The Cape Cod Museum of Natural History

A Guide for High School Science Teachers

The mission of the Cape Cod Museum of Natural History is to inspire appreciation, understanding, and stewardship of our natural environment through discovery and learning. The Cape Cod Museum of Natural History integrates the three strands of its organization identity- as museum of natural history, nature education center, and steward of conservation land. Visit the CCMNH website here, and watch a video about the CCMNH here!

For a photographic walkthrough of the museum, use this guide to follow along with “A Walk Through CCMNH” (ppt).

The Cape Cod Museum of Natural History is a wealth of information, history, and examples of natural phenomena. These resources can be used in many facets of the classroom and beyond. The following guide contains lesson and topic suggestions based on MA High School Biology and STEM standards, but the museum is a great opportunity for learning with students of all ages, abilities, and interests.

UPSTAIRS

History Hall

People of the Land: The Wampanoag

Some of the earliest native settlers came to Cape Cod thousands of years ago. The Wampanoag tribe was the group of native peoples who utilized the land and its wildlife for all of their survival needs. This exhibit provides some insight into how these natives lived, and how they used the land and all parts of harvested animals to sustain their community.

Salt Works and Fishing Weirs

Cape Cod was settled by Europeans in the mid- to late 1600s. Settlers used marsh grasses for hay, and removed much of the woody vegetation for heat and building supplies. As a coastal community, early Cape Cod relied heavily on local products for sustenance and for income. Salt was an expensive commodity (used for preservation of food before refrigeration), and is abundant in ocean waters. Colonists utilized water pumps and large, flat water beds to evaporate the ocean water to collect salt. They also set up fishing weirs to direct the water flow in streams and creeks to trap local fish.

Geology/Geography

On the time scale of our planet, Cape Cod is relatively new. Since it was formed at the end of the last ice age (18K years ago), It is also constantly changing (shrinking). The land we know as Cape Cod was deposited here by glaciers, and has been shaped slowly over time by the ebb and flow of tides and larger marine events.
You can see examples of the changing landscape in two displays: changes in the Stony Brooke Valley (south of the museum), and a map of geological changes of the entire Cape Cod region over the past 12,000 years.

STEM Connections

- *HS-LS2-7; HS-LS4-5; HS-ESS2-2*
- *Observe how humans have affected Cape Cod over hundreds to thousands of years. Consider major differences in use of the land by the Wampanoag and the Colonists.*
- *Glaciers and changing climate have majorly shaped Cape Cod over thousands of years. Climate, weather patterns, and water continue to affect the geological features of the island.*

John Hay Room: STEM education

The John Hay room is a space created specifically for inquiry and exploration, with a library of resources and local literature and STEM challenges for students to test their problem solving skills. There are also regular nature videos that play in the small theater (change monthly). This is a great space for students or visitors who need a break from museum activities or a quieter spot to think and process.

Biomimicry: “Innovations Inspired by Nature”

Biomimicry is the design of materials or technology based on natural patterns, phenomena, or adapations. The museum exhibit provides several fascinating examples of how modern products have learned from natural phenomena to create efficient and effective modern technologies: airplanes modeled after birds, water collection modeled after desert beetles, Velcro modeled after burrs, and more! See the videos below for more examples.

- Biomimicry at CCMNH
- Biomimicry: RoboBees

The Biomimicry exhibit at CCMNH is assembled and sponsored by Biomimicry New England.

STEM Connections:

- *HS-ETS1-1; HS-ETS1-3; HS-LS4-5*
- *Find adaptations in local ecosystems (throughout the museum) that could be used to design helpful technology.*
- *What is a common problem humans have that animals don't? Is there an adaptation we could copy to make a useful technology?*

Pollinators: Honey Bees

CCMNH has an indoor observation hive. The bees have access to the pollinator garden outside, but have their honeycomb in a glass box where students can observe up close the interactions of this unique population. Three types of bees (workers, drones, and a queen) exist in the hive and play very unique roles. Bees play the roles of scouts, workers, foragers, undertakers, babysitters, caretakers, and more. Bees also have the ability to remember smells and can be trained to detect specific chemical markers (explosives and some cancers, for example). For some more interesting information about honeybees, see this video of a hive inspection.
Attend beehive openings: limited availability (seasonal); additional cost

STEM Connections:

- *HS-LS2-2; HS-LS2-4; HS-LS2-6*
- *Honeybees and pollinators are incredible examples of symbiosis.*
- *Honeybees are altruistic—they interact within their population and each have very specific roles.*
- *Observe interactions within populations and between populations (within communities)*

Marshview Room: Our Own Backyard

Bird Watching

The MA state bird is the Black Capped Chickadee (*right*). From the window of the Marshview room, overlooking the feeders, many different local birds can be easily observed. Common sightings include the Black Capped Chickadee, blue jays, cardinals, red winged black birds, nuthatches, tufted titmice, sparrows, and finches. Look closely and you will also find lots of our local rodent friends: gray and red squirrels, and chipmunks.

Osprey Cam

From the Marshview room, you can also spot a nearby Osprey nest (*left*). The museum has a camera in the nest with a live feed. Osprey live on Cape Cod during the spring and summer, laying 2-4 eggs each season. After 35-40 days, the chicks hatch, and will fledge in another 7-8 weeks. The museum osprey raise their young and

then fly back to South America. Find more information about the CCMNH Osprey cam by watching the Osprey Cam information video. Watch the Osprey Cam live feed here.

Upland Woodland Creatures

The Marshview room also has terrariums and preserved woodland species. Box turtles, frogs, and an Easter milk snake live in Marshview terrariums and also throughout the woodlands of Cape Cod. Preserved mammals (fox, fisher, coyote) and birds from the woodlands can also be found here. All together, the Marshview room presents a comprehensive summary of the woodlands of Cape Cod, with beautiful views of wildlife and the marsh.

STEM Connections:

- *HS-LS2-1; HS-LS2-2; HS-LS2-6; HS-LS2-7*
- *Multiple ecosystems are described in and observable from the Marshview room.*
- *The turtles, frogs, and snake can often be difficult to find in their terrariums—how are they well adapted to their environment and why is it beneficial?*

Eldridge Arnold Wing

Eldridge Arnold was known as a world class bird carver, capturing the reality of nature in his artwork. The history of bird carving started as a functional work used in hunting but later turned into a form of artwork. The Native Americans first started using duck decoys that they made out of reeds. The decoys are used to attract the animal to be captured. When the government added restrictions on hunting, the art of decoy became more elaborate. Arnold became the premier artist in the art of decoy making. In this exhibit, you will find Arnold's work benches for carving and painting, examples of his work (sculpture, painting, and photographs), and the numerous recognitions he received for his art.

The Inflatable Whale

Did you know that a whale's brain weighs about 10 pounds? That whales can only breath through their nose? That most whales wouldn't be able to swallow a human even if they tried? This inflatable whale fills the museum auditorium and lets visitors and students get a unique inside look at the Humpback Whale, one of the giant whales that spends its summer just off the coast of Cape Cod.

The short program starts with a background on the history of whales on Cape Cod—from whaling to conservation, and the whale's lifecycle from birth to its 'vacation' in the northeast. Once inside the whale, students learn about the many anatomical adaptations that allow one of the largest mammals on the planet to live successfully underwater: lungs and respiration; diet, ingestion and digestion; and more. *Limited availability; 30-45 minute program*

STEM Connections:

- *HS-LS4-5*
- *How are human anatomy and whale anatomy similar? (also consider skeletal/homologous structure)*
- *What makes a whale a mammal and not a fish?*
- *What types of adaptations do whales have to make them able to survive underwater?*

DOWNSTAIRS

Tidal Pool

The tidal pool ecosystems is one of the most diverse on Cape Cod. The CCMNH has a small viewing tidal pool with many of the common species inside, including mollusks, crabs, flounder, and skate.

Aquarium: One Cape / Many Waters

CCMNH has several types of aquaria exhibiting species from all sorts of aquatic environments. Each have examples of plants and animals that thrive there. Almost all species have plaques or labels with lots of helpful information: habitat, niche, adaptations, diet, etc. The volunteers stationed throughout the museum are also extremely knowledgeable and can help answer questions or point you in the right direction

- Fresh Water (Pond and Stream)
- Salt Water (Open Ocean)

- Salt Water (Marsh)
- Salt Water (Sandy Bottom)
- Moon Jellies

Turtle Bay

The aquarium area also features several turtle tanks and a display of common turtle shells found in species throughout Cape Cod. Myrtle (a 26 year old white Northern Diamond-backed Terrapin) tends to steal the show.

STEM Connections:

- *HS-LS2-1, HS-LS2-2, HS-LS2-4, HS-LS2-6; HS-LS4-5*
- *The aquaria allow students to observe many of the aquatic ecosystems up close, with descriptions of many of the resident organisms.*
- *Each organism has a unique niche in its habitat—how do they all fit together?*
- *Observe the Interaction of biotic and abiotic factors that define the unique ecosystems*

Bird Banding Station

The Wing Island Bird Banding Station has been in operation since 2000. Over 158 species of birds utilize the museum conservation land and surrounding waterways. The goals of the banding station are primarily research and public awareness.

Bird Alley: Preserved Bird Collection

This large collection of mounted specimens includes many birds that can all be found in Cape Cod's many ecosystems. They are organized by habitat (shore, meadow, forest, etc.), making it simple for students to recognize and classify similarities in adaptations.

OUTSIDE

OUTSIDE

The Rain Garden

The Rain Garden is a perfect example of the water cycle. It is set up to show how plants and soil are used to filter rainwater to an underground aquifer. These gardens are helpful in urbanized spaces where paving and construction prevents the absorption of water into the ground.

STEM Connections:

- *HS-ESS2-2; HS-ETS1-1*
- *Why are biogeochemical cycles important to maintain, especially in urbanized areas?*
- *How does a structure like a rain garden benefit the environment, the people living and working here, and the organisms that live here?*

Pollinator Path

Pollinator plants are plants that are especially attractive to pollinators like hummingbirds, butterflies, and bees due to their colorful, sweet, and hydrating flowers and fruits. Along pollinator path, you will see many varieties of plants as well as the insects that feed and pollinate.

STEM Connections:

- HS-LS2-2; HS-LS2-6
- *Consider the mutualism between the plants and the insects.*
- *What would happen to the ecosystem [and to our food sources] if we didn't have pollinators?*

The Butterfly House (June 1-September 3)

At the end of Pollinator Path, you will find the butterfly house. This year, the butterfly house has hundreds of butterflies and moths of seven different species. Students can walk through the house and observe the butterflies feeding, flying, and resting. The exhibit also has chrysalises on display, showing the life cycle of these beautiful insects. *Butterfly feedings require reservations and additional cost.*

Wildflower Garden

Outside of the museum is a wildflower garden path, where students can take a walk through the many flowers and shrubs found in local woodland and meadow ecosystems. Flowers in bloom differ seasonally, but always offer a unique view at local plant species and wildlife.

Trails of the CCMNH

Guided Field Walk (John Wing Trail)

Museum volunteer guides walk you through Brewster Conservation Land behind the CCMNH. You will walk through upland woodland, salt marsh, forest, dunes, tidal flats, and the beaches of Cape Cod Bay—giving ample opportunity for visitors and students to explore the many ecosystems of Cape Cod. Guides are knowledgeable about the history of the land—from glacial movement to development by early settlers, to modern conservation efforts; as well as the numerous animal and plant species unique to

Cape Cod and the Northeast.

The John Wing trail (right) is part of over 300 acres of Brewster Conservation land stewarded by the museum.

Trip to the Mudflats/Tidal Flats

Mudflat Mania guides will walk you through the conservation lands behind the museum straight out to the tidal flats at low tide. Here you can observe, dig, and walk through the mudflats, tidal pools, and creek to find creatures unique to these tidal habitats. Be prepared to get a little muddy!

Lee Baldwin Trail (Stony Brook Valley)

Part of museum-owned 80 acres of land south of the museum. The Trail takes you through several ecosystems including woodland and freshwater habitats, that are part of the Stony Brook Valley (right).

Before a field trip, teachers may fill out a form to request guides with specific field knowledge, or walk activities and conversations that will fit with specific curricular or classroom goals.

Habitats/Ecosystems at the CCMNH

1. Woodland (upland): an open forest characterized by many grasses, shrubs, and trees; often found as a transition between forest (dense trees) and shrubland/grassland ecosystems. Here, the woodland ecosystem exists on Wing's Island, surrounded by salt marsh.
    - By the late 1800's, much of lower Cape Cod was denuded of forests. In Brewster, few trees remained on properties. Succession occurred resulting in the current climax community of Oak and Pitch Pine.
    - Indicator species: Pitch Pine, oaks, Eastern Red Cedar; lowbush blueberry; blazing star, wintergreen; gray squirrel, chipmunk; warblers, mourning doves, Great Horned Owls
    - Key abiotic factors: changing seasons, salt air and erosion, primarily sandy soil

with decaying organic matter from fallen trees; hard bedrock 300-400 feet below surface

below surface

2. Salt marsh: In the intertidal zone so it floods and drains with the tides. Salt marsh has many grasses and shrubs that are tolerant to high levels or salt and can grow in the marshy ground made mostly of decomposed plants and peat (soil composed primarily of detritus). The salt marsh is important in maintaining sediment, and bringing nutrients toward the open ocean.
    - The salt marsh is extremely important for local ecosystems, acting as a safe and nutrient-rich nursery for young organisms (from birds, to fish, to bugs), a sponge to prevent tidal waters from flooding nearby habitats, and as a filter, bringing together water from rain, streams, and rivers.
    - Key abiotic factors: exposed constantly to light (high plant productivity); flood twice a day with tides; zones from high to low salt; sponge-like peat soil from plant decay and material brought in with tides

3. Coastal Dunes: A dynamic ecosystem that is heavily impacted by weather, plant growth, and human disturbance. Often, the profile of the dunes changes seasonally.
    - Key abiotic factors: tides, winds, dehydration, and seasonal temperatures; constant change due to erosion and deposition

4. Barrier beach (sand bars) and tidal flats (mudflats): wetlands formed when receding tides deposit mud and sediment. The mudflat is an intertidal zone, made mostly of deposited minerals and clays, and detritus. [crabs, mollusks, and fish]
    - Relatively free of vascular plants; rich in marine algae and seaweed; many burrowing marine invertebrates
    - Key abiotic factors: nutrients from runoff and estuaries; tidal, wave, and water movement; temperature; often harsh and exposed environment

5. Tidal Pools: only exposed at low tide (submerged at high tide) that is home to especially hardy animals capable of withstanding a constantly changing environment (temperature, salinity, oxygen, etc.) as the tide ebbs and flows. While the tide pools provide little protection for their inhabitants, the ever changing tide brings a constant source of food for the small marine animals and plants.

6. Ocean (Cape Cod Bay): Cape Cod Bay is home to an abundance of wildlife. In the museum, students can learn about the sharks, whales, turtles, and fish that call the ocean waters home.

7. Fresh Water (streams and ponds): Freshwater ecosystems on Cape Cod are home to an abundance of fish, reptiles, and amphibians, as well as diverse plant life. South of the museum is Stony Brooke, where there is a herring run. Around April each year, Herring swim from the ocean upstream to spawn in the fresh water.

8. Quivett & Paine's Creek: Brackish and salt-water creeks that feed some of our local beaches.

LS2. Ecosystems: Interactions, Energy, and Dynamics

- Standards focused on ***ecosystems: interactions, energy, and dynamics*** help students formulate an answer to the question, *"How and why do organisms interact with their environment, and what are the effects of these interactions?"*

- Students can use mathematical reasoning to demonstrate understanding of fundamental concepts of carrying capacity, factors affecting biodiversity and populations, and the cycling of matter and flow of energy among organisms in an ecosystem.
- These models support students' conceptual understanding of systems and their ability to develop design solutions to reduce the impact of human activities on the environment and maintain biodiversity.

- The high school biology standards place particular emphasis on science and engineering practices of ***developing and using models; constructing explanations; engaging in argumentation from evidence; and obtaining, evaluating, and communicating information***.

- Students are expected to use multiple types of models, including mathematical models, to make predictions and develop explanations, analyze and identify flaws in the model, and communicate ideas that accurately represent or simulate the biological system.
- Students are asked to construct and revise explanations and claims based on valid and reliable evidence and apply scientific reasoning to evaluate complex real-world problems such as the effects of human activity on biodiversity and ecosystem health.
- Students must be able to find and interpret scientific literature to compare, integrate, and evaluate sources and communicate phenomena related to genetics, the functioning of organisms, and interrelationships between organisms, populations, and the environment.
- The application of these practices across the core ideas gives students a rich grounding in biology.

HS-LS2-1. Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.

HS-LS2-2. Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.

HS-LS2-4. Use a mathematical model to describe the transfer of energy from one trophic level to another. Explain how the inefficiency of energy transfer between trophic levels affects the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic components from the environment.

HS-LS2-5. Use a model that illustrates the roles of photosynthesis, cellular respiration,

decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-LS2-6. Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tends to have greater resistance to change and resilience.

HS-LS2-7. Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

Other Relevant STEM Standards Addressed

HS-LS4-5. Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to earth's hydrosphere can create feedbacks that cause changes to other Earth systems.

HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved. Determine necessary qualitative and quantitative criteria and constraints for solutions, including an requirements set by society.

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, aesthetics, and maintenance, as well as social, cultural, and environmental impacts.