Crash Course. "Pollution: Crash Course Ecology #11." YouTube. YouTube, 14 Jan. 2014. Web. <https://www.youtube.com/watch?v=kdDSRRCKMiI>.
- Student selected environmental weekly news
- Teacher selected articles and multimedia

Time Allotment

- Approximately 5 weeks

UNIT 5

Resources

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources has influence human migrations over the last 150,000 years.
NGSS.HS-ESS3-2	Evaluate the advantages and disadvantages for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
NGSS.HS-ESS3-6	Use a web-based simulation to identify how changes in human activity have impacted the flow of energy and the biogeochemical cycles around the planet.
CCSS.ELA-LITERACY.RST.11-12.7	Research the pros and cons of each source of renewable and nonrenewable energy.
CCSS.ELA-LITERACY.SL.11-12.1	Collaborate and discuss their research into renewable and nonrenewable energy sources.
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.
1.5 Computational Thinker	Develop and employ strategies for understanding and solving cost-benefit analysis in ways that leverage the power of technological methods to develop and test solutions.

Unit Essential Questions

- How have human activities been influenced by the occurrence of natural resources?
- What methods are utilized to obtain natural resources, and what best practices can be employed to exploit resources while minimizing detrimental effects to the environment?

Unit Scope and Sequence

- Mineral deposits
 - Mining
 - Usage of minerals
- Fossil Fuels
 - Energy usage locally and globally
 - Review of fossil fuel formation
 - Coal Mines, Hydraulic Fracking, and Deep Sea Drilling
- Nuclear
- Renewable Energy
 - Types and their pros and cons

Unit Assured Assessments

Formative Assessments:

- Students will complete a table of advantages and disadvantages to nonrenewable and renewable energy sources.
- Students will collect environmental news weekly and write a brief analysis. It can be in the form of a print, broadcast, or internet media.
- Weekly check-in based on each week's content.

Summative Assessments:

- Each student will develop a profile on an energy resource. This will include how companies explore for these resources, how it is used, the cost-effectiveness of the resource, and environmental impacts it may have. Students will be evaluated utilizing the THS school-wide problem solving through critical thinking rubric.

Resources

Core

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

Supplemental

- The Need Project. *Secondary Energy Infobook*. National Energy Education Development Project, 2017.
- "The Engineering Challenges of Renewable Energy." YouTube. YouTube, 03 Jan. 2019. Web. <https://www.youtube.com/watch?v=4k5gyYAAEEU>.
- Student selected environmental weekly news
- Teacher selected articles and multimedia

Time Allotment

- Approximately 2 weeks

UNIT 5

Climate Change and Sustainability

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS2-4	Create a model of Earth and identify how changes in the composition of the atmosphere can lead to a cascade of changes around the planet.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how changes in climate have influence human activity.
NGSS.HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.HS-ETS1-3	Evaluate a solution to climate change based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
CCSS.ELA-LITERACY.W.11-12.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY.WHST.11-12.8	Conduct research using multiple resource platforms in order to further their background and understanding of the problem.
1.3 Knowledge Constructor	Critically curate a variety of resources using digital tools to construct knowledge of a human induced disaster and make meaningful learning experiences for themselves and others.

Unit Essential Questions

- How does the ozone layer shield Earth from harmful radiation and what threat exists?
- What evidence explains the increase in the average global temperature and sea level?
- What will the Earth be like with continued global warming?
- What are the goals of sustainable development?
- How can you do to live more sustainably?

Unit Scope and Sequence

- Atmosphere & Climate Change
 - Factors
 - Consequences
 - Ozone layer - CFCs
 - Rising sea levels
 - Global weather patterns
 - Effects on human health, flora and fauna
- Sustainability & Climate Literacy
 - Sustainable Development Goals
 - Conservation

Unit Assured Assessments

Formative Assessments:

- Students will develop a proposal for how they would reduce their own environmental impacts. Students will be evaluated on key vocabulary and the correct and various uses of strategies.
- Students will collect environmental news weekly and write a brief analysis. It can be in the form of a print, broadcast, or internet media.
- Weekly check-in based on each week's content.

Summative Assessments:

- Students will pick a human induced environmental disaster and how the disaster influenced policy. Details and content to incorporate will be in a project handout. Students will be evaluated utilizing the THS school-wide problem solving through critical thinking and independent learner and thinker rubrics.

Resources

Core

- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.

Supplemental

- TED-Ed. “How quantum mechanics explains global warming.” YouTube. YouTube, 17 July, 2014. Web. <https://www.youtube.com/watch?v=-EJOO3xAjTk>.
- Stevens, Fisher. *Before the Flood*. National Geographic Documentary Films, 2016.
- Student selected environmental weekly news
- Teacher selected articles and multimedia

Time Allotment

- Approximately 2 weeks

CREDIT

1.25 credit in Science

One class period daily for full year

PREREQUISITES

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

CURRENT REFERENCES

- Greene, Thomas F. *Marine Science: Marine Biology and Oceanography*. 2nd ed. New York: Amsco, 2004. Print.
- Heithaus, Michael, and Karen Arms. *Environmental Science*. Houghton Mifflin Harcourt, 2013.
- North American Marine Environment Protection Association. *An Educator's Guide to the Marine Environment*. NAMEPA, 2019. Print.
- Project WET. *Climate, Water and Resilience*. 1st ed, Project WET Foundation, 2020. Print.
- "The Essential Principles of Climate Literacy." *Climate.Gov*, 2009. Web.
www.climate.gov/teaching/climate.
- University of Connecticut Sea Grant. *Long Island Sound Curricular Resource Guide*. University of Connecticut Sea Grant and Environmental Protection Agency Long Island Sound Study. 2010. Print.

ASSURED STUDENT PERFORMANCE RUBRICS

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

Trumbull High School School-Wide Reading Rubric

Category/Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Respond X_____	Demonstrates exceptional understanding of text by: - Clearly identifying the purpose of the text - Providing initial reaction richly supported by text - Providing a perceptive interpretation	Demonstrates understanding of text by: - Identifying the fundamental purpose of the text - Providing initial reaction supported by text - Providing a clear/straight forward interpretation of the text	Demonstrates general understanding of text by: - Partially identifying the purpose of the text - Providing initial reaction somewhat supported by text - Providing a superficial interpretation of the text	Demonstrates limited or no understanding of text by: - Not identifying the purpose of the text - Providing initial reaction not supported by text - Providing an interpretation not supported by the text
Interpret X_____	Student is able to exceptionally interpret text by : - Extensively reshaping, reflecting, revising, and/or deepening initial understanding - Constructing insightful and perceptive ideas about the text. - Actively raising critical questions and exploring multiple interpretations of the text	Student is able to interpret text by : - Reshaping, reflecting, revising, and/or deepening initial understanding - Summarizing main ideas of text - Actively interpreting text by raising questions and looking for answers in text	Student is able to interpret text by : - Guided reflection and/or revision of initial understanding - Summarizing some main ideas of text - Guided interpretation of text by answering questions locating answers in text	Student demonstrates limited ability to interpret text as evidenced by : - Struggle to implement guided reflection and/or revision of initial understanding - Struggle to summarize any main ideas of text - Struggle to answer questions by locating responses in text
Connect X_____	Demonstrates perceptive connections - text to text - text to self - text to world	Demonstrates specific connections - text to text - text to self - text to world	Demonstrates general connections - text to text - text to self - text to world	Struggles to make connections - text to text - text to self - text to world
Evaluate X_____	Insightfully evaluates the text by one or more of the following elements: - Critical analysis to create a conclusion supported by the text - Perceptive judgments about the quality of the text - Synthesis of text - Express a personal opinion.	Evaluates the text by one or more of the following elements: - critical analysis to form a conclusion from the text - thoughtful judgments about the quality of the text - Evaluation of text to express personal opinion(s)	A general evaluation of the text by one or more of the following elements: - Forms a superficial conclusion from the text - Assesses the quality of the text - Uses text to express personal opinion(s)	Struggles to evaluate the text by any of the following elements: - Forming a conclusion from the text - Assessing the quality of the text - Using text to express personal opinion(s)

Trumbull High School School-Wide Writing Rubric

Category/Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
	Student work:	Student work:	Student work:	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

Trumbull High School School-Wide Independent Learning and Thinking Rubric

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.

Trumbull High School School-Wide Problem Solving Through Critical Thinking Rubric

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.