DEERING ESTATE

MIAMI SHARK RESEARCH & CONSERVATION PROGRAM

Marine Conservation Science and Policy

Lesson Breakdown

Marine Conservation Science and Policy

Lesson Breakdown

Thematic Unit	Lesson Focus	Lesson Summary
Ocean and Coastal Habitats	Ocean Zones	Students will explore the different ocean zones and the variety of life found in them. Students will learn to: • Identify the five ocean zones. • Compare and contrast the conditions in the different zones. • Demonstrate knowledge of the five different ocean zones. **Activity: In small groups, students will draw and label a scale diagram of the ocean zones.**
	Ocean Features and Coastal Landforms	Students will explore some of the main features of the ocean and coastal landforms and examine interactions that are globally significant. Students will learn to: • Identify ocean and coastal features. • Analyze the importance of these features and how their interactions affect humans. • Summarize their knowledge of ocean and coastal landforms. **Activity: In small groups, students will elaborate a news report summarizing their knowledge of ocean and coastal landforms.**
	Intertidal Zone	Students will explore the intertidal zone and discover some of the unique qualities of this ecosystem. Students will learn to: • Identify the four subzones of the intertidal zone. • Identify some of the organisms that live in this habitat and the challenges they face. • Demonstrate knowledge of food chains and the interconnectedness of organisms. **Activity: In small groups, students will connect their knowledge through the jigsaw method and elaborate a food web.**
	Salt Marsh	Students will explore the salt marsh and the animals that inhabit this important ecosystem. Students will learn to: • Identify the four zones of a salt marsh. • Recognize threats to this habitat and elaborate ways to protect it. • Demonstrate knowledge and analyze the importance of this ecosystem. **Activity: In small groups, students will create an educational poster explaining the salt marsh and its importance.**
	Sandy Beaches	Students will explore the features of sandy beaches, reflecting on the importance of this ecosystem as well as threats and conservation efforts. Students will learn to: • Identify some features that form a beach and some of the animals that inhabit this community. • Explain the importance of this ecosystem and some threats that it faces. • Elaborate a visual representation of the beach habitat and discuss how this habitat can be protected for future generations. **Activity: Students will illustrate individual squares to be pieced together to form a class beach blanket.**

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Ocean and Coastal Habitats	Mangroves	Students will explore the mangrove ecosystem and some of the animals that live in this habitat. Students will learn to: • Identify three species of mangroves and some animals that live in this habitat. • Analyze the importance of this ecosystem and the pressures that threaten it. • Explain the key features of mangroves and how to protect them. **Activity: In small groups, elaborate an educational commercial about mangroves.**
	Barrier Islands	Students will explore the barrier islands and some of the habitats, animals and plants found on these formations. Students will learn to: • Identify the main features of a barrier island. • Identify the different habitat found on a barrier island and some of the organisms that live there. • Demonstrate knowledge and explain the importance of the barrier islands. **Activity: In small groups, elaborate a visual representation of a barrier island.**
	Seagrasses	Students will discover special features of seagrass and explore the coastal ecosystem of the seagrass meadow, Students will learn to: • Identify features of seagrass meadows and animals that live in this habitat. • Analyze the importance of this ecosystem and elaborate ways to protect it. • Demonstrate knowledge of seagrass meadows and analyze their importance. **Activity: In small groups, students will create seagrass meadow vocabulary cards for every letter of the alphabet.**
	Coral Reefs	Students will explore the coral reef and discover some of he organisms that live in this habitat. Students will learn to: • Identify features of a coral reef and some animals that live in this habitat. • Analyze the importance of this ecosystem. • Demonstrate knowledge and elaborate ways to protect this important habitat. **Activity: In small groups, students will create an educational brochure explaining key features of the coral reef.**
	The Everglades	Students will be introduced to the various habitats that make up the greater Everglades ecosystem and explore the significance of this ecosystem. Students will learn to • Identify several main features of the Everglades. • Identify animals that live in the Everglades habitats and the resources they depend on. • Demonstrate knowledge and analyze the significance of the Everglades. **Activity: Students will compose an original poem about the Everglades.**

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Marine Life	Introduction to Zoology and Fish Classification	Students will explore the field of zoology and the importance of classification. They will be introduced to the three classes of fish and practice classifying them. Students will learn to: • Identify the field of zoology and describe classification. • Explain some of the characteristics of fish and how they are distinguished. • Use the scientific method to observe and classify the three classes of fish by their distinguishing characteristics. **Activity: In small groups, students will work as a scientific community by classifying fish according to their physical characteristics.**
	Morphology and Echinoderms	Students will be introduced to the external anatomy and the study of marine species morphology. Students will learn to: • Define morphology and how it is applied. • Identify the main body forms and characteristics of echinoderms. • Demonstrate their knowledge by identifying the external body parts of a specimen and forming a hypothesis based on its morphology. **Activity: In small groups, students will identify the external body parts of an echinoderm specimen and form a classification hypothesis based on its morphology.**
	Plankton Communities	Students will study the different types of plankton and identify the characteristics that distinguish these groups. Students will learn to: • Identify the four types of plankton. • Explain three differences between phytoplankton and zooplankton. • Explain three reasons that plankton communities are important. **Activity: In small groups, students will use microscopes and water samples to analyze local plankton species.**
	Cartilaginous Fish & Shark Dissection	Students will research the cartilaginous fish class and their defining characteristics. Students will learn to: • Identify the defining features of the cartilaginous fish. • Explain what resources they depend on and where they can be found. • Demonstrate knowledge by researching and presenting a species of cartilaginous fish. **Activity: In small groups, students will dissect a dogfish.**
	Marine Mammals	Students will discuss marine mammals and factors that make these animals distinct, and form a solution to a threat marine mammals face. Students will learn to: • Identify South Florida marine mammals and describe their distinguishing features. • Explain the importance of these animals to South Florida food webs and economies. • Describe 3 threats these animals face and build a model that can resolve one threat. **Activity: In small groups, students will invent and build a model to prevent propeller damage to marine mammals and other organisms.**

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Thematic Unit	Lesson Focus	Lesson Summary
Ocean Connections	Marine Biodiversity	Students will explore three habitats to compare and contrast different levels of biodiversity. Students will learn to: • Use the scientific method to sample for biodiversity. • Evaluate differences in habitat that encourage more species variety and form biodiversity hotspots. • Analyze the importance of marine biodiversity and conservation methods. **Activity: In small groups, students will use explore, quantify and analyze the biodiversity of lawn, garden and forest habitats.**
	Trophic Structure	Students will explore the concept of trophic levels by elaborating a marine food web. Students will learn to: • Identify the different trophic levels. • Explain energy flow along the trophic levels. • Analyze the importance of food web components and discuss how humans affect this system. **Activity: In small groups, students will elaborate a food web mobile.**
	Species Interactions	Students will explore the different species interactions through examples in the marine environment. Students will learn to: • Identify the different types of species interactions. • Identify factors that influence these interactions. • Analyze the importance of these interactions on an ecosystem and global level. **Activity: In small groups, research and analyze the interactions of organisms within a marine ecosystem.**
	Population Sampling	Students will explore the population dynamics and the factors that influence them. Students will learn to: • Define species population. • Identify factors that influence population. • Implement a population sampling technique and discuss the importance of the scientific method in establishing conservation plans. **Activity: In small groups, students will practice a population sampling technique and elaborate a fish conservation plan.**
	Ocean Resources	Students will explore ocean resources and their importance. Students will learn to: • Define a resource and identify three resources provided by the ocean. • Identify the importance of ocean resources. • Analyze the importance of ocean resources and explain how they can be protected for future generations. **Activity: In small groups, students will elaborate a poster collage educating others on the conservation of ocean resources.**

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Thematic Unit	Lesson Focus	Lesson Summary
Marine Issues	Coastal Development	Students will explore the concept of coastal development and analyze coastal development impacts and management strategies Students will learn to: • Identify coastal development. • Analyze environmental issues associated with coastal development. • Analyze the human impacts on coastal ecosystems and compare and contrast different coastal management strategies. **Activity: In small groups, students will analyze a coastal development case study and elaborate a coastal management solution.**
	Fishing and Bycatch	Students will explore the state of global fisheries and attempt to create a sustainable fishery. Students will learn to: • Define bycatch and fisheries. • Identify factors influencing global fishery sustainability. • Discuss methods that can protect fisheries for future generations. **Activity: In small groups, students will play a fisheries game and elaborate a sustainable fisheries management plan.**
	Pollution, Water Quality, and Bioaccumulation	Students will explore different sources of pollution and analyze the effects of water pollution on humans and ecosystems. Students will learn to: • Define pollution and bioaccumulation. • Identify sources of pollution and factors that affect water quality. • Elaborate a water management plan and discuss water quality protection. **Activity: In pairs, students will analyze the uses of land along rivers through a puzzle, and create a sustainable community water management plan.**
	Invasive Species	Students will examine invasive species and the effects they are having on the Everglades and native species. Students will learn to: • Define native, non-native and invasive species. • Identify factors that allow species to become invasive and consequences of their introduction. • Analyze the importance of maintaining native species and elaborate ways to prevent the introduction of invasives. **Activity: In small groups, students will research invasive species in the Everglades and demonstrate their knowledge by creating a wanted poster.**
	Climate Change	Students will explore the causes and effects of climate change and elaborate a climate change prevention plan. Students will learn to: • Define climate change and its causal factors. • Analyze the global effects of climate change. • Identify climate change prevention measures and analyze the importance of protecting the planet for future generations. **Activity: In small groups, students will elaborate a school emissions reduction plan.**

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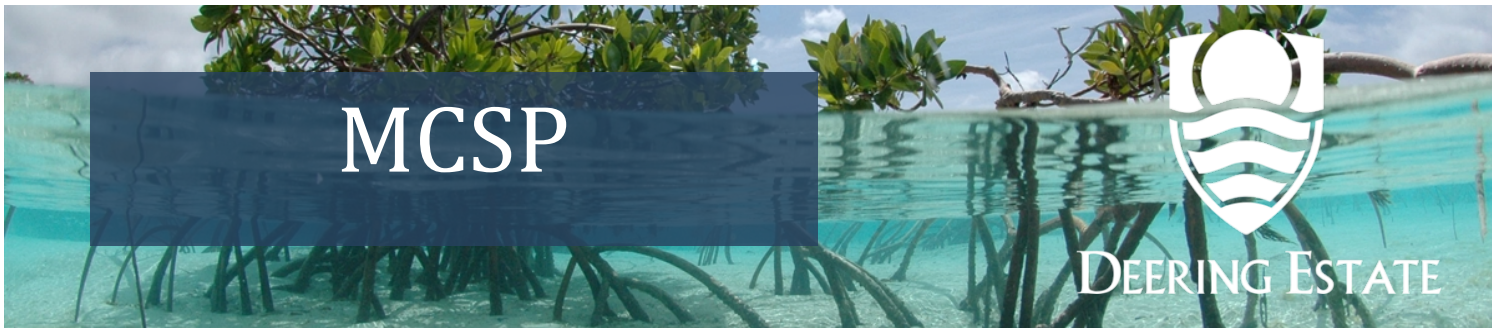
Management, Conservation, Research and Actions	Fisheries and Management	Students will explore fisheries and their management strategies. Students will learn to: • Identify different methods of calculating a fish population. • Analyze the efficacy of different management strategies. • Discuss the importance of managing and protecting fisheries. **Activity: In small groups, students will conduct an experiment to assess a fish population and implement a management strategy.**
	Aquaculture	Students will explore different systems of aquaculture. Students will learn to: • Define aquaculture and the basic components of an aquaculture system. • Describe two advantages and two disadvantages of aquaculture. • Discuss the social, economic and environmental impacts of aquaculture. **Activity: In small groups, students will research and describe a local example of aquaculture.**
	Mercury Toxicity Data	Students will explore mercury and the effects of mercury toxicity on organisms. Students will learn to: • Identify mercury and pollution sources. • Explain the effects of the bioaccumulation and biomagnification. • Discuss methods that can help prevent further mercury pollution. **Activity: As a class, students will conduct a biomagnification simulation to explore the effects of mercury on organisms.**
	Tagging and Satellite Tracking	Students will examine tagging and satellite tracking techniques and explore how these technologies apply to marine conservation. Students will be able to: • Identify different tagging and tracking methods. • Explain how tagging and tracking data can improve understanding and protection of marine organisms. • Discuss how tagging and satellite tracking technology can be applied to improve understanding of marine organisms and improve conservation efforts. **Activity: In pairs, students will conduct a tracking simulation and analyze the importance of the data learned.**
	Principles of Conservation and Environmental Stewardship	Students will explore the idea of conservation and environmental stewardship and plan a conservation project. Students will learn to: • Identify natural resources and the principles of conservation. • Analyze the importance of resource conservation. • Apply conservation ethics to help protect the planet. **Activity: In small groups, students will plan a conservation project for their school or community.**

Marine Conservation Science and Policy Curriculum Supported in South Florida Parks	A.D. Barnes Park & Nature Center	Amelia Earhart Park	Bill Baggs Cape Florida State Park	Bill Sadowski Park	Biscayne National Park	Black Point Park & Marina	Camp Greynolds	Camp Owaissa Bauer	Castellow Hammock Park & Nature Center	Chapman Field Park	Crandon Park & Biscayne Nature Center	Deering Estate at Cutler	Everglades National Park- Flamingo	Everglades National Park- Shark Valley	Fairchild Tropical Botanic Gardens	Gifford Arboretum	Greynolds Park	Haulover Park	Homestead Bayfron Park	Hugh Taylor Birch State Park	John Pennekamp Coral Reef State Park	John U. Lloyd State Park	Larry and Penny Thompson Memorial Park	Long Key State Park	Matheson Hammock Park	Oleta River State Park	Secret Woods Nature Center	Seminole Wayside Park	The Kampong	Virgina Key Park	West Lake Park & Anne Kolb Nature Center	Zoo Miami
1.1 Ocean Zones												X																				
1.2 Ocean Features and Coastal Landforms			X		X	X					X	X	X								X			X	X				X		
1.3 Intertidal Zone			X		X						X	X								X				X	X						
1.4 Salt Marsh					X							X	X							X											
1.5 Sandy Beaches			X		X						X	X						X	X	X	X	X		X	X	X			X	X	
1.6 Mangroves			X		X	X				X	X	X	X		X		X		X	X	X				X	X	X	X		X	X	
1.7 Barrier Islands			X		X						X	X						X						X						X		
1.8 Seagrasses			X		X						X	X							X		X	X		X	X					X		
1.9 Coral Reefs					X						X	X							X		X			X								
1.10 The Everglades	X	X		X	X		X	X	X			X	X	X	X				X	X	X		X	X		X	X	X			X	
2.1 Introduction to Zoology& Fish Classification				X	X						X	X	X	X						X	X	X		X		X					X	
2.2 Morphology and Echinoderms				X	X						X	X	X							X	X	X		X		X					X	
2.3 Plankton Communities					X							X	X							X	X	X		X		X					X	
2.4 Cartilaginous Fish and Shark Dissection											X	X																				
2.5 Marine Mammals												X																				



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3.1 Marine Biodiversity					X						X	X	X							X	X										X	
3.2 Trophic Structure					X							X	X	X																		
3.3 Species Interactions					X							X	X	X																		
3.4 Population Sampling												X																				
3.5 Ocean Resources and the Tragedy of the Commons												X							X		X											
4.1 Coastal Development											X	X																				
4.2 Fishing and Bycatch												X		X																		
4.3 Pollution, Water Quality and Quantity, and Bioaccumulation												X		X																		
4.4 Invasive Species												X	X	X																		
4.5 Climate Change					X							X	X	X		X				X												
5.1 Fisheries and Management												X																				
5.2 Aquaculture												X																				
5.3 Mercury Toxicity Data												X																				
5.4 Tagging and Satellite Tracking												X																				
5.5 Principles of Conservation and Environmental Stewardship	X	X		X	X		X				X	X	X	X	X	X			X	X	X	X	X	X		X	X		X		X	

Ocean Fast Facts

The ocean covers 140 million square miles, or nearly 71% of the Earth's surface.

Humans have explored less than 5% of this vast ecosystem,
leaving many mysteries waiting to be discovered!

Over 250,000 marine species have been identified, and scientists estimate at least 750,000 more have yet to be discovered.

Life began in the ocean 3.1 billion years ago,
about 2.7 billion years before terrestrial life evolved.

The Gulf Stream transports nearly four billion cubic feet of water per second,
greater than the amount carried by all of the world's rivers combined.

Ocean-related businesses account for $9 billion
annually in goods and services in South Florida.

Photosynthetic organisms in the ocean
produce about 70% of the oxygen we rely on.

While other colors are absorbed by water,
blue is reflected back, giving the ocean the azure hues we see.

Fish supply the greatest percentage of the world's protein consumed by humans.

The gray whale migrates more than 10,000 miles every year, the longest migration of any mammal.

South Florida is home to the third largest coral reef in the world,
stretching 358 miles from Dry Tortugas National Park to St. Lucie and
hosting over 80 species of coral, 70 species of sponges, and over 1,000 fish species.

80% of all marine pollution comes form land-based activities.

The blue whale is the largest animal on our planet,
its heart is the size of a Volkswagon.

Water pressure at the deepest point in the ocean is more than 8 tons per square inch, the equivalent of one person trying to hold 50 jumbo jets. Incredibly, many organisms thrive in this environment.

The ocean contains 97% of the planet's water, and provides 99% of Earth's habitat.

Although coral reefs cover less than 0.5% of the ocean floor,
more than 90% of marine species are directly or indirectly dependent on them.

The Great Barrier Reef, measuring 1,243 miles, is the largest living structure
on Earth. It can be seen from the Moon.

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Ocean Zones

Grade Level:

4th – 12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Physical Science

Big Idea

The Practice of Science

Earth Structures

Standards

SC.K.N.1.4

Create a visual representation of an object which includes its major features.

SC.2.L.17.2

Recognize and explain that living things are found all over Earth, but that each is only able to live in habitats that meet its basic needs.

SC.912.E.6.5

Describe the geologic development of the present day oceans and identify commonly found features.

WL.K12.NM.1.4

Demonstrate understanding of information supported by visuals.

Focus Question

What are the ocean zones and how do they differ? What kinds of animals live in each zone? Why is it important to learn more about the ocean?

Objectives

Students will explore the different ocean zones and the variety of life found in them. Students will learn to:

- Identify the 5 ocean zones.
- Compare and contrast the conditions in the different zones.
- Demonstrate knowledge by drawing a scale diagram of the five ocean zones.

This will be a project-based activity in which students will work together to draw a scale diagram of the ocean zones.

Background

An **ocean** is a major body of saline water, which covers 71% of the Earth's surface forms part of the hydrosphere, Earth's largest ecosystem, hosting an estimated 50-80% of all life on earth, though much is unknown as 95% of this underwater world remains unexplored.[4] Scientists estimate that life with the ocean evolved 3 billion years prior to life on land, from simple obligate anaerobes to the first photosynthesizing organisms to the blue whales and clown fish we recognize today.[1] Some 230,000 marine species are known so far, but an estimated 1-10 million species remain to be discovered.[2] These organisms have adapted to the varying conditions of the different ocean zones.

Ocean zones are layers within the oceans with diverse physical and biological conditions that support distinctive plant and animal life. The ocean is divided into two realms, the **benthic realm** (consisting of the seafloor) and the **pelagic realm** (consisting of the ocean waters), which are then subdivided into five different vertical zones depending on depth.

The benthic realm is the ecological region at the bottom of the ocean, and includes the sediment layer below which hosts crustaceans, snails, sea stars and other creatures. This realm begins at the shoreline and continues downward along the continental shelf, a slope that drops down to the abyssal plain at around 4,000 m. The ocean floor has submarine mountains, canyons, ridges and trenches, and the organisms that live in this realm vary as the pressure, salinity, temperature, nutrients and light change.[3]

The photic zone covers the oceans from surface level to 200 meters down, the only zone in which sufficient sunlight penetrates to permit photosynthesis. Because photosynthesis can take place, many plants and photosynthetic organisms live in this zone forming the first link in the food chain as primary producers. Some of these primary producers, microscopic free-floating plants called phytoplankton, are the most abundant organisms on earth and generate 50-90% of Earth's oxygen. Because of this abundant food source, this zone supports 90% of ocean life, though it is the smallest zone, featuring coral reefs, sea grass beds, and much more.[4]

Vocabulary:

Ocean Zones:
The divisions of the ocean from the surface to the ocean floor, which vary by depth, pressure, light, and nutrients.

Benthic Realm:
This realm begins at the shore and extends along the continental shelf and the ocean floor, shaped by submarine mountains, ridges and trenches

Pelagic Realm:
The open part of the ocean (or lakes) that is neither near the bottom nor the shore.

Mesopelagic Zone:
The zone extending from 200 to 700-1000 m deep, only dimly lit but host to millions of microorganisms.

Bathyal Zone:
This zone is cold, dark, and ranges from 1,000-4,000 m deep.

Abyssal Zone:
Extending from 4,000 to 6,000 m deep, this zone is perpetually dark and cold but surprisingly hosts a wide array of organisms.

Hadal Zone:
Diving from 6,000 m to the bottom of the deepest ocean trench, this zone is characterized by extreme cold and pressure, populated by extremophiles.

Background

Most light remains in the sunny photic zone, with few rays penetrating the **mesopelagic**, or twilight **zone**, which extends from 200 to 700-1000 meters. This zone is significant in the diurnal (daily) vertical migration of numerous species of small organisms upwards to the photic zone at night, a movement often referred to as the greatest migration on earth in terms of biomass. This movement makes the ocean the world's largest carbon sink and essential to mitigating climate change.

The **bathyal**, or midnight, zone is a chill 4° C (39° F) extending in inky darkness from 1,000 to 4,000 meters. This zone marks the beginning of the aphotic, or no light, zone, and It is so dark that some species don't even have eyes, while others have adapted transparent skin, slimy bodies or even bioluminescence to survive. This zone is the feeding ground of many whales, squid, and octopuses, as well as many unusual creatures.

From 4,000 to 6,000 meters deep, the **abyssal** zone is characterized by perpetual darkness, with temperatures an almost freezing 2-3° C (35° F). Fissures in the ocean floor create hydrothermal vents with boiling temperatures, lethal levels of hydrogen sulfides and pressures that would crush a human instantly. Creatures in this zone are mostly scavengers that depend upon marine snow for nutrients, sinking organic matter that includes dead or dying plants and animals. Though conditions were thought to be too hostile to support life, scientists using the minisubmarine Alvin in 1977, discovered an extraordinary abundance of creatures in these depths, ranging from the ten-foot long tube worms, clams over a foot wide, wriggling spaghetti worms, and even Giant squid. This extraordinary exuberance actually stems from the deep sea vents, where tiny, unassuming bacteria are converting the toxic compounds into sustenance and thereby providing the means to support a food chain independent of light, oxygen or anything else normally associated with life. This system is supported by chemosynthesis rather than photosynthesis, and could help us understand the possibilities on life on other planets.

The **hadal** zone, named after the underworld realm of Hades, is found in the deepest trenches of the ocean from depths of 6,000 meters to bottom of the ocean. Food is sparse and the pressure can reach 11,000 p.s.i., the equivalent of a human trying to hold 50 jumbo jets. Because of the extreme pressure, low nutrient availability and lack of light, this zone is only sparesely populated by creatures adapted to withstand the harsh conditions, including jellyfish, viperfish, sea cucumbers and tube worms.

Though these zones are distinguished by their differences, they are all interconnected by currents and each is an important habitat for a variety of organisms. Likewise, the oceans provide the air we breathe, the food we eat, life-saving medicines, jobs, recreation and many other necessities. Over 95% of the ocean remains unexplored, and we must preserve this wondrous world for the untold discoveries of future generations.[4]

Supplemental Resources

1- "History of Life on Earth." BBC Nature. http://www.bbc.co.uk/nature/history_of_the_earth

2- "The Census of Marine Life." Smithsonian National Museum of Natural History. http://ocean.si.edu/census-marine-life

3- "The Deep Sea." MarineBio. http://marinebio.org/oceans/deep/

4- "Name that Zone!"National Oceanic and Atmospheric Administration (NOAA). https://coast.noaa.gov/data/SEAMedia/Presentations/PDFs/Grade%203%20Unit%202%20Lesson%201%20The%20Open%20Ocean.pdf

Marine Conservation Science & Policy: Ocean Zones

Vocabulary Continued:

Ocean Zones:
The divisions of the ocean from the surface to the ocean floor, which vary by depth, pressure, light, and nutrients.

Benthic Realm:
This realm begins at the shore and extends along the continental shelf and the ocean floor, shaped by submarine mountains, ridges and trenches

Pelagic Realm:
The open part of the ocean (or lakes) that is neither near the bottom nor the shore.

Extension Activity:

Students will investigate the history and limitations of ocean exploration, and justify future explorations by summarizing and analyzing an article. The objective is for students to understand how deep the ocean is and why organisms are limited to certain depths. Why is the ocean mostly unexplored and what prevents humans from diving using SCUBA to explore the deep ocean? What technologies are being developed to push the limits of ocean exploration?

Assessment:

Students will complete the ocean zones worksheet after class, and should write a science journal entry answering the following prompt:

If you could visit any ocean zone, which would it be and why? How would you get there and what would do you think you'll discover? Remember to use the five senses when describing your trip.

Activity: Illustrating the Ocean Zones

Materials

- Four large butcher or poster paper sheets
- Multicolor markers, crayons or colored pencils
- Large meter stick or ruler
- Pictures of marine life from different depths (can be pre-glued onto index cards to strengthen)
- Glue or double-sided tape
- Tape for hanging the diagram

Procedure

1. Have students divide into four groups and lay their paper on the floor.
2. Using the meter scale on either side of the diagram, have students label from 0 m at the ocean surface to 6,000 m and deeper and draw some of the geological structures of the ocean basin (i.e. continental shelf, slope, rise and continental plain).
3. At the top of the diagram, have students draw the surface of the ocean and structures found at this level (i.e. coral reefs, a sailboat, a leaping dolphin).
4. At the bottom of the diagram, have students draw some features of the benthic realm, (i.e. trench, hydrothermal vent).
   Labels and features to include on the diagram:

Photic (sunlit) zone	Shoreline	Abyssal plain
Aphotic (no light) zone	Sea level	Rift valley
Benthic realm	Coral reef	Continental shelf
Pelagic realm	Mid-ocean ridge	Continental slope
Bathyal zone	Trench	Continental rise
Abyssal zone	Hydrothermal vent	Submarine canyon
Hadal zone	Subfloor sediment	

5. Have students place different organisms at their appropriate depths in the ocean.
6. Groups should present their work. Encourage discussion by asking which zones would they like to visit, which zone hosts the most interesting organisms, why ocean exploration is important, etc.

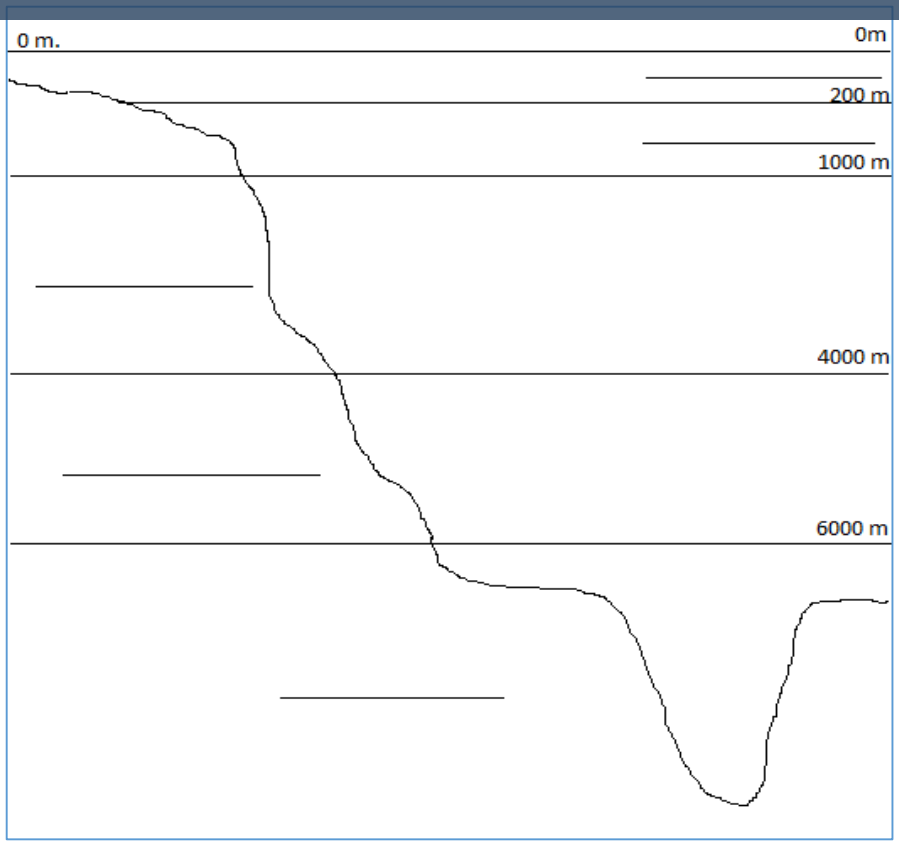
Worksheet Answer Key

1. From shallow to deep: photic – mesopelagic – bathyal – abyssal – hadal
2. Oceanography, five
3. Photic, photosynthesis
4. Submarine trenches, anglerfish

Ocean Zones:

The ocean is divided into five zones: the photic zone is the sunny top layer which supports photosynthesis and hosts most of the ocean's organisms; the mesopelagic zone begins 200 m deep and is home to many microorganisms; the bathyal zone is dark as midnight and is where many whales go to feed; the abyssal zone is almost freezing cold and many fantastic creatures live here; and finally the hadal zone delves into the deepest ocean trenches.

1. *Please label the zones, color them according to light conditions, and draw some organisms in the zone that is their home.*



2. The science of studying the ocean is called _____, and these scientists have divided the ocean into _____ zones.
3. The _____zone hosts phytoplankton which produces most of the world's oxygen through _____.
4. In the _____ of the hadal zone, some species like the _____ use bioluminescence to lure in their prey.

Word Bank: anglerfish -photosynthesis - submarine trenches –oceanography – photic – five

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Big Idea

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The Practice of Science

Standards

SC.K.N.1.1

Collaborate with a partner to collect information.

SC.4.E.6.4

Describe the basics of erosion (movement of rock by gravity, wind, water, and ice).

SC.8.G.5.2

Describe the impact of human modifications on the environment and ecosystems.

SC.912L.17.16

Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What are some ocean and coastal features? How do these features interact and why are they important?

Objectives

Students will explore some of the main features of the ocean and coastal landforms and examine interactions that are globally significant. Students will learn to

- Identify ocean and coastal features.
- Analyze the importance of these features and how their interactions affect humans.
- Elaborate a news report summarizing their knowledge of ocean and coastal landform features.

This will be a project-based activity in which students will explore the main features of the ocean and coastal landforms.

Background

The ocean covers nearly 70% of our planet and contains 97% of the world's water, affecting everything from climate to recreation and making Earth unique in the Solar System as the only planet with perfect conditions for liquid water. This exceptional body of water makes all of life possible, and this significance draws scientists to study the features, coastal landforms and interactions that support this complex system.

The ocean plays an essential role in regulating the Earth's **climate**, particularly through the **water cycle**, the process of evaporation, condensation, and eventual return of moisture through the precipitation upon which all life depends. The ocean is partly responsible for the temperature of the atmosphere, as the Sun heats the water, the heat is transferred to the atmosphere which then warms the globe. Because water changes temperature less rapidly than air, the ocean helps balance seasonal extremes by absorbing summer heat and slowly releasing it throughout the winter; without these moderations the planet would be a frigid ball of ice.

Ocean **currents**, a stream of water running through a larger body of water, in some ways aid in climate regulation, transferring heat from the Equator to the poles and returning with cooler water. The water of the ocean is also shifted by **tides**, the daily rise and fall of the ocean's surface partly due to the Moon's gravitational pull. Tides move nutrients, shift sediment and shape shorelines, forming a rich intertidal habitat on land and a renewable energy resource that engineers hope to develop further.

Coastal landforms both affect and are affected by the ocean, particularly through erosion. **Erosion** is the breakdown and movement of rock by water and wind, a process particularly evident along shorelines where waves beat at cliffs, pulverizing the rock and grinding the resulting sediment that accumulates at the base. On **erosional coasts**, this sediment is dragged to the deep by currents and tides, introducing new nutrients to ocean depths, while carving sheer cliffs, sea stacks and sea arches.

Vocabulary:

Climate:
The weather conditions prevailing in one area over a long period of time

Water Cycle:
The process by which water moves from land, ocean and atmosphere through evaporation, condensation and precipitation.

Current:
A stream of water moving through a larger body of water.

Tides:
The daily rise and fall of the ocean's surface partly due to the Earth's gravitational pull.

Ocean Floor:
The bottom of the ocean that stems form the continental shelf and rises and falls through mountains, canyons, plains and trenches.

Erosion:
The breakdown and movement of rock by water and wind.

Erosional Coasts:
Shorelines characterized by the reduction of rock and sediment by erosion, often featuring sea stacks, cliffs, and arches.

Depositional Coasts:
Shorelines characterized by the accumulation of sediment often from large distances, and usually divided into deltas, barrier island and estuarine systems, and strand plain coasts.

Marine Pollution:
The entry of harmful materials into the ocean.

Background

Conversely, **depositional coasts** are shaped by currents, tides and wave action and marked by deep accumulations of sediment, usually divided into three categories: deltas, barrier island and estuarine systems, and strand plain coasts. Deltas form at the mouth of the rivers when the continental shelf is only gently sloped, accumulating rich sediment from upstream that can form tidal flats and salt marshes. Barrier island and estuarine systems consists of elongated narrow islands that run parallel to shore and often shelter lagoons and brackish water bodies called estuaries. The term strand plain coasts has been applied to many coastal environments but are usually characterized by beaches and coastal dunes. The mix of nutrients running off land with the vibrant energy of the tides makes the coasts some of the most productive ecosystems in the world, including crucial habitats such as mangrove forests, seagrass meadows, coral reefs, and salt marshes.

Aside from providing critical habitats, ocean features and coastal landforms make incalculable contributions to trade, recreation, tourism, renewable energy developments, mining, oil drilling, food resources, carbon absorption and climate regulation. Humans have relied on the ocean and coasts for thousands of years for exploration, food sources and livelihood, and continue that dependence today.

Despite their global importance, the ocean and coasts are some of the most threatened and damaged regions of the world, suffering from sewage and chemical runoff, global warming and climate change, sea level rise, erosion, and vast amounts of pollution. This may be most evident in the Great Pacific Garbage Patch, a swirling vortex of plastic bags, Styrofoam cups, and other non-biodegradable debris weighing an estimated 3.5 million tons, disturbing wildlife, leeching chemicals and introducing harmful PDBs to the food chain, toxins that are especially devastating by the time they reach tertiary consumers like humans.[3]

In order to prevent some of this destruction, some governments and companies have taken steps to reduce their wastes, but individuals must take steps to correct harmful habits as well. For example, the Exxon Valdez oil spill of 1989 slopped over 10 million gallons of oil into the sensitive ecosystem of Prince William Sounds, and while the company was vilified and forced to pay reparations, U.S. and Canadian consumers continue to dump about 16 million gallons of oil from runoff into the Atlantic and Pacific oceans. To really make strides in marine conservation, governments, companies and individuals must be held accountable, reducing plastic production, decreasing chemical use, and minimizing waste. While it is important to remember that all drains lead to the ocean, it is equally critical to remind people the ocean is what makes life possible. This isn't an isolated intangibility under discussion, but a complex ecosystem to which humans are indebted, interconnected and indivisible.

Supplemental Resources

1- "Ocean." National Geographic Education.
http://education.nationalgeographic.org/encyclopedia/ocean/

2- "Tides." National Geographic Education.
http://education.nationalgeographic.org/encyclopedia/tide/

3- Virtual Tour: "The Properties of Water." Odyssey Earth.
http://www.odysseyearth.com/videos/the-properties-of-water/

Vocabulary:

Water Cycle:
The process by which water moves from land, ocean and atmosphere through evaporation, condensation and precipitation.

Erosional Coasts:
Shorelines characterized by the reduction of rock and sediment by erosion, often featuring sea stacks, cliffs, and arches.

Depositional Coasts:
Shorelines characterized by the accumulation of sediment often from large distances, and usually divided into deltas, barrier island and estuarine systems, and strand plain coasts.

Marine Pollution:
The entry of harmful materials into the ocean.

Extension Activity:

Have students think on how pollution and trash end up in the ocean and how much trash humans create every day. Have them write a paragraph in their journal about a school action plan, explaining some habits they have observed in their school and listing at least five steps that can be taken to improve. Follow up next class by asking about their progress on their individual, home and school action plans.

Assessment:

Have students complete the Ocean and Coastal Conservation worksheet after class and write a list of three items they learned today and three items they would like to research further.

Ocean and Coastal Landforms News Flash

Materials

- Lined Paper for script (may be cut into slips or index cards)
- Butcher paper for visuals
- Pens or pencils for report writing
- Coloring utensils for visuals (crayons, markers, or colored pencils)

Procedure

1. Explain to students that they will be writing a news report to inform the public about today's lesson and briefly introduce some of the formats for the news (i.e. slips of paper with different informative reports, visual representations, weather report).
2. Divide the class into groups of four. Each group will write a news report demonstrating knowledge from today's lesson. Some topics may include:
   -How the ocean affects climate
   -Categorization and formation of local coastal landforms (i.e. Miami has barrier islands, a form of depositional coast)
   -Explanations of currents, tides, and wave motion
   -Why the ocean is important, threats and conservation methods
3. Have students brainstorm ideas for 5 minutes within their groups and decide on 1-5 news report headlines, however many you decide they can handle depending on age and ability.
4. Once each group has decided on their topics, have them write a headline and a brief report on slips of paper or index cards.
5. Have students elaborate on some visuals to pair with their reports.
6. Have groups present their news reports. Encourage discussion about the importance of the ocean and how coastal landforms particularly affect Miami as a coastal city.

Worksheet Answer Key

Answers may vary, can include:
Reduce use of plastics, fertilizers, and household chemicals; walking or biking instead of driving; reusing materials, i.e. using an old tire for a swing; reducing electrical and water use by turning off lights, taking showers instead of baths, and using low-flow showerheads, etc.

Ocean and Coastal Conservation

While the ocean and coasts are critically important for the health of the planet, humans continue to pollute these valuable resources, including dumping over 1.4 billion pounds of trash into the ocean every year. This debris floats into twisting vortexes like the Great Pacific Trash Gyre or washes up on coasts, harming wildlife, commercial fisheries and human health. As individuals, even if we live far from the ocean, we can help prevent this waste by practicing the three R's: Reduce, Reuse, and Recycle. Think about your daily routine and decide what you can do to practice the three R's and help protect the planet's oceans and coasts.

I can reduce by…	I can Reuse by…	I can Recycle by…

Using the table above, convert these lists into an action plan. Determine five steps that you and your family can take at home to reduce, reuse and recycle and help protect the planet's oceans and coasts.

1. _____
2. _____
3. _____
4. _____
5. _____

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Intertidal Zone

Grade Level:

4th- 12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.1.L.17.1

Recognize that all plants and animals, including humans, need the basic necessities of air, water, food and space.

SC.4.L.17.2

Trace the flow of energy from the Sun as it is transferred along the food chain through the producers and the consumers.

SC.7.L.17.1

Explain and illustrate the roles and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.

SC912.L.17.9

Use a food web to identify and distinguish producers, consumers and decomposers.

Focus Question

What is the intertidal zone? What organisms live in this habitat and what challenges do they face? What is a food chain and what organisms of the intertidal zone are interconnected?

Objectives

Students will explore the intertidal zone and discover some of the unique qualities of this ecosystem. Students will learn to:

- Identify the four subzones of the intertidal zone.
- Identify some of the organisms that live in this habitat and the challenges they face.
- Describe a food chain and elaborate one found in the intertidal zone.

This will be a project-based activity in which students will discuss the interconnectedness of organisms and the habitats in which they live.

Background

The rhythmic rise and fall of the ocean surface is due mostly to the pull exerted on the water by the moon's gravity. This daily flooding and draining exposes a unique habitat along the coasts called the intertidal zone. The intertidal zone, also known as the littoral zone, is the area along the shore of marine environments that is exposed to the air in low tide and flooded by the seawater during high tide.

The intertidal zone can be divided into four subzones, including the spray zone, the high tide zone, the middle tide zone, and the low tide zone. The spray zone, or supratidal zone, is more of a terrestrial environment, as it lies above the spring high tide line and is only flooded during storm surges or other extreme weather events. While this zone receives waves splash and wind-blown spray, organisms here must be able to cope with exposure to air, heat, freshwater from rain, and predators like sea gulls. Some organisms that make this zone their habitat include barnacles, as well as land crabs, sea gulls, possibly even raccoons and seals.

Just lower than the spray zone, the high intertidal zone, as the name implies, is only flooded during high tide, and is exposed to the air for the longest amounts of time. This exposure means that marine organisms risk **desiccation**, or loss of water, and must adapt by hiding or clamming up, which means sealing off their shell to conserve moisture. Marine organisms that have adapted to withstand this exposure include red, brown and green algae, hermit crabs, limpets, and some snails and whelks.

The middle intertidal zone, also called the lower mid-littoral zone, is generally submerged, except for brief periods during low tide. Organisms that thrive in this zone have adapted to the turbulence of the daily tidal rhythms, and include sea stars, snails, barnacles, anemones, crabs, sea lettuce, and mussels.

The low intertidal zone is usually underwater, only exposed to the air when the tide is unusually low. Organisms that live in this zone are not well adapted to long periods of dryness

Vocabulary:

Intertidal Zone:
The area along the coastal shores that are exposed and flooded alternately by the ocean tides.

Spray Zone:
The area just above the tide line that still receives splash from wind and waves.

High Intertidal Zone:
The shore area only flooded by high tide, exposing its marine organisms to the elements.

Desiccation:
Drying out or loss of water.

Middle Intertidal Zone:
The shore area generally submerged but still exposed daily during low tide.

Low Intertidal Zone:
The shore area is only exposed during extreme low tides, hosting organisms that are not well adapted to dryness or extreme temperatures.

Food Chain:
A group of organisms linked in the order of the food they eat, starting with primary producers and continuing through consumers and eventually to decomposers.

Food Web:
The natural overlapping interconnections between food chains in an ecosystem.

Primary Producers:
Organisms that use photosynthesis to convert energy from the sun into nutrients, forming the base of most food chains.

Consumers:
Organisms that need to eat other organisms for nutrients, these can be divided into herbivores, carnivores, and omnivores.

Decomposers:
Organisms that consume organic material, including dead tissues and wastes, breaking down nutrients and returning them to producers.

Background

or extreme temperatures. Some organisms that may be found in this zone include abalone, sea urchins, sea stars, brown seaweed, sea cucumber, sponges, shrimp, surf grass, tubeworms, and some small octopus species.

Particularly along rocky shores, tide pools can form in the intertidal zones, areas of low depression that retain seawater as the tide recedes. Tide pools can range from shallow to deep, and can be found in all subzones of the intertidal zone. Because the water can evaporate, tide pools threaten inhabitants with wild changes in salinity, oxygen and temperatures, and exposure to the sweltering sun and predators. Despite the challenges, many creatures can be found in tide pools, including sea anemones, starfish, barnacles, hermit crabs, and even fish.

This zone forms an extreme environment for four particular reasons: providing only intermittently the supply of water which marine organisms need to survive; poorly adapted animals can be dislodged and washed away by the intense wave action along the shore; the high exposure to the sun causes an extreme range of temperatures from near boiling to almost freezing; and a much higher salinity as sea water left in pools evaporates leaving behind salt deposits.

While the intertidal zone poses many challenges to organisms trying to cope, it also provides many advantages to those able to adapt. The relentless wave action, though abrasive, also constantly supplies the zone with fresh nutrients and oxygen. The rocky protrusions also provide all sorts of nooks and crannies that make perfect hiding places and surfaces to cling to. These benefits also include plentiful sources of food, as the abundant sunlight also supports many algae and intertidal plants that form the base of a rich food chain.

A **food chain** is a group of organism linked in the order of the food they eat, starting with **primary producers** like plants and algae and moving up through **consumers**, including prey, predators, and ending with **decomposers**. A **food web** can connect many food chains and demonstrate the interconnections between organisms.

In the intertidal zone, the food chain begins with phytoplankton, microorganisms that use photosynthesis to create energy from the sun. These are usually consumed by zooplankton, which in turn is eaten by mussels, barnacles or other invertebrate. Barnacles are usually eaten by whelks, a type of snail that in turn is preyed upon by sea stars. While sea stars are near the very top of the food chain, they can be still be gobbled up by a sea gull or a sea otter. When the highest predator, such as a gull or a sea otter, dies, its body is consumed by decomposers, animals that break down dead tissues and wastes. Sea urchins are common intertidal zone decomposers, and as they can be eaten by sea stars, the food chain can be linked into the food web. In this manner, the food web displays not just the "who eats what", but highlights the complex interactions and interconnectedness of all organisms and their environment.

Supplemental Resources

"Food Web." National Geographic Education.
http://education.nationalgeographic.org/encyclopedia/food-web/

"Intertidal Zone." BBC Nature.
http://www.bbc.co.uk/nature/habitats/Intertidal_zone

"Point Reyes Intertidal and Subtidal Zones." National Park Service.
http://www.nps.gov/pore/learn/nature/intertidal.htm

Vocabulary:

Intertidal Zone:
The area along the coastal shores that are exposed and flooded alternately by the ocean tides. This zone can be divided into four subzones, including the spray zone, and the high, mid and low intertidal zones.

Food Chain:
A group of organisms linked in the order of the food they eat, starting with primary producers and continuing through consumers and eventually to decomposers.

Food Web:
The natural overlapping interconnections between food chains in an ecosystem

Extension Activity:

Have students reply to the following prompt in their science journal:
The food web is an important concept for all of us to know. Write an explanation of the food web that would help your younger brother or sister understand.

Assessment:

Have students complete the intertidal worksheet after class. Have students write a reflection paragraph imaging what would happen if one of the links of the food web (i.e. phytoplankton) were completely eliminated. How would that affect other organisms?

Program Partner:

Materials

- Chalkboard or marker board or large butcher paper
- Chalk, dry erase marker or other marker, depending on above availability
- Tape
- Index cards (or similar sized pieces of paper)
- Crayons, markers, or colored pencils
- Pens or pencils
- Specimens from the intertidal zone or books, magazines or printouts, or include photos in a data show of animals from the intertidal zone if available)

Procedure

1. Write the names of the four intertidal zones on the board or butcher paper to create four columns.
2. Divide the students into four groups and assign each group one of the four zones.
3. Have each group complete the following on the index cards:
   - 1 card describing their assigned zone including physical factors that affect the habitat (i.e. turbulence, sun exposure, etc.)
   - Several cards demonstrating some of the organisms that live in their assigned zone, each card should feature: the name of the organism, what they eat, any special features that help them adapt to the intertidal zone, and a drawing of the animal.
4. Have each group present their zone and organisms, taping their cards in the appropriate column.
5. Once all zones are presented, ask students to help connect them all to form a food web by drawing arrows from producers to consumers, prey to predator. If there is space, draw the Sun, water and bubbles (to indicate oxygen) and include them in the food web. Encourage discussion on the interconnectedness and interdependence of organisms and their environment. Where do humans fit in? What would happen if one type of organism disappeared?

Worksheet Answer Key

1. Spray zone
2. High intertidal zone
3. Middle intertidal zone
4. Low intertidal zone
5. Answers will vary, may include (but are not limited to):
   Producers- kelp, bladder wrack, spiral wrack, saw wrack
   Consumers- sea urchins, rock crabs, sunflower stars, barnacles, hermit crabs
   Decomposers- sea slugs, bacteria, fungi,

The Intertidal Zone

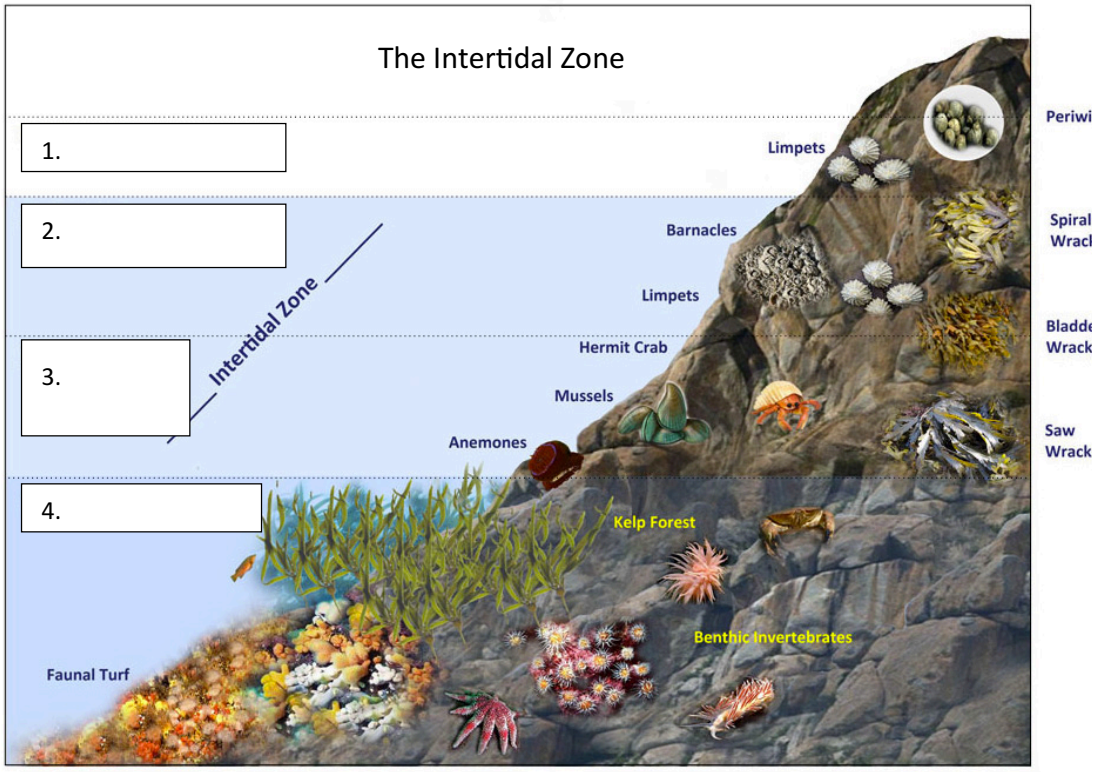
Write in the names of the subzones of the intertidal zone and match them with their description.

This zone is only flooded during high tide, exposing organisms to the sun and air for over 12 hours a day.

This zone is only dry during extreme low tides, hosting organisms that are not well adapted to air exposure.

This zone lies just above the tideline, receiving spray from wind and waves.

This zone is mostly submerged but is drained daily by the turn of low tide.



A food web is a chart that connects organisms, showing the interconnections and who eats what in an ecosystem. Most systems begin with primary producers that use photosynthesis to convert energy from the Sun and create nutrients. Consumers are organisms that need to eat other organisms for nutrients, and these can be divided into herbivores and carnivores. Decomposers are organisms that consume organic material, including dead tissues and wastes, breaking down nutrients and returning them to producers.

5. Using the above diagram and your knowledge, write one organism from the intertidal zone that fits in each category of the food web:

Sun → Producers → Consumers → Decomposers

_____ _____ _____

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science and Policy: Salt Marshes

Grade Level:

4th – 12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.K.N.1.1

Collaborate with a partner to collect information.

SC.K.N.1.4

Observe and create a visual representation of an object.

SC.8. G.5.2

Describe the impact of human modifications on the environment and ecosystems.

SC.912L.17.16

Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What is a salt marsh? What animals live in this environment and why is it important? How can we better protect this habitat?

Objectives

Students will explore the salt marsh and the animals that inhabit this important ecosystem. Students will learn to:

- Identify the four zones of a salt marsh.
- Recognize threats to this habitat and elaborate ways to protect it.
- Work with a partner to demonstrate knowledge by creating an educational poster.

This will be a project-based activity where students will work together to design an educational poster on the importance of the salt marsh.

Background

Salt marshes are coastal wetlands that are flooded and drained daily by salt water washed in by the tides. These saltwater feature grasses, rushes and other non-woody plants, while trees and shrubs are not found here. Their sediment may be composed of mud and **peat**, a spongy material made of decomposing plant matter that often causes the rotten-egg smell usually associated with marshes. These intertidal zones are usually divided into several areas that demonstrate distinct habitat conditions, including tidal creeks, mudflats, low marsh, and high marsh, with a border of uplands that is just outside of the tide's reach.

The tidal creeks and pools are bodies of water that are affected by the ebb and flow of the ocean tides, forming an estuary with variable salinity. Some of these bodies of water may be full all year while others may be filled and emptied with the tides, depending on depth. This zone also features **salt pannes**, shallow depressions that evaporating seawater leaves so salty that only glasswort and a few other organisms can tolerate these areas. Tidal creeks are an essential nursery for shrimp, crabs, and fish including flounder, bluefish and bass. Diamondback terrapins, saltmarsh watersnakes and even river otters can also be found here.

As tides retreat, they often expose long, low areas of mud composed of silt and clay. These expanses are called **mudflats** and host many creatures including oysters, fiddler crabs, sand shrimp, mussels and clams that burrow in the sediment during low-tide to avoid exposure to the sun and to predators.

As the land rises slightly, salt-loving plants called halophytes are able to take root and form the **low marsh**. These species most commonly include smooth cordgrass, saltwort, and others, which are able to withstand the high salinity, brought in daily by high tide. Although the **high marsh** is only elevated a few centimeters above the low marsh, the slight height makes all the difference in salinity, so that this zone is usually only inundated by the highest tides twice a month rather than daily. Plants of the high marsh usually include salt hay, spike grass and black

Vocabulary:

Salt Marsh:
Coastal wetlands that are flooded and drained daily by the ocean tide.

Peat:
A spongy material made of decaying plant matter that often forms part of the root-filled and waterlogged substrate of salt marshes.

Salt Pannes:
Shallow water-retaining depressions in tidal creeks that have increasing levels of salinity as water evaporates.

Mudflats:
A low-lying expanse of mud in the salt marsh intertidal zone that is exposed and flooded with the ebb and flow of the ocean tide.

Low Marsh:
Low-lying levels of the marsh covered by salt-loving plants that can withstand the daily influx of the tide.

High Marsh:
Slightly higher levels of the marsh that are only affected by the highest tides twice a month rather than daily, resulting in slightly lower soil salinity.

Uplands:
The higher ground bordering the marsh or sometimes isolated on islands that are above the intertidal zone and are only flooded during extreme events such as storm surges.

Environmental Stewardship
The responsible use and protection of the natural environment through conservation and sustainable practices.

Background

rush. Beyond the intertidal zone, just clear of the salty tide line, the **upland**s form the marsh border and some higher isolated islands. These areas are only flooded during storm surges and extreme astronomical tides, so organisms here do not experience the severe salt stress of the intertidal zone. This area hosts a high diversity of trees, shrubs and herbs including seaside goldenrod, marsh elder, switchgrass, sweet gale and many more.

Because the waters of salt marshes are constantly being flooded with fresh nutrients and minerals, they provide a rich environment for a myriad of organisms, including 75% of important fisheries species like blue crab, shrimp and finfish. The salt marsh provides feeding and nesting grounds for crocodiles, turtles, marsh rabbits, raccoons, manatees, muskrats, and marsh deer, as well as vital bird habitat, hosting herons, egrets, osprey, songbirds, eagles and shorebirds. While salt marshes offer crucial habitat for millions of organisms, they also offer essential services to humans. Salt marshes protect shorelines from erosion by buffering wave action and trapping sediments. They also reduce flooding by slowing and absorbing rainwater, and protect water quality by filtering runoff and by absorbing excess nutrients. An estimated 75% of seafood harvested in coastal waters is spawned in the salt marsh, contributing millions of dollars to the economy and providing an important protein source.

Though awareness of this important habitat is growing, salt marshes still face several threats. Most salt marshes were filled in and destroyed by real estate developments before their significance was understood. Dredging and diking can dramatically increase or decrease the water flow through the marsh, stressing or drowning marsh plants and increasing erosion. Fertilizer and pesticide runoff from roads, farms and mosquito control can overload the marshes ability to regulate pollution, causing toxins to accumulate, poisoning and killing the marsh, seafood, and coastal habitats. Overfishing and indiscriminate trapping prohibit population regeneration: if the small shrimp, crabs and fish aren't allowed to grow big enough to produce offspring, then there won't be any for future generations to enjoy. The salt marsh is also threatened by climate change, sea level rise, and storms, as this fragile ecosystem is vulnerable to salinity changes, water flow alterations, and erosion.

Although these threats may seem daunting, there are many actions we can all take to ensure the future of the salt marsh through **environmental stewardship**. Reducing fertilizer and pesticide use on lawns can help reduce non-point source pollution, as these products are washed downstream in the rain and can affect ecosystems far from home. Always put depositing trash in the trashcan is important, but recycling or reducing waste in the first place is even better as trash doesn't just disappear when it's placed in the bin. Adhering to catch and size regulations, season limitations and licensing rules is a vital practice that will help ensure future species populations. Additionally, educating others by taking them out on a marsh hike or joining a local volunteer group to replant marsh grass are great examples of responsible environmental stewardship.

Supplemental Resources

Listen to "What good is a salt marsh?" by George W. Frame. Highlights for Kids.
https://www.highlightskids.com/audio-story/what-good-salt-marsh
National Oceanic and Atmospheric Administration (NOAA)
http://oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar06a_saltmarsh.
"Dynamics of the Salt Marsh." Sea Science. South Carolina Department of Natural Resources.
http://www.dnr.sc.gov/marine/pub/seascience/dynamic.html

Vocabulary:

Salt Marsh:
Coastal wetlands that are flooded and drained daily by the ocean tide, essential habitat for many birds, fish, crustaceans and mollusks. This habitat is divided into levels of tidal creeks, mudflats, low marsh, high marsh and uplands, each with distinct environmental conditions.

Environmental Stewardship
The responsible use and protection of the natural environment through conservation and sustainable practices.

Extension Activity:

Have students research one of their favorite salt marsh animals or plants. The students will investigate the habitat, necessities, threats and importance of their chosen subject and write a summary.

Assessment:

Students will complete the Salt Marsh worksheet after class, and will write a reflective entry in their science journals responding to the following prompt:
The salt marsh is being negatively impacted by coastal development, overfishing, water pollution, jet skis and others human activities. Choose one of these issues and write a paragraph arguing how you would correct this problem if you were in charge.

Project Partners:

Salt Marsh Educational Poster

Materials

- Large construction paper, posterboard, or other paper
- Crayons, markers, or colored pencils
- Tape for hanging posters

Procedure

1. Divide students into pairs and give each pair a sheet of large construction paper and coloring utensils.
2. Have students draw an educational poster promoting environmental stewardship of the salt marsh. The poster should contain some of the following elements, depending on grade level:
   -the four levels of the intertidal zone and the uplands
   -a reason the salt marsh is an essential ecosystem
   -an example of a negative human impact on the salt marsh
   -an example of environmental stewardship of the salt marsh
   -a slogan or message promoting environmental stewardship of this valuable ecosystem
3. Have pairs briefly present their posters and encourage discussion of effective communication and educational methods to maximize impact, possibly analyzing which slogans were most efficacious in accomplishing the objective of promoting good stewardship. Voting (anonymously avoids hurt feelings!) by peers or adults can add scope.

Worksheet Answer Key

1. C. Kayaking is environmental stewardship because it allows recreation in a natural area without harming the resource.
2. D. Littering is harmful because it introduces toxic chemicals and other noxious substances into an area, damaging water bodies, habitats, and polluting the environment.
3. A. Sewage dumping is harmful because it pollutes natural areas with medical waste, harmful bacteria, and chemicals that contaminate water ways, habitats and other natural resources.
4. E. Measuring catch is environmental stewardship because it allows smaller catch to be returned and to grow to mature, reproductive age, helping to ensure future generations of fish.
5. B. Planting marsh grass is environmental stewardship because it helps restore an important ecosystem, providing habitat, protecting water quality, and reducing erosion.

History & Ecology

DEERING ESTATE

Protecting the Salt Marsh

Aside from providing an irreplaceable habitat for birds, fish and mollusks, the salt marsh also offers essential services to humans including erosion and flood control, recreation, jobs and food. Despite their significance, salt marshes face many threats from human activity, including contamination from sewers and runoff, overfishing, pollution and erosion. However, the importance of the salt marshes are encouraging some people to practice environmental stewardship, which include responsible and sustainable practices such as hiking, permitted fishing and clamming, trash cleanups and more. These activities help ensure that the salt marsh will continue providing essential habitat and important services to future generations.

Some examples of human activity in the salt marsh are pictured above. Match the photo with the name of the activity and decide whether it is harmful or an example of environmental stewardship. Explain your answer.

Example: *F* *Bird watching is environmental stewardship because it can increase knowledge of birds to improve conservation efforts.*

1. ____Kayaking is _____ because _____.
2. ____Littering is _____because _____.
3. ____Sewage dumping is _____ because _____.
4. ____Measuring catch is _____ because _____.
5. ____Planting marsh grass is _____ because _____.

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Sandy Beaches

Grade Level:

4th – 12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Physical Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.4.L.17.4

Recognize ways that humans can impact the environment.

SC.8. G.5.2

Describe the impact of human modifications on the environment and ecosystems.

SC.912L.17.16

Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What features form a beach? What animals and plants live in this ecosystem and why is it important? What are some of the threats to this habitat and how can we protect it?

Overview

Students will explore the features of sandy beaches and some of its habitats, reflecting on the importance of this ecosystem as well as threats and conservation efforts. Students will learn to:

- Identify some features that form a beach and some animals that inhabit this community.
- Explain the importance of this ecosystem and some threats that it faces.
- Elaborate a visual representation of the beach habitat in small groups.

This will be a project-based activity in which students will discuss how this habitat can be protected for future generations.

Background

A **beach** is a sloping coastal landform covered in loose sand, gravel, pebbles or seashell fragments. Most beaches are products of weathering and erosion, which have worn away land to create sediment, which is then carried by ocean currents and deposited on land by the tide. Sediment can drift only a few feet or be carried hundreds of miles before landing on the shoreline. The sediment on beaches varies depending on origin, changing in size from fine white sand to fertile mud along an estuary to pebbles, shingles and cobbles, which are common near cliff sides. Sandy beaches may feature sediment from eroded coral reefs just offshore, or they may be covered in jet-black volcanic sand, made from lava that eroded long ago.

Beaches are constantly shifting, changing daily with the tide and seasonally by storms and wind. They often feature sandbars, narrow, exposed areas of sand just off the beach, and can be divided into four subzones including: the swash zone, which is flooded and drained by the waves; the beach face, the sloping section below the berm; the wrack line which marks the highest reach of the daily tide with debris left by waves; and the berm, the higher area that usually remains dry and can feature **sand dunes**. Beach temperatures range from frigid to balmy and feature a variety of organisms depending on its features.

Though beaches form a harsh habitat, many animals and plants have adapted to the salt spray, shifting and infertile sands, baking sun and abrasive waves. Some specialized dune plants have adapted to the lack of nutrient-rich soil by absorbing essential elements like potassium, sodium, calcium and magnesium from the salt spray, including species such as sea oats, panic grass, and seagrape. As these plants stabilize the sediment, more plants can move in and form shelter for crabs, mollusks and small mammals like the red fox and beach mice. Seaweed, seagrass and other organic materials can also wash up on the beach to form **wrack**, which provides food and habitat to many insects, birds and small crustaceans while incubating the beach plants that help anchor the dune. Beaches also provide vital feeding grounds for

Vocabulary:

Beach:
A sloping coastal landform covered in loose gravel, pebbles sand or fragmented seashells.

Dunes:
A sand hill or ridge formed by wind that lies above the tide line and helps prevent flooding further inland during storm surges

Dune Plants:
Species that have adapted to the infertile and droughty conditions of sandy beaches, anchoring sediment with their roots and providing habitat for animals.

Wrack:
Seaweed, seagrass, and other organic material that wash on shore and mark the high tide line, providing food and shelter for many birds, insects and small crustaceans.

Beach Pollution:
Contaminating wastes that wash up on shores including chemicals from runoff, litter, sewage and medical debris that can be hazardous to human and ecosystem health.

Coastal Erosion:
The natural process of the moving of beach sediment due to wind, waves, and storms.

Sea Level Rise:
The increased height of the ocean surface due to many factors including climate change and glacier melting, causing increased flooding, erosion, and salt intrusion.

Background

many migrating birds, and shorebirds that include the pelican, piping plover and sand piper. Some birds feed on invertebrates that burrow in the sand like beach hoppers, beach pillbugs and bloodworms. Beaches are also essential nesting habitats for endangered sea turtles, which emerge from the surf only at night to dig a nest in the dry sand and lay their eggs before returning to sea. Aside from forming important habitat, beaches play crucial roles in preventing erosion and flooding, provide jobs by increasing tourism, and are popular sites for recreation, as people of all ages enjoy the sandy shores to fish, build sand castles, and frolic in the waves.

Despite their importance, beaches face many threats, including erosion, **pollution** and **sea level rise**. **Coastal erosion** is the natural process of the moving of the beach due to waves, wind and storms. Some coastal erosion is natural, and can be influenced by weather systems that cause more intense storms and storm surges, but some erosion is anthropogenic, or human-caused.

Because people like living near the beach, and many tourists like to visit, increases in construction near beaches are evident worldwide. However, this development can actually speed up the natural process of erosion, removing dune plants, leaving narrower spaces for beaches as buildings move closer to the waterfront, and inhibiting the natural, seasonal movement of beach sediment. As sediment is removed it is lost rather than constantly replaced naturally, so communities are forced to spend millions digging or dredging sand from elsewhere to replenish their own beach (often causing further erosion with the dredging). The beach reduction also exposes buildings to the pummeling of wind, waves and storm surges that would otherwise have been reduced by the former beachfront. Miami Beach has already experienced extreme flooding that would have been alleviated by former beaches and barrier islands that have been consistently dredged, dammed and developed, and as sea levels rise this damage will become even more costly.

Sea level rise is the increased height of the ocean surface due to many factors including climate change, glacier melting, and some weather patterns. As sea levels rise, they can damage coastal plants, animals and human developments, with increases in erosion, storm damage and salt water encroaching in aquifers. Beaches are also affected by pollution, which can include garbage that can entangle animals, chemicals from runoff, medical waste and even raw sewage, which can cause algae blooms that can be hazardous to human health.

Despite the many threats to beaches, there are movements by governments, organizations and individuals to protect beaches. Important actions to take include: reducing pollution by always throwing trash in a bin; leaving wildlife alone and taking pictures rather than specimens; limiting beachfront development; helping to replant dune plants; and educating others on the importance of protecting this ecosystem for future generations.

Resources

"Beach Ecosystem." National Geographic Education.
http://education.nationalgeographic.org/encyclopedia/beach/

"Treading Water." Climate Change Economics. National Geographic.
http://ngm.nationalgeographic.com/2015/02/climate-change-economics/parker-text

Coastal Care Flora and Fauna.
http://coastalcare.org/educate/flora-and-fauna/

Vocabulary:

Beach:
A sloping coastal landform covered in loose gravel, pebbles sand or fragmented seashells.

Beach Pollution:
Contaminating wastes that wash up on shores including chemicals from runoff, litter, sewage and medical debris that can be hazardous to human and ecosystem health.

Environmental Stewardship
The responsible use and protection of the natural environment through conservation and sustainable practices.

Extension Activity:

Have students write an advertisement for a beach near them to encourage new visitors, and include good habits to teach newcomers how to protect beaches.

Assessment:

Have students complete the beach worksheet during class and reflect upon a time they've visited a beach. Next time they visit, what can they do to protect beaches for future generations?

Program Partner:

Beach Blanket

Materials

- 12x12 swatches of un-dyed muslin (or paper if fabric not available)
- Watercolors, pastels, markers (or crayons or colored pencils if using paper)
- Brushes
- Embroidery thread and needle (optional)
- Books and magazines with beach habitat examples to inspire the artists
- Hole puncher
- Ribbons to tie all the squares into a quilt

Procedure

1. Demonstrate some quilts and explain to students that each will paint or color a square with one main idea from today's lessons, including good beach stewardship, beach importance as habitat or recreation, animals and plants from this habitat, etc.
2. Divide the students into small groups so that they may share ideas while still elaborating individual quilt squares.
3. They may surround their central square with smaller squares that demonstrate other beach features, (i.e. wrack, dune grass, dolphins, etc.) or they may draw patterns surrounding their center square, depending on preference. (Ideas will generate from examples shown)
4. If using muslin, older students may wish to outline their squares in embroidery thread while younger students may use marker
5. Students may present their squares, explaining how they incorporated today's lesson, and all the squares may be collected and joined together by ribbon (or staples if ribbon not available) to display in the classroom.

Worksheet Answer Key

1. Physical characteristics of this beach include: the swash zone which is daily washed by the tide, the beach face that slopes upward, and the berm, which features sand dunes and dune plants.
2. Some animals that may live here include: crabs, shorebirds, mollusks, beach mice, and insects like beach hoppers.
3. The activities that are harmful include dune buggies, which cause erosion, and sewage dumping, which causes point source pollution. Activities that are examples of environmental stewardship, enjoying nature while conserving it for future use, include beach cleanups, dune planting, photography, windsurfing, and building sand castles.

MSCP

DEERING ESTATE

Sandy Beaches

Sandy beaches form an essential habitat for many organisms including shorebirds, crustaceans, mollusks and even sea turtles that lay their eggs in the dry sand. This habitat also provides many important services to humans, including erosion and flood control, recreation, and jobs. Despite their importance, beaches face many threats from human activity, including pollution and overdevelopment that causes erosion. We can help prevent this damage by taking photos not specimens, replanting dune plants, depositing trash in trash bins, and educating others to help maintain beautiful, healthy beaches!

Use the above diagram to answer the following questions:

1. Describe some of the physical characteristics of this beach. _____

_____

2. Which animals may make their home in this habitat? _____

_____

3. Many human beach activities are pictured here. Which can be harmful and which are examples of environmental stewardship? _____

_____

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Mangroves

Grade Level:

4th – 12th

Subject Area

Science
Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science
Nature of Science
Physical Science

Big Idea

Organization and Development of Living Organisms.
The Practice of Science

Standards

SC4.L.17.4
Recognize ways that plants and animals, including humans can impact the environment.

SC.8. G.5.2
Describe the impact of human modifications on the environment and ecosystems.

SC.912L.17.16
Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What are mangroves? What animals live in this habitat and what services do they provide? How can we better protect this environment?

Objectives

Students will explore the mangrove ecosystem and some of the animals that live in this habitat. Students will learn to:

- Identify three species of mangroves and some of the animals that live in this habitat.
- Analyze the importance of this ecosystem and the pressures that threaten it.
- Elaborate an educational commercial explaining the key features of mangroves, what services they provide, and how to protect them.

Student will discuss how this habitat can be protected for future generations. This will be a project-based activity where students will explore the mangrove habitat.

Background

Mangroves are trees and shrubs that grow in the tropical and subtropical coastal intertidal zones, thriving in the hot, muddy, salty conditions that would kill most plants. They survive through complex adaptations including a filtration system that extracts freshwater by eliminating up to 90% of the salt from the seawater. Mangroves also hoard freshwater in thick succulent leaves to minimize evaporation, and have elaborated a root structure strong enough to maintain the mangrove upright, anchored fast despite beating waves and shifting sediment.[1] These high-arching roots are a distinctive feature of many mangroves, and some species have even evolved ways of using their roots to breathe. Because of these ingenious adaptations, over 80 species flourish along coasts, with three species particular to Florida.

These Florida species include the red, black and white mangroves, each characterized by distinct features. The red mangrove, *rhizophora mangle*, grows right along the water's edge, and is easily identified by its prop-roots, the reddish, tangled mass that make the mangrove appear to be standing on the water. This species uses lenticels to aid in respiration, thousands of cell-size breathing pores that take in oxygen at low tide and then close tightly to keep the tree from drowning at high tide. Features include dark green leaves with lighter undersides, small white flowers, and long, torpedo-shaped seedlings called **propagules** that actually germinate while still attached to the fruit so that they are ready to root the moment they fall.

The black mangrove, *Aviccenia germinans*, is usually found just inland and on slightly higher elevations than the red mangrove. This species can be recognized by its **pneumatophores**, the black pencil-like projections that pop up from the sediment and can grow up to 30 cm, taking in oxygen during high tide. The leaves tend to be somewhat narrower than those of the red mangrove and are often encrusted with salt as they excrete salt in filtering the water.

The white mangrove, *Languncularia racemosa*, occupies higher ground than the red and black mangroves, and is prominent in high marsh areas. This species usually has no visible

Vocabulary:

Mangrove:
A tree or shrub that grows in chiefly tropical coastal swamps, which are flooded at high tide. Mangroves often have thick, tangled roots and form dense thicket that is a crucial habitat for many species.

Pneumatophores:
Thin, pencil-like roots that stick up through the sediment and act as snorkels for some mangrove species

Lenticels:
Cell-like breathing pores on the aerial roots of some mangroves that take in oxygen at low-tide and close up during high tide.

Propagules:
Elongated seedpods of the mangroves which are already germinated and ready to root when they fall from the tree, and may withstand up to a year floating in salt water until they land in a suitable spot.

Red Mangrove:
A Florida species that grows right along the coast and features arching red roots that rise above the water, dark leaves and long propagules.

Black Mangrove:
This Florida species grows slightly inland, and sends out thousands of black, pencil-like pneumatophores and often has salt-encrusted leaves.

White Mangrove:
This Florida species prefers to be further inland, producing spikes of light green flowers and two small glands at the base of each leaf.

Deforestation:
The clearing of forests that results in environmental damage

Environmental Stewardship:
The responsible use and protection of the natural environment through conservation and sustainable practices.

Background

roots, but can develop peg roots, shorter, stouter versions of pneumatophores that aid in respiration in oxygen-deprived sediment. The white mangrove produces oval leaves with two distinguishing white glands at the base called neotrines, which excrete salt, and light green flowers.

These three species cover 469,000 acres in Florida, and play a vital role in establishing habitat for many species. Mangroves provide essential feeding and breeding grounds for fish, crustaceans, mollusks, birds, turtles, oysters, and even alligators. Mangroves are often deemed "nature's nursery", hosting at some point in their life cycle an estimated 90% of recreationally important fish and serving as nesting grounds for many endangered bird species.[2] Aside from providing essential habitat, mangroves contribute key environmental services. Their elaborate root systems accumulate organic matter, forming a rich ecosystem while slowing water flow, filtering harmful nitrates and phosphates, and sometimes even collecting enough sediment to create small islands. Mangrove forests help stabilize shorelines against erosion and form a buffer zone that helps to reduce hurricane and storm surge damage. Although coastal habitats like mangroves cover less than 20% of the total ocean area, they account for more than half of the carbon sequestered in ocean sediments, mitigating climate change through "blue carbon."

Despite their importance, mangroves are disappearing faster than the rainforest, with only an estimated 50% of mangrove forests intact, many of these in poor condition.[2] The worldwide greatest threat to mangroves is **deforestation** for shrimp farms, which in turn contaminate aquifers and remaining mangroves with chemical waste from antibiotics, pesticides and fertilizers. Millions of acres of mangroves have also been cut for agriculture and real estate development, which further compromise surviving mangroves by pumping industrial, and organic wastes into water supplies, which then negatively affects the fishing industry. In Florida, coastal development most threatens mangroves.

As fisheries decline and coastal areas become more exposed and vulnerable to storm damage, people are investigating in mangrove restoration and protection projects like living shorelines. Resolutions vary depending on locally specific threats, including legal action against shrimp farms, books teaching elementary students **environmental stewardship**, replanting thousands of acres of mangroves, and promoting ecotourism to provide jobs while protecting this valuable ecosystem. Due to damage from coastal development, Florida implemented the Mangrove Protection Act to conserve and restore this valuable ecosystem.

Everyone can help protect the mangroves by keeping the water clean, being vigilant and reporting damage to the appropriate authorities, talking to others to educate them on the benefits of mangroves, and getting involved with volunteer groups replanting and maintaining the mangroves. Buying sustainably raised shrimp at the grocery store and donating money and time to mangrove restoration projects are also helpful. It's important to take part and help save the mangroves and the rich variety of life that depends upon them.

Supplemental Resources

1- Ocean Portal. Smithsonian National Museum of Natural History. http://ocean.si.edu/mangroves
2- Virtual Tour: "Mangroves: Protectors of the Coast." Odyssey Earth. http://www.odysseyearth.com/videos/mangroves-protectors-of-the-coast/
3- Virtual Tour: "Lifecycle of the Red Mangrove." Odyssey Earth http://www.odysseyearth.com/videos/the-life-cycle-of-the-red-mangrove/

Vocabulary:

Mangrove:
A tree or shrub that grows chiefly along tropical coastal shorelines, which are flooded at high tide. Mangroves often have thick, tangled roots and form dense forest that is a crucial habitat for many species.

Deforestation:
The clearing of forests that results in environmental damage

Environmental Stewardship:
The responsible use and protection of the natural environment through conservation and sustainable practices.

Extension Activity:

Have students write a postcard to their mom and dad from the mangroves, summarizing today's lesson to describe the ecosystem they are "visiting" and explain its importance.

Assessment:

Students will complete the mangrove worksheet after class, and write an explanatory entry in their science journals responding to the following prompt:
If you could be an animal in the mangrove ecosystem, which animal would you be and why? How would the mangroves support you?

Program Partner:

Protect the Mangroves! Commercial

Materials

- Lined writing paper
- Blank paper
- Pencils or pens
- Coloring utensils (markers, crayons, or colored pencils)
- Tape or glue as needed
- Props that may be available

Procedure

1. Divide students into groups of four and supply each group with paper and coloring utensils.
2. Have students imagine that they are a Mangrove Protection Organization that wants the city of Miami to protect its mangroves, while a construction company wants to cut down the mangroves to build a shopping mall.
3. Each group will choose a name for their fictional protection organization and a slogan to present their message to protect the mangroves (i.e. Save the Miami Mangroves!)
4. Have students define the mangrove habitat and make a list of benefits that mangroves provide to the community.
5. Using the definition and list of benefits, students will write and prepare a commercial convincing voters to protect the mangroves. They may decide to use props, prepare a visual or sign with the paper and colors, and may decide to use animals as characters. (Remind them of script format:
   Brenda: "Hello"
   Bobby: "Hi!")
6. Have each group present their commercial.

Worksheet Answer Key

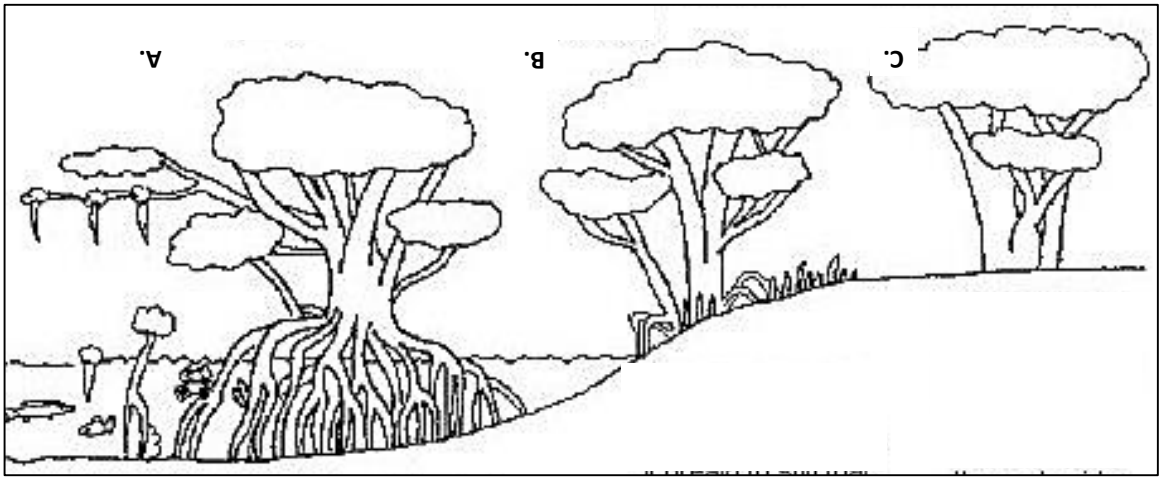
1. Black Mangrove: B
2. White Mangrove: C
3. Red Mangrove: A
4. Word Scramble:
   Coast
   Habitat
   Fish
   Erosion
   Hurricanes
   Deforestation
   Planting

Mangroves

Mangroves are trees or shrubs that grow in tropical and subtropical coastal swamps which are flooded at high tide. Mangroves have thick, tangled roots and form a dense thicket that is a crucial habitat to many marine and terrestrial species. Three species can be found in Florida, each forming an essential part of the mangrove ecosystem, protecting coasts from erosion, reducing flooding, and providing a home for many animals including oysters, turtles, fish, crocodiles, and birds such as the brown pelican and roseate spoonbill.

Draw lines to match the name of the mangrove with the corresponding picture and description.

1. Black Mangrove	2. White Mangrove	3. Red Mangrove

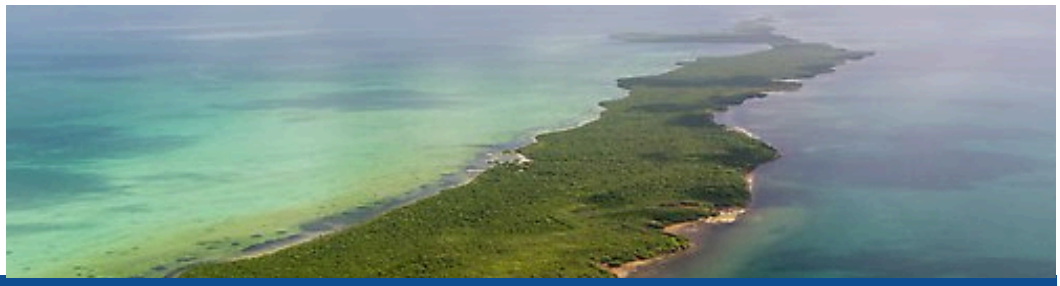


a. This species grows slightly inland, sending out thousands of black, pencil-like pneumatophores to aid in respiration, and often has salt-encrusted leaves.	b. This species prefers to be further inland than the others, producing spikes of light green flowers and two small glands at the base of each leaf.	c. A species that grows right along the coast and features arching red roots that rise above the water, dark leaves and long propagules.

4. Mangroves are important species that grow along the (OTASC) _____, forming a dense thicket that provides (BAHTTAI) _____ for many organisms. Many of the (FHSI)_____, crustaceans and mollusks that we eat are born here, that's why the mangroves are often called "nature's nursery". Mangroves also protect our coastlines from (ORSEINO)_____ by securing the sediment with their strong root systems, and reduce flooding and damage during strong storms like (URIRAENCSH) _____. Unfortunately, many mangroves are being damaged by (NIASRFDEOETTO) _____, the cutting down of large tracts of forests. We can help protect the mangroves and the animals that live in this habitat by educating others and (LTANPNGI)_____ new mangroves for future generations to enjoy.

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI



Marine Conservation Science & Policy: Barrier Islands

Grade Level:

4th – 12th

Subject Area

Science

Biology

Duration

1.5 Hrs.

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Physical Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.4.L.17.4

Recognize ways that humans can impact the environment.

SC. 7.E.6.6

Identify the impact that humans have had on Earth, such as urbanization, erosion and changing flow of water.

SC.912L.17.16

Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What are barrier islands? What are the main features of a barrier island and what organisms live there? Why are barrier islands important and how can we better protect them?

Objectives

Students will explore the barrier islands and some of the habitats, animals and plants found on these formations. Students will learn to:

- Identify the main features of a barrier island.
- Identify the different habitats found on a barrier island and some of the organisms that live there.
- Explain the importance of the barrier islands and demonstrate knowledge by elaborating a visual representation.

Students will discuss how this habitat can be protected for future generations. This will be a project-based activity in which students will explore the various habitats of the barrier island.

Background

Barrier islands are long, narrow deposits of sediment that run parallel to shore but are separated from the mainland by a calm, protected body of water called a bay or lagoon. Barrier islands form when sand from the weathering and **erosion** of rock is transported to the coast by rivers, and the force of the waves, tides and currents work the sediment into an island or a chain of islands. Current islands were formed about 4,000-6,000 years ago, when melting glaciers from the last ice age caused a rapid rise in sea level and tidal actions forced sediment shoreward. Barrier islands dynamic landforms, as the tides, wind and waves constantly shift their sediment and move them towards the mainland.

Each barrier island can be divided into four zones, including the ocean shoreline, the sand dunes, the back barrier and tidal inlets and deltas. The ocean shoreline, often called the **beach**, extends from the intertidal zone to the high tide line and bears the full force of the ocean waves, tides and currents. Sediment here can range from fine to coarse sand, pebbles, seashells, and sometimes even fossils. Despite the lack of fresh water, this area hosts a rich variety of species adapted to the tidal turbulence, including sea stars, hermit crabs, scavenging animals like the ghost crab and shorebirds such as seagulls, sand pipers and pelicans.

Just inland of the beach are **sand dunes**, formed by the wind blowing sediment into mounds and the first colonizing plants helping to anchor more sediment. The dunes provide a hostile environment due to high salinity, sandy soil and lack of fresh water, but they do receive moisture from rain, surf and occasional storm surges. Organisms found in the sand dune zone include sea oats, bitter pancum, crabs and birds. On wider barrier islands, the root systems of the plants provide stability and their leaves function as a windbreak, allowing sediment and nutrients to accumulate, sometimes forming soil rich enough to support trees. Some barrier islands are large enough to support **maritime forests**, with live oak, slash pine, raccoons, rabbits, even deer, while others may be little more than loose sand and a few stunted plants.

Vocabulary:

Barrier Islands:
Long, narrow deposits of sediment that run parallel to shore but are separated by a protected lagoon or bay.

Erosion:
The natural process of the breaking down and movement of rocks and sediment by wind and water.

Beach:
The oceanfront shore extending from the lower intertidal zone to the high tide line.

Sand Dunes:
A sand hill or ridge that lies above the high tide line and is formed by accumulating sediment from wind and tide.

Maritime Forests:
A coastal wooded habitat found on higher ground behind dunes, sheltered from the harshest winds and salt spray.

Back Barrier:
The inner shore of barrier islands sheltered from the harshest ocean waves but still drained and flooded by the daily tide.

Tidal Inlets:
A channel forged by the tidal flow connecting the ocean and lagoon.

Beach Replenishment:
The process of pumping sand from offshore onto an eroding shoreline

Background

Behind the sand dunes is the **back barrier**, an area to a certain extent sheltered by the dunes from the full force of the wind and waves, though still flooded and drained daily by the tide. This protected shoreline can include salt marsh, mangroves, sawgrass and mudflat communities depending on conditions, habitats teeming with flora and fauna thriving on the rich organic sediment of the back barrier. The variety of life supported in this zone can include clams, mussels, worms, snails, crabs, small fish, invertebrates and birds.

Finally, barrier islands often feature **tidal inlets** that allow tidal water to flow in and out of the lagoon. Inlets can be deeper and wider depending on the size of the lagoon and the variance in the tidal range, allowing for more water to flow between the ocean and the sheltered lagoon. The tides supply sustaining nutrients and carry away wastes from the barrier island system, and provide habitat for mussels, clams, and crabs.

Barrier islands form essential marine habitat for many organisms, including birds, manatees, endangered sea turtles, commercially important fish species and many more. Both the Atlantic and Gulf coasts of Florida feature extensive barrier islands including Key Biscayne, Caladesi Island, and Sand Key, which are home to more than a million residents and provide beautiful locations for tourism and recreation. Most importantly, barrier islands are the first line of defense against the powerful storms that threaten coastal communities, reducing the devastating effects of wind and waves and absorbing some of the storm's energy. Much of Hurricane Katrina's disastrous effects on Louisiana could have been avoided had the coastal wetlands and barrier islands been restored to their natural state.

Unfortunately, the ability of many barrier islands to deliver these important environmental services has been compromised due to anthropogenic damages. Many barrier islands have been paved with roads, parking lots and buildings that inhibit the natural movement of sediment and make the islands more prone to erosion. Because many rivers and estuaries have been dammed, the supply of sediments that would usually replenish barrier islands has been diminished, further reducing their ability to withstand the naturally erosive force of the waves. Rising sea levels and stronger storms due to climate change are also subjecting barrier islands to more wave action, and the accumulating effects of these factors are leaving them more vulnerable and less able to protect coastal communities.

In order to restore barrier islands to their former health, many cities and organizations are working together to find solutions. Some cities are investing in **beach replenishment**, dredging sand from the ocean bottom, pumping it onto the beach and shaping it into new sand dunes. However, these expensive solutions are only temporary, while allowing barrier islands to be protected as wild seashores can help restore the natural movement of the sediment. Solutions must be made on a case-by-case basis, examining the environmental and social factors of each region and taking appropriate action to protect this critical habitat.

Supplemental Resources

1- "Nature's Coast Guard." Science New for Kids.
https://student.societyforscience.org/article/natures-coast-guards
2- "How Barrier Islands Work." How Stuff Works Science.
http://science.howstuffworks.com/environmental/conservation/issues/barrier-island.htm
3- "What will climate change and sea level rise mean to barrier islands?" NASA.
http://www.nasa.gov/topics/earth/features/barrier-islands.html

Vocabulary:

Barrier Islands:
Long, narrow deposits of sediment that run parallel to shore but are separated by a protected lagoon or bay.

Extension Activity:

Have students interview a parent about our local barrier islands. Students should plan for the interview by writing questions about which they are curious prior to the interview, questions that may include: how many barrier islands shelter the bay, have they been damaged by development, have you ever visited one, etc. Parents should be encouraged to help their child locate barrier islands on a map and reflect on their importance to local communities.

Assessment:

Have students complete the Barrier Island worksheet after class and write a brief paragraph on what they learned during today's lesson and how it applies to their daily lives.

Program Partner:

Drawing a Barrier Island

Materials

- White paper
- Coloring utensils (i.e. crayons, markers, or colored pencils)
- Tape to hang illustrations
- Fact sheets and maps of different Florida barrier islands

Procedure

1. Divide students into pairs and assign each pair a different Florida barrier island. Explain that each pair will explore their barrier island using their fact sheet and map, and then create an illustration of their assigned island.
2. Pass each pair one sheet of paper and coloring utensils and explain that each barrier island should include and label the following features:
   -Beach -Sand dunes -Ocean
   -Back barrier -Tidal inlets -Lagoon or bay
3. Have students illustrate some of the animals and plants that can be found in the different areas of the barrier island habitat.
4. Allow each pair to present their island and briefly explain the features. Conduct a class discussion analyzing the importance of these coastal landforms and ways in which they can be protected.

Worksheet Answer Key

1. Bay
2. Marsh
3. Back barrier (including maritime forest on Elliott Key)
4. Sand Dunes
5. Beach
6. Ocean
7. Like most barrier islands, both are long and narrow, and are characterized by all of the above listed features.
8. While Elliott Key can support a maritime forest with trees, the back barrier of Assateague island is more barren, hosting just smaller vegetation.
9. The different latitudes and climates of the two islands, as Assateague Island is so much further North, has probably resulted in their different ecosystems.
10. Some suggested species: Elliott Key hosts live oaks, raccoons, opossums, mice, the endangered Schaus swallowtail butterfly, and even sea turtles use the island to nest. Both islands support many birds, including egrets, gulls, osprey, herons, sandpipers, and Assateague island also supports eagles, ducks, and geese, as well as whitetail and silka deer, mud turtles, sea stars, sea scallops, sea cucumbers, spider crabs, and even wild horses.
11. These examples, like all barrier islands, are constantly shifting, gaining and losing sediment and slowly being rolled over towards the mainland by winds, currents and tides.

Barrier Islands

Assateague Island, North Carolina

Elliot Key, Florida

Referring to the two figures above, label the main features of a barrier island.

Bay Back Barrier Beach Sand Dunes Marsh Ocean

1. _____ 2._____ 3._____

4. _____ 5._____ 6._____

7. Carefully observe the two barrier islands featured above. What are some of the similarities? _____

_____

8. What are some differences? _____

_____

9. Consider the locations of these islands. Why might they demonstrate some differences? _____

_____

10. What animals might live on these islands? _____

_____

11. Will these islands always be shaped this way? Why or why not? _____

_____

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Sea Grasses

Grade Level:

4th – 12th

Subject Area

Science
Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science
Nature of Science
Physical Science

Big Idea

Organization and Development of Living Organisms.
The Practice of Science

Standards

SC.K.N.1.1
Collaborate with a partner to collect information.
SC.K.N.1.4
Observe and create a visual representation of an object.
SC.8. G.5.2
Describe the impact of human modifications on the environment and ecosystems.
SC.912L.17.16
Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What are sea grasses? What animals live in this habitat and what services does it provide? How can we better protect this environment?

Objectives

Students will discover special features of seagrass and explore the coastal ecosystem of the seagrass meadow, Students will learn to:

- Identify features of seagrass meadows and animals that live in this habitat.
- Analyze the importance of this ecosystem and elaborate ways to protect it.
- Work in small groups to form a vocabulary alphabet demonstrating knowledge of seagrass meadows.

This will be a project-based learning module in which the students will work in small groups to present a visual representation of this habitat, discussing its importance and ways to protect it.

Background

Seagrasses are submerged aquatic plants that grow on the bay floor, with long, thin, grass-like leaves covering parts of the ocean floor to form seagrass meadows. Despite popular misconception, seagrasses are not seaweeds; seagrasses are actually more closely related to flowering terrestrial plants and belong to a group of plants that includes grasses, lilies and palms. Like their terrestrial relatives, seagrasses produce seeds, roots, stems, fruit, veins and leaves and are the only flowering plants beneath the sea. In contrast, seaweeds have no flowers or veins, and their roots merely anchor rather than absorb nutrients. These similarities to land plants and differences with seaweeds lead scientists to suggest that seagrasses evolved from algae to land plants and then transitioned back to the sea over 100 million years ago.[1]

Seagrasses use **photosynthesis** to harness the Sun's energy to convert carbon dioxide and water into sugar and oxygen, which they use for energy. Their roots also absorb nutrients from the sediment of the ocean floor and act as anchors securing them to the bottom. Seagrasses also have tiny air pockets in the leaves to keep them buoyant, and to exchange gases throughout the plant. Because seagrasses use photosynthesis to create energy, they are the primary producers and basis of many marine food webs, supporting diverse ecosystems.

Seagrasses can reproduce through sexual reproduction, the fertilization of a female plant by male pollen, and **clonal growth**. Asexual clonal growth is when seagrasses, similar to terrestrial grasses, send root-like rhizomes out sideways to produce new shoots, so that entire seagrass meadows can actually be connected stems with the genetic code of only a few plants. The oldest known plant is a clonal growth in the Mediterranean of the seagrass Posidinia oceanica, which dates back to the last ice ages at over 200,000 years old.[1]

Seagrasses only grow in the photic zone, the shallow ocean depths where enough light penetrates for photosynthesis. There are 72 distinct species of seagrasses found in salty or brackish water, usually along gently sloping coastlines that are somewhat protected from the

Vocabulary:

Seagrass:
Angiosperms, flowering plants that grow submerged in salty and brackish waters, forming meadows that support a complex food web.

Photosynthesis:
The process by which plants produce energy by converting carbon dioxide, hydrogen and other nutrients in to simple carbohydrates, releasing oxygen as a by-product.

Clonal Growth:
The reproduction process that send root-like rhizomes out sideways to produce new shoots, used by terrestrial and seagrasses

Seagrass Meadows:
Highly productive coastal ecosystems formed by dense growths of seagrass and supporting thousands of organisms from shrimp to sea turtles.

Food Web:
The natural overlapping interconnections between food chains in an ecosystem, including primary producers, consumers and decomposers.

Prop Scarring:
Damage to seagrass meadows and other coastal ecosystems by boat propellers; these scars can take years to recover and can be avoided by responsible boating.

Environmental Stewardship
The responsible use and protection of the natural environment through conservation and sustainable practices.

Background

turbulence of battering waves. Some seagrasses are long, flat and ribbon-like while others resemble spaghetti, ferns or paddles, reaching lengths of 3 inches to 35 feet. Seven species of seagrass are found in Florida, including turtle grass, shoal grass, manatee grass, widgeon grass, stargrass, paddle-grass and Johnson's sea grass.[3] All are found in Biscayne Bay.

Seagrass meadows are considered one of the most productive ecosystems in the world; a single acre can produce over 10 million tons of biomass every year. The high productivity provides indispensible feeding and nursery grounds for a myriad of organisms founding a complex **food web**, with a single acre capable of hosting an estimated 40,000 fish and 50,000,000 invertebrates.[2] Seagrass beds support many crustaceans, snails and fish species by providing a protecting buffer from strong currents, and are and essential food source for herbivores like the endangered manatee and green sea turtle. Additionally, seagrasses are known as "the lungs of the sea", producing 10 liters of oxygen daily per meter of seagrass. Their stabilizing roots also reduce erosion and protect coastlines.

Seagrasses also provide economical benefits. For over 10,000 years humans have used seagrasses to fertilize fields, insulate homes, fill mattresses, make bandages, thatch roofs, and as source of food. In Florida alone, seagrasses support the commercial fish and shellfish harvest, earning over $124 billion annually.[2] Estimates value an acre of seagrass in Florida at $20,500, while an acre of corn in comparison earns $373. Despite the extraordinary economic and ecologic contributions of seagrass meadows, this vital habitat faces many threats.

Seagrasses endure natural pressures such as storms, excessive grazing and disease, but this valuable ecosystem also suffers from human threats. Because of their coastal proximity, seagrass beds are especially vulnerable to runoff pollution from urban and agricultural areas, carrying contaminants such as pesticides, household chemicals, oils, automotive wastes, fertilizers and other chemical and debris. This excess leads to algae blooms, which deplete oxygen supplies and smother seagrasses, causing massive die-offs. Dredging and **prop scarring** also tear up meadows, leaving open spaces that take years to regrow.

Unfortunately, the world is losing an estimated 1.5% of seagrasses annually, or about 2 football fields every hour, disappearing faster than the rainforest. To protect this valuable habitat, South Florida is limiting harmful fishing practices, reducing dredging and trawling, and decreasing runoff. Some simple steps that everyone can take to protect seagrass meadows include: limit pesticide and fertilizer use; don't litter; don't dump toxic substances down drains as drains; go slow and avoid shallow areas when boating, or pole off seagrass meadows rather than using the engine; educate others; and support local conservation efforts by donating and volunteering. If everyone contributes and practices **environmental stewardship**, and participates in restoration efforts, the globally vital seagrass habitats will be protected for future generations.

Supplemental Resources

1- "Indian River Seagrass Habitats." Smithsonian Marine Station.
http://www.sms.si.edu/IRLspec/Seagrass_Habitat.htm
2- "Seagrass." Florida Department of Environmental Protection.
http://www.dep.state.fl.us/coastal/habitats/seagrass/
3- Virtual Tour: The Seagrass Habitat. Odyssey Earth.
http://www.odysseyearth.com/videos/the-seagrass-habitat/

Vocabulary:

Seagrass:
Angiosperms, flowering plants that grow submerged in salty and brackish waters, forming meadows that support a complex food web.

Seagrass Meadows:
Highly productive coastal ecosystems formed by dense growths of seagrass and supporting thousands of organisms from shrimp to sea turtles.

Environmental Stewardship
The responsible use and protection of the natural environment through conservation and sustainable practices.

Extension Activity:

Students will find a current event relating to seagrass meadows in Biscayne Bay (or Florida) and summarize the article, reflecting on the status of the local seagrass and current threats.

Assessment:

Students will complete the seagrass worksheet in class and write a reflective paragraph on what services local seagrass meadows provides for them, and how they can do to help protect local seagrass meadows.

Program Partner:

Seagrass Alphabet

Materials

- Index cards or paper of similar size
- Coloring utensils (crayons, markers or colored pencils)
- Pen or pencil
- Tape

Procedure

1. Divide the students into four groups; assign two groups six letters of the alphabet and two groups seven letters of the alphabet so that together they make the full alphabet.
2. Using an index card for each letter, students will write a relevant word from today's lesson beginning with each letter (i.e. G=Green Sea Turtle)
3. On each word's index card, students will define the word, connect it to today's lesson and draw a representation. (i.e. The green sea turtle is a large marine reptile that is endangered. They are the only herbivorous sea turtles and like to graze on seagrasses.)
4. Each group will present their letters in order of the alphabet, taping each index card on the board or around the room. Highlight the interconnections between all of these seagrass organisms and conduct a class discussion on the importance of this complex ecosystem.

Worksheet Answer Key

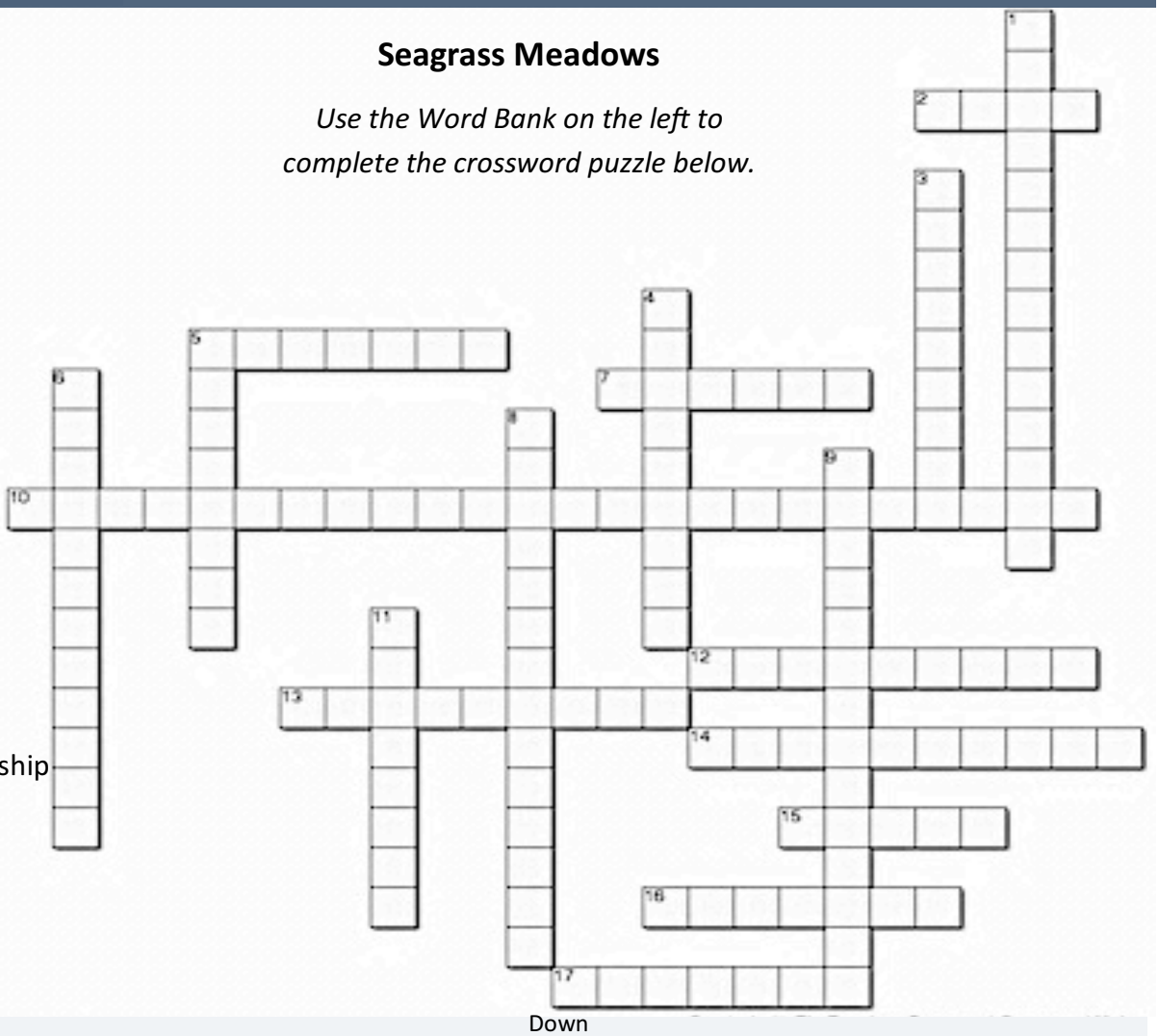
1. Photosynthesis
2. Roots
3. Producers
4. Pollution
5. Seagrass
6. Clonal growth
7. Flower
8. Seagrass meadow
9. Green sea turtle
10. Environmental stewardship
11. Economic
12. Consumers
13. Prop scar
14. Antarctica
15. Lungs
16. Habitat
17. Manatee

Word Bank

Lungs
Manatee
Habitat
Clonal Growth
Root
Flower
Producers
Consumers
Pollution
Economic
Seaweed
Green Sea Turtle
Seagrass Meadow
Antarctica
Photosynthesis
Environmental Stewardship
Prop Scar
Seagrass

Seagrass Meadows

Use the Word Bank on the left to complete the crossword puzzle below.



Across

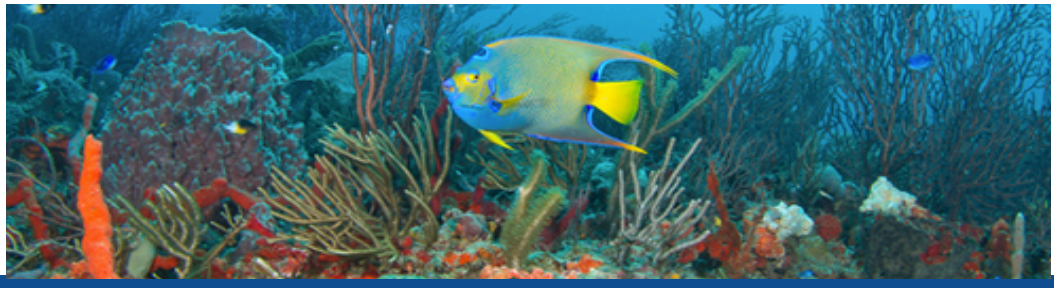
2. This part of the seagrass helps absorb nutrients and anchors it
5. Seagrasses are not related to the marine plants
7. Seagrasses are the only marine plants that produce these
10. The responsible use and protection of the environment
12. Seagrass food webs support many _____that feed on other organisms.
13. Damage to seagrass by motorboats
14. Seagrass grows near all continents except this one.
15. Seagrass meadows are the _____ of the sea because they create so much oxygen
16. Seagrass meadows for an essential _____ for many creatures
17. This endangered mammal grazes on seagrass

Down

1. Process that plants use to create energy from the Sun
3. Seagrasses are primary _____ in the food web
4. Contamination that comes from runoff, dumping and littering
5. Grass-like flowering plants that grow in salty or brackish water
6. Type of reproduction that occurs when send out root-like Rhizomes
8. Highly productive ecosystem formed by marine flowering plants
9. This reptile is an herbivore that loves to graze on seagrass
11. Seagrass meadows have enormous _____value because they contribute to the commercial fishing industry

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM
MIAMI



Marine Conservation Science & Policy: Coral Reefs

Grade Level:

4th – 12th

Subject Area

Science
Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science
Nature of Science
Physical Science

Big Idea

Organization and Development of Living Organisms.
The Practice of Science

Standards

SC.K.N.1.1
Collaborate with a partner to collect information.
SC.K.N.1.4
Observe and create a visual representation of an object.
SC.8. G.5.2
Describe the impact of human modifications on the environment and ecosystems.
SC.912L.17.16
Discuss the large-scale environmental impacts resulting from human activity.

Focus Question

What is a coral reef? What organisms make up this ecosystem and why are they important? What are the threats to this ecosystem and how can we protect it?

Objectives

Students will explore the coral reef and discover some of the organisms that live in this habitat. Students will learn to:

- Identify the features of a coral reef and some of the animals that live in this habitat.
- Analyze the importance of this ecosystem and elaborate ways to protect it.
- Elaborate an educational brochure explaining key features of this habitat.

Student will discuss the importance of this habitat and how it can be protected for future generations. This will be a project-based activity where students will apply new knowledge to create an educational brochure.

Background

While corals are usually categorized as ancient animals, they actually have features that place them in the unique position of resembling plants, animals and minerals. Corals are individually known as polyps, tiny, simple organisms related to jellyfish and anemones that consist almost entirely of a stomach and a tentacled mouth that is used to snare and ingest plankton. These animal-like traits of consuming other organisms are then counterbalanced by their relationship with zooxanthellae, microscopic, single-celled algae that live inside each polyp. **Coral polyps** and **zooxanthellae** have a **symbiotic relationship**, with the corals providing nutrient to the zooxanthellae and who provide nutrients to the polyp through photosynthesis. By receiving energy from the Sun and remaining rooted in the photic zone, this relationship lends the coral plant-like traits. In addition, each polyp forms a calcium carbonate exoskeleton, with thousands of polyps constructing coral colonies together with the mineral strength to house millions of marine organisms. Some of these colonies form the largest living structures on Earth, such as the Great Barrier Reef in Australia which be seen from space.

Coral reefs are formations of the skeletal remains of coral polyps, built up over thousands of years and found in coastal waters in tropical and subtropical oceans all around the world. Coral reefs are usually found at depths of 0-450 ft, but some slow-growing coral without zooxanthellae have been found thriving in the dark, cold depths 20,000 ft. below the surface. A common misconception is to group corals as hard and soft, while they are actually divided into three sub-groups according to their cellular symmetry as viewed under microscope (i.e. 8-sided symmetry means that each polyp has eight tentacles and eight membranes).

Coral can reproduce sexually by synchronous spawning or they can divide their cells in a form of asexual reproduction. When building a coral colony, three main types of coral reefs can be formed: fringing reefs that hug the coastline; barrier reefs that run parallel to the shore but are separated by a channel; and atolls, which are ring-shaped and are often topped with sand around an inner lagoon. To allow for photosynthesis and a healthy reed system, most

Vocabulary:

Coral Polyps:
Tiny soft-bodied organisms that excrete a protective calcium carbonate exoskeleton that accumulates to form coral reefs.

Zooxanthellae:
A microscopic algae living inside coral polyps, lending them their color and providing some energy through photosynthesis.

Coral Reef:
A formation of the skeletal remains and living coral built up over thousands of years to form an elaborate ecosystem.

Symbiotic Relationship:
When two organisms form a relationship that can be beneficial to both (mutualism) or only one (parasitism).

Coral Bleaching:
The loss of the colorful zooxanthellae due to environmental stress, leaving only the translucent coral polyps that appear white or bleached. It is important to remember that bleached coral is not yet dead.

Biodiversity:
The variety of life surviving in an ecosystem or habitat.

Background

corals need clear, warm, shallow water unclouded by sediment, plankton or seaweed. If allowed to thrive, coral reefs form immense habitats for other species.

Coral reefs are estimated to be some of the most valuable and diverse ecosystems in the world, supporting about 2 million species. Florida is home to several reef systems, including a fossilized reef, one of only two world-wide, in Crandon Park on Key Biscayne, and the third largest barrier reef system in the world, extending 150 miles from Soldier Key to the Dry Tortugas. Some species found on South Florida reefs include sea turtles, lobster, nurse sharks, eels, and a vast array of colorful fish. Like the polyps and their zooxanthellae, many of these species also display symbiotic relationships: some corals have shrimp and crabs that live in their branches, defending the coral from predators while the coral provides shelter. Other fish hide among the tentacles of jellyfish, baiting the trap for other fish while eating the leftovers. The **biodiversity** of the reef is considered the key to finding breakthrough cures for cancer, arthritis, human bacterial and viral infections and other diseases. Healthy reefs provide goods and ecological services to local economies through tourism, fishing, recreation, and other businesses, contributing an estimated $7.6 billion in Florida alone. Coral reefs also buffer coastal shores from wave action, reducing erosion and storm damage as well as protecting harbors and ports.

Despite their importance, the globe's coral reefs form only 1% of the entire marine environment, an area about the size of France, and an estimated 80% are endangered or threatened.[2] Many of these threats are human-caused, stemming from overfishing, destructive fishing practices like trawling, grounding or overfishing, collecting for aquariums, dredging and other coastal impacts, scarring from motorboat propellers and anchors, warmer waters temperatures due to global warming, and even lack of awareness and appreciation. However the most significant threat to coral reefs is land-based pollution from runoff, litter, coastal development, agriculture, sewage treatment, leaking fuels, and petroleum spills. Scientists have recently discovered that a chemical commonly found in sunscreen and other lotions, benzophenone-2 or BP-2, can kill juvenile corals. This continued damage is causing **coral bleaching**, or the loss of the zooxanthellae, which leaves and the coral turns white. Though coral can survive a bleaching event, they are more vulnerable to stress and subject to mortality.

Actions to take to protect valuable coral reefs include: don't buy or take home corals, as it is illegal to do so; look for coral-safe labels on sunscreen and other beauty products; keep beaches clean and reduce household chemical and pesticide use because all drains lead to the sea; throw back small fish when fishing in accordance with law, be careful that the anchor doesn't damage the reef, and keep only what you are going to eat; practice good stewardship by reducing freshwater use, recycling, and educating others on resources like the Coral Reef Protection Act, the South Florida Coral Reef Initiative, and the Florida Keys National Marine Sanctuary. By taking action to protect coral reefs now, this valuable ecosystem will continue providing valuable environmental, medical and economic services for future generations.

Supplemental Resources

1- Coral Reef Conservation Program. National Oceanic and Atmospheric Administration.
http://oceanservice.noaa.gov/education/kits/corals/coral11_protecting.html
2- "Corals and Coral Reefs." Ocean Portal. Smithsonian Natural Museum of Natural History.
http://ocean.si.edu/corals-and-coral-reefs
3- Virtual Tour: The Coral Reef Habitat. Odyssey Earth.
http://www.odysseyearth.com/videos/the-coral-reef-habitat/

Vocabulary:

Coral Polyp:
Tiny soft-bodied organisms related to sea anemones that excrete a protective calcium carbonate exoskeleton that accumulates to form coral reefs.

Coral Reef:
A formation of the skeletal remains and living coral built up over thousands of years to form an elaborate ecosystem.

Coral Bleaching:
The loss of the colorful zooxanthellae due to environmental stress, leaving only the translucent coral polyps that appear white or bleached.

Extension Activity:

Have students research their favorite reef organism. Each student will prepare a brief description of the organism, a visual representation, and explain why they think their chosen organism is interesting and important.

Assessment:

Have students complete the coral reef worksheet after class. Have them write a paragraph in their journal comparing threats and protective measures of coral reefs to those of other marine ecosystems they've studied.

Program Partner:

Coral Reef Brochure

Materials

- Writing paper for drafts
- White or construction paper for brochures
- Coloring utensils (colored pencils, markers, or crayons)
- Pens or pencils

Procedure

1. Divide students into groups of four and explain that each will be designing an educational brochure of the coral reef. Show an example of a brochure so they understand the folded layout.
2. Each brochure should answer some of the following questions:
   -What is a coral?
   -What is a coral reef and where can they be found?
   -What animals live on the coral reef?
   -Why are coral reefs important?
   -What threatens the coral reefs and how can we protect them?
3. Members of the group may want to divide the questions, and each write a draft of their response before combining everyone's section to form their final brochure.
4. Each group should illustrate their brochure and present it to the class. Encourage discussion comparing and contrasting the information elaborated, asking students why they find corals and other reef organisms interesting and important.

Worksheet Answer Key

1. Figure 1 shows a bleaching event, Figure 2 shows a healthy reef.
2. Answers may vary: Figure 1 shows a bleached reef, with very few fish around a colorless reef, while figure 2 demonstrates many interacting fish species swimming and sheltering amongst many species of colorful, healthy coral reef.
3. It is important to protect coral reefs from bleaching because they form the foundation of an ecosystem, and their loss causes a devastating species loss.
4. Ecosystem
   Jellyfish
   Anemones
   Polyps
   Zooxanthellae
   Symbiotic
   Structure
   Food
   Shelter
   Humans
   Fishing
   Tourism
   Clean
   Footprint

Coral Reefs

Coral reefs are important habitats that are currently endangered around the world. They face many threats including overfishing and pollution which are causing coral bleaching. Coral bleaching is when the coral polyp loses their colorful and helpful zooxanthellae from inside their stomachs, leaving them white in appearance. Coral bleaching occurs when the coral is stressed or in danger and affects the rest of the coral reef ecosystem.

Answer the following questions using the figures on the right:

1. Which of the figures shows a coral bleaching event and which shows a healthy reef? _____
_____
_____

2. What are some of the differences between the figures? _____
_____
_____

3. Judging from the figures, why is it important to prevent coral bleaching?
_____
_____
_____

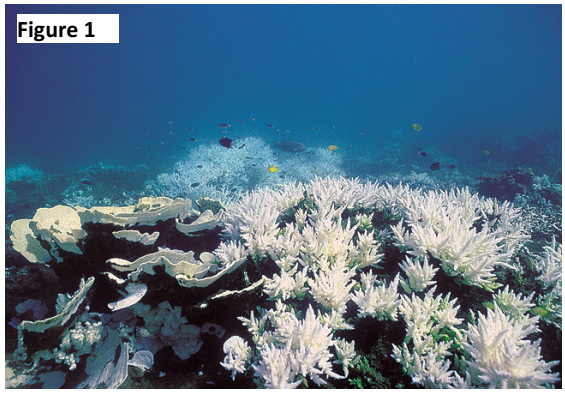


Figure 1


Figure 2

Word Bank

Food
Ecosystem
Jellyfish
Footprint
Zooxanthellae
Structures
Clean
Anemones
Symbiotic
Polyps
Tourism
Shelter
Humans
Fishing

4. A coral reef is a _____, a place where organisms live together. The reef is made of coral, tiny animals related to _____ and _____. Individual coral are called_____ and inside each lives a microscopic algae called _____. These two organisms have a _____relationship, as they both help each other to survive. Corals build large _____ of the reef as they grow, providing _____ and _____ to many diverse organisms. Coral reefs are also important to _____, helping reduce erosion, providing medicinal cures, and supporting the _____ and _____ industries. We can help protect this critical habitat by keeping the beach _____, using only coral-safe sunblock, and reducing our carbon _____ by walking or biking instead of driving. We can also protect coral reefs by educating others to protect this important ecosystem for future generations.

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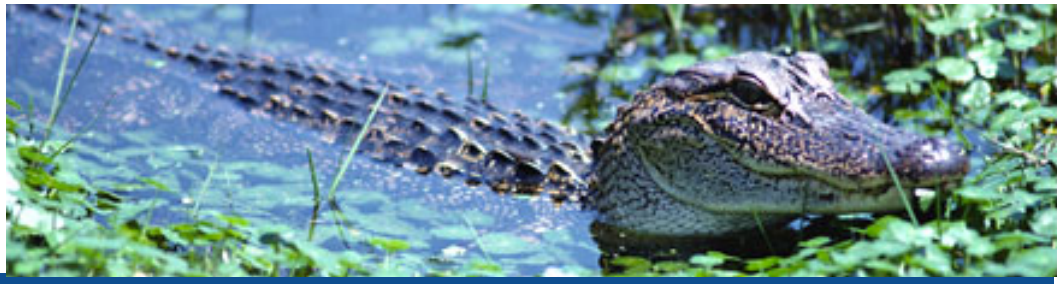

Marine Conservation Science & Policy: The Everglades

Grade Level:

4th – 12th

Subject Area

Science
Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science
Nature of Science
Physical Science

Big Idea

Organization and Development of Living Organisms.
The Practice of Science

Standards

SC.K.N.1.2
Make observations of the natural world using the five senses

SC.2.L.17.2
Recognize and explain that living things are found all over Earth, but each is only able to live in habitats that meet its basic needs.

SC.4.L.17.4
Recognize ways plant and animals, including humans, can impact the environment.

SC.912.L.17.12
Discuss the political, social, and environmental consequences of sustainable use of land.

Focus Question

What is the Everglades? What animals live in the Everglades and where do they live? Why is this ecosystem important and how can we better protect it?

Objectives

Students will be introduced to the various habitats that make up the greater Everglades ecosystem and explore the significance of this ecosystem. Students will learn to

- Identify three main features of the Everglades.
- Identify animals that live in the Everglades habitats and the resources they depend on.
- Demonstrate their knowledge and analyze the significance of the Everglades by writing an original poem.

This will be a project-based activity where students will explore the various Everglades habitats and analyze the importance of this ecosystem.

Background

The **Everglades** is a hundred-mile long ecosystem comprised of freshwater and coastal prairie, mangroves, marshland, pine forests and cypress swamps, and the waters and barrier islands of Florida Bay. This ecosystem, famously dubbed the “river of grass” by Marjory Stoneman Douglas, has been preserved as a national park since 1947, protecting 1.5 million acres of unparalleled biodiversity. Since its formation roughly 21,000 years ago, this complex system has been continuously in flux, particularly subject to three forces: water, rock and fire.

Water may be considered the most dominant force in the Everglades, abounding throughout the system in springs, rivers, and estuaries, allowing plants to take root, eating away the limestone to form sinkholes, and constantly trickling new nutrients downstream. The area remains especially moist even during the dry season due to the underlying limestone, porous calcium carbonite or oolite that absorbs vast amounts of water. Only a veneer of peat or marl soil covers this limestone, making the area unsuitable for industrial agriculture but providing perfect conditions for vast prairies of sawgrass. Sawgrass is ingeniously adapted to the final forging element of the Everglades: fire. Usually sparked by lighting strikes, fires roar through the prairies, burning acres of stems while the roots remain preserved underwater. Other plants have also adapted to the frequent fires, some, like the slash pine, are even dependent upon it for seed dispersal. These forces have been continually transforming the Everglades, forging several different habitats that have evolved with the landscape.

The greater Everglades hosts several types of ecosystems, though boundaries between them are often insubstantial or nonexistent. The most dominant of these habitats is the **sawgrass prairie**, vast expanses of sharp-leafed plants that thrive in slow-moving water and are woven with deeper channels of water called sloughs. The sawgrass is the preferred nesting ground of the endangered American alligator, and this area also supports wading birds, invertebrates, fish, small mammals and reptiles. Slight rises in elevation create small islands within prairies, forming **hardwood hammocks** that allow for tree growth, including live oak,

Vocabulary:

The Everglades:
A 2 million acre wetland national park in South Florida characterized by sawgrass and serpentine waterways.

Sawgrass Prairie:
A habitat dominated by razor-leafed sawgrass, slow-moving water and deeper channels of water called sloughs.

Hardwood Hammock:
Slightly elevated islands within sawgrass prairies that are typically covered in dense thickets of hardwood trees.

Pine Rockland:
A forest habitat characterized by sandy soil, slash pine and frequent fires.

Cypress Swamp:
A wetland habitat dominated by cypress trees.

Mangrove Forest:
An estuary ecosystem populated by mangroves that anchor coastal sediment, reduce erosion and provide crucial habitat for many fish, birds, mollusks and crustaceans.

Florida Bay:
The body of water separating the Florida Keys and the southern tip of the peninsula dotted with mangrove, keys and rich seagrass meadows.

Everglades Restoration:
A plan enacted by Congress in 2000 to restore, protect and preserve the water resources of the greater Everglades ecosystem.

Background

gumbo limbo, and hackberry. Though these dense thickets are often impenetrable for humans, they make ideal habitats for grey foxes, marsh rabbits, and key deer. Also found at higher elevations, the **pine rocklands** of the Everglades are characterized by sandy soil and frequent fires. While these conditions make growth difficult, some organisms find this area congenial, particularly slash pine, saw palmetto and coonties. This habitat hosts over 90 plant and animal species listed as endangered, including bald eagles, gopher tortoises and panthers. **Cypress swamps** combine sandy soil with the more aqueous conditions of the swamp. These communities are dominated by bald cypress and shelter river otters, alligators and herons.

Along the coast, the freshwater of the Everglades meets the salt water of the Gulf of Mexico and Florida Bay, creating an estuary populated by red, black and white mangroves. The **mangrove forests** reduce erosion, anchor sediment, and decrease flooding during storms, while serving as nurseries for fish, rookeries for birds, and fostering shrimp, crustaceans, and mollusks. Beyond the mangrove forests, more than 800 miles of the **Florida Bay** are considered part of the Everglades ecosystem, featuring seagrass meadows and over 100 keys, providing crucial habitat and feeding grounds for sea turtles, manatees, and flamingos.

Aside from providing essential habitat to millions of organisms, the Everglades has also historic-ally been the territory of several Native American tribes. Though the Calusa and Tequesta were decimated by war and disease, the Seminole and Miccosukee tribes have survived, maintaining traditions while developing gaming and tourism businesses. The Everglades also filters Lake Okeechobee overspill through miles of wetlands, allowing it to absorb through the limestone into the aquifer, which supplies some of the world's purest water to an estimated 7 million people in South Florida. This unique national park also supports tourism and recreation, filters pollution, reduces storm damage and flooding, and contributes to an estimated 80-90% of the state's commercially harvested fish and crustaceans.

Despite its significance, the Everglades faces many threats. Though the national park preserves a large part of the watershed, the upper half, which begins near Orlando and includes the Kissimmee River and Lake Okeechobee, has fallen to development, discharging vast amounts of agricultural runoff and urban pollution that seep downstream to the park. The Everglades are also threatened by loss of habitat from encroaching urban development, invasive species, excessive nutrient and agro-chemicals from sugarcane and other crops, and overdrainage from canals. To restore the Everglades, an estimated $11 billion will be invested in buying sugarcane land, reconstructing marshes, removing dams, and replacing straight canals with the original serpentine waterways that slow water flow and increase absorption and filtering. Individuals can contribute to Everglades conservation by reducing water use, planting native plants instead of grass, avoiding products with a lot of packaging and plastic, planting trees, recycling, volunteering in restoration projects, and educating others. Restoring this critical ecosystem will ensure clean water, essential habitat, and a beautiful park for future generations to enjoy.

Resources

1- National Park Service
www.nps.gov/ever/learn/nature/mangroves.htm
2- Everglades Foundation
www.evergladesfoundation.org/2014/06/09evergladesrestort-level-rise/
3- "Everglades Poems." Poetry Soup.
http://www.poetrysoup.com/poems/everglades

Vocabulary:

The Everglades:
A 2 million acre wetland national park in South Florida characterized by sawgrass and serpentine waterways.

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A plan enacted by Congress in 2000 to restore, protect and preserve the water resources of the greater Everglades ecosystem.

Extension Activity:

Have students deliberate on their new knowledge of the Everglades and the 3-2-1 assessment that they concluded with a question they wanted to investigate. With a parent, have students research their question and explain their discoveries in their science journal, to be presented next class.

Assessment:

Have students complete the Everglades worksheet after class. Have them write a 3-2-1 reflection on today's lesson by writing 3 things they discovered today, 2 interesting facts they're going to share with others, and 1 question they want to learn more about.

Program Partner:

University of Miami – Shark Research & Conservation Program

Ode to the Everglades

Materials

- Lined paper for draft
- Blank paper for final draft
- Coloring utensils (markers, colored pencils, crayons)
- Pencils or pens

Procedure

1. When planning, consider the age and ability of your students and decide on a line-limit for the assignment. Haikus may be considered for younger students or shorter time periods.
2. Briefly introduce poetry by reading one or two poems from the Everglades.[5] Explain to students that poems are a type of art, allowing us to express emotions, convey ideas, and inspire others through words, meter and rhythm. Explain that they will each be writing a poem to illuminate the wonders of the Everglades.
3. Have students brainstorm key words from today's lesson on the board for 2-3 minutes. You may decide to simply write The Everglades and have them suggest words and themes that they are reminded of (this step and step 4 may be replaced with your favorite brainstorming activity).
4. Hand each student paper for individual brainstorming. Students should brainstorm for 3-5 more minutes, writing down more words around the theme and possibly selecting more words that rhyme with those words.
5. Explain to them that they will write a first draft poem using their words according to the poem limits you selected. Remind them that poems often use literary devices like similes, metaphors, alliteration, symbolism and personification.
6. Have them edit their first draft and write their final, clean draft on an unlined sheet of paper, which they may decorate and present if time permits. Encourage them to share their work with family and friends.

Worksheet Answer Key

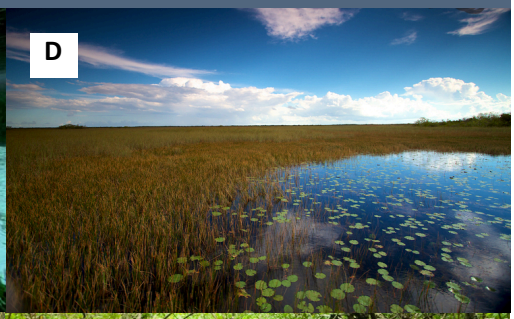
1. D
2. F
3. E
4. C
5. B
6. A
7. Okeechobee
8. Limestone, oolite or calcium carbonite
9. Answers will vary, may include: sawgrass, gumbo limbo, slash pine, bald cypress, etc.
10. Answers will vary, may include: Florida panther, American alligator, snail kite, West Indian manatee, etc.
11. The Everglades are important because it is a unique ecosystem that provides habitat to endangered species, ensures water quality for South Floridians, filters pollution, reduces flooding and storm damage, and supports many industries, including fishing, tourism and recreation.
12. Humans have altered the Everglades by draining, diking and damming for development, changing the natural water flow, contaminating water sources through point and non-point source pollution, and introducing many invasive species.
13. We can help protect the Everglades by reducing water use, planting native species instead of grass, volunteering in restoration projects and educating others.

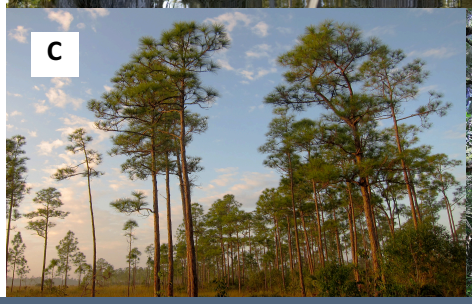
The Everglades

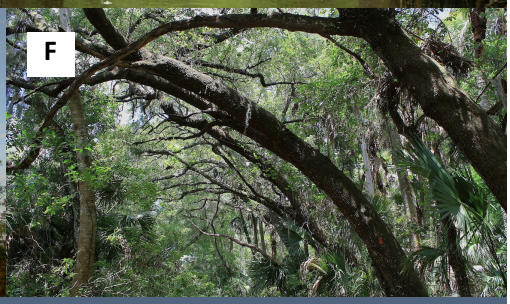
The Everglades is a two million acre national park in South Florida that hosts a wide variety of plant and animal life and forms a complex interconnected ecosystem of six distinct habitats.

Match these habitats with the photos on the right.

1. Sawgrass prairie _____
2. Hardwood hammock _____
3. Mangrove forest _____
4. Pine rockland _____
5. Cypress swamp _____
6. Florida Bay _____







Complete the following sentences.

7. Rivers and lakes flow downstream into Lake _____, which overspills into the Everglades.

8. The rock beneath the Everglades is called _____ and filters the water as it passes into the aquifer, providing some of the purest water in the world to the 7 million people of South Florida.

9. Some of the plants of the Everglades include _____.

10. Over 60 endangered species live in the Everglades, including _____.

11. The Everglades are important because _____.

12. Humans have affected the Everglades by _____.

13. I can help protect the Everglades by _____.

DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Cartilaginous Fish and Dogfish

Grade Level:

4th -12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Physical Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.3.L.15.1

Classify animals into major groups according to their physical characteristics and behaviors.

SC.5.L.17.1

Compare and contrast adaptations displayed by animals that enable them to survive in different environments such as behaviors and physical characteristics.

SC912.L.14.2

Relate structure to function for the body parts of animals.

Focus Question

What are cartilaginous fish? What features differentiate them and where are their habitats? How do humans affect them and why are they important?

Objectives

Students will research the cartilaginous fish class and their defining characteristics. Students will learn to:

- Identify the defining features of the cartilaginous fish.
- Explain what resources they depend on and where they can be found.
- Demonstrate knowledge by researching and presenting a species of cartilaginous fish.

Student will discuss how these organisms can be protected for future generations. This will be a project-based activity where students will dissect a dogfish.

Background

The **cartilaginous fish** class, or Chondrichthyes, is defined by one particular feature: a skeleton made of **cartilage**, a dense, rubbery material that is lighter and more flexible than bone. This class encompasses all sharks, rays and skates, as well as sawfish and chimaeras. All modern Chondrichthyes are thought to have evolved from acanthodians almost 400 million years ago, from which they retained a few common characteristics, including their skeleton. Because of this cartilage, the species in this class do not have bone marrow, so their red blood cells, essential for delivering oxygen throughout the body, are produced in the spleen.

Aside from being jawed vertebrates, all Chondrichthyes also share paired nostrils, gills, scales, and a multi-chambered heart. Unlike fish, these species have no swim bladder. The respiratory system of these organisms relies upon five to seven **gill** pairs on the underside or side of the head, which extract oxygen as water passes through them. Some species must remain moving in order to keep water flowing through their gills, while others have adapted active-pumping spiracles. The spiracle allows species like the nurse shark to rest, while thresher sharks and mackerel sharks no longer have them and must maintain motion.

The scales of these species are called **dermal denticles** and are physically similar to rows of tiny teeth, giving their skin the distinct sandpaper-like texture that both protects and streamlines. The scales of bony fish grow in size, while those of the Chondrichthyes class form new scales in new spaces as the body grows. Other features of these species, such as the nose of sawfishes and the spines of stingrays, are also structurally modified scales. Rather than being firmly attached to their jaws, the teeth of Chondrichthyes are imbedded in a fibrous material so that when one becomes broken or worn down, it is replaced by another moving forward from behind, with new tooth buds developing as needed.

While some species of this class lay egg cases, most are considered **ovoviviparous**, with females giving birth to live young. Males of these species tend to have modified fins called **claspers** that are used to inseminate the female. Pregnant females often stop eating and select isolated nursery areas to give birth, but often leave shortly thereafter.

Vocabulary:

Cartilaginous Fish:
A class of fish characterized by a rubbery cartilage skeleton, complex and diverse bodies, and species that include sharks, rays, skates, sawfish and chimaeras.

Cartilage:
A dense connective tissue that is lighter and more flexible than bone.

Dermal Denticles:
The tooth-like scales of cartilaginous fish.

Ovoviviparous:
Producing young by means of eggs that hatch within the female body.

Claspers:
A pair of appendages on male sharks and rays, used for reproduction.

Tapetum Lucidum:
A layer of tissue within the eye that maximizes light reflection to allow for superior night vision.

Gills:
Paired respiratory organs of which extract oxygen from water flowing over the surface.

Countershading:
A protective coloration of some fish with distinct delineation between a dark upper and a light lower section.

Apex Predators:
An organism residing at the top of a food chain, upon which no other organisms prey.

Bycatch:
The unwanted fish and marine organisms caught in commercial fishing nets.

Finning:
A process by which only the fin is removed from a shark while the body is left to die.

Background

Most species also feature a **tapetum lucidum**, a layer of tissue that maximizes light reflection in the eye, allowing for superior night vision. While this adaptation is particularly useful to the nocturnal carnivores of the Chondrichthyes class, feeding during the day is also common. The diet of this class varies, some eating almost anything from birds to seals to tuna to other sharks; others like the whale, basking and megamouth sharks prefer plankton.

While a few of these species venture into brackish and fresh water, most are found strictly in marine habitats. While some species like the bonnethead shark spend their entire lives within a hundred mile range, others like the blue and mako sharks migrate thousands of miles to breed and hunt. The majestic golden cow-nose rays, measuring up to 6 ½ feet, migrate twice a year from Mexico to Florida to New England in groups, or fevers, of up to 10,000!

There are at least 1,100 known species of cartilaginous fish, ranging in size from the short-nosed electric ray at 4 inches to the massive whale shark, which grows up to 30 ft. and can weigh up to 10 tons. Coloration varies, but most feature a distinct lateral line and many show **countershading**, a dark-upper and light-lower body that helps them camouflage in the water. While most sharks live between 20 and 30 years, and most rays and skates an average 40-50 years, the spiny dogfish and whale shark have been known to survive for over a century. Most cartilaginous fish are considered **apex predators**, organisms at the top of food chains. As apex predators, these organisms play a crucial role in sustaining the health of the marine ecosystem, maintaining stability by keeping the prey species' populations balanced. Without sharks, the increased populations of smaller fish cause a crash in plankton, upon which the entire food web depends as primary producers. Humans also use cartilaginous fish to create various products, including meat, shark liver oil, leather, jewelry, rope, and even drumheads.

Despite their importance, cartilaginous fish have declined by 80%, with one third of species facing extinction. These population drops are mostly due to anthropogenic, or human-caused threats. Marine pollution from fisheries, plastic that amasses in apex predators through bioaccumulation, agricultural and urban runoff, coastal development and sewage destroy habitat and prey populations. Overfishing threatens these species on multiple levels: by decreasing their food sources as well as unintentionally tangling them in nets where they often die needlessly as **bycatch**. By far the greatest threat to most species is fishing, as 126,000 tons of rays and an estimated 100 million sharks are killed each year, about 73 million of these deaths due to finning. **Finning** refers to the practice in which a fisherman cuts off just the shark's fin, throwing the body overboard to die a slow death by suffocation or predation. The problems in the food web are already evident in an increase in jellyfish numbers and a steep decline in fish populations. In order to protect these fascinating creatures, individuals can reduce plastic use, symbolically adopt a great white, donate to conservation organizations, urge government officials to limit fisheries and increase marine protected areas, consume only sustainable seafood, and educate others on the importance of all cartilaginous fish.

Supplemental Resources

1- "Sharks." National Geographic Education.
http://education.nationalgeographic.org/search/?q=sharks
2- "Sharks and Rays." Smithsonian Natural Museum of Natural History—Ocean Portal.
http://ocean.si.edu/ocean-life-ecosystems/sharks-rays
3- Virtual Tour: "Sharks: Predators in Peril." Odyssey Earth.
http://www.odysseyearth.com/videos/sharks-predators-in-peril/

Vocabulary:

Cartilaginous Fish:
A class of fish characterized by a rubbery cartilage skeleton, complex and diverse bodies, and species that include sharks, rays, skates, sawfish and chimaeras.

Apex Predators:
An organism residing at the top of a food chain, upon which no other organisms prey.

Bycatch:
The unwanted fish and marine organisms caught in commercial fishing nets.

Finning:
A process by which only the fin is removed from a shark while the body is left to die.

Extension Activity:

Have students research another cartilaginous species with a parent or adult. Have them cut construction paper lengthwise into bookmark size. On one side, the student should illustrate their chosen species, while the other side should feature its name, habitat, food, and three fun facts.

Assessment:

Have students complete the Cartilaginous Fish worksheet in class. In their science journal, have them write a paragraph summarizing today's lesson and its relevance to them.

Program Partner:

University of Miami – Shark Research & Conservation Program

Dogfish Dissection

Materials

- A large dissection tray
- Surgical scissors
- Scalpel
- Probe
- Forceps

Procedure

1. Divide students into small groups of 3-4. Explain that as teams of ichthyologists, each group will be dissecting a dogfish specimen in order to better understand its organs and their functions. Hand each group their materials and read the Guidelines together. An incision diagram should be placed on the board or demonstrated on an overhead projector.
2. Students may wish to assign one person to note taking during the dissection, completing the assigned sections of the worksheet.
3. Students should measure and examine the external features of the dogfish.
4. Students should begin the dissection by carefully following the incision diagram.
5. Students should examine the musculature of the specimen.
6. Have students examine the digestive system of the specimen. They should then remove those organs to examine the urogenital, nervous and circulatory systems.
7. Students should clean up after the dissection by placing all dogfish parts in the bag, secure the bag with a rubber band, and place the bag in one of the used specimen boxes. They should wash all dissection tools and the tray, and return tools and tray to the teacher.
8. Students should all complete their Shark Anatomy worksheets. Go over the questions as a class and encourage discussion on the importance o the scientific method, the similarities and differences to human anatomy, and the evolution, function and importance of the body's systems.
9. Dissection Extension: Students should research and discuss the ethics of dissection with a parent or adult. Students should prepare a of list pros and cons and formulate their own opinion. Students should summarize both arguments and elaborate their own decision in a paragraph.

Answer Key

1. D
2. C
3. F
4. G
5. E
6. B
7. A

8. Cartilaginous fish play an important role in most marine food webs as apex predators, helping to maintain balance in ecosystems.
9. Cartilaginous fish are threatened by finning and unsustainable fishing practices that reduce prey species and lead to bycatch of cartilaginous fish, and other anthropogenic factors like bioaccumulation from contaminants.
10. Individuals can help protect these species by eating sustainably caught seafood, supporting wildlife organizations and programs like Adopt-a-Shark, and educating others.

Shark Anatomy

Spiny Dogfish Dissection

Section I: External Anatomy

1. Illustrate the external anatomy. Measure the specimen and label features.

2. What interesting things do you observe about the skin and external organs?

_____

3. What purpose might the lateral line system serve, especially for a fish in murky waters? _____

4. Is the shark's skin as thick as you expected it to be? Why or why not? _____

_____

Section II: The Digestive System

5. Illustrate the digestive tract from mouth to anus. Label the organs.

6. How does the oil in the liver aid in buoyancy? _____

_____

7. How does the shark's digestive system compare with that of a human? _____

_____

_____

Section III: Internal Organs

8. Illustrate the heart.

9. Unlike a mammal's heart, the shark's heart circulates deoxygenated blood. Where is the blood oxygenated in the shark? _____

_____

10. Is the shark male or female? What internal and external features helped you identify sex? _____

_____

11. What is the largest part of the shark's brain and why? _____

_____

12. How is the shark's skeleton different from our own? _____

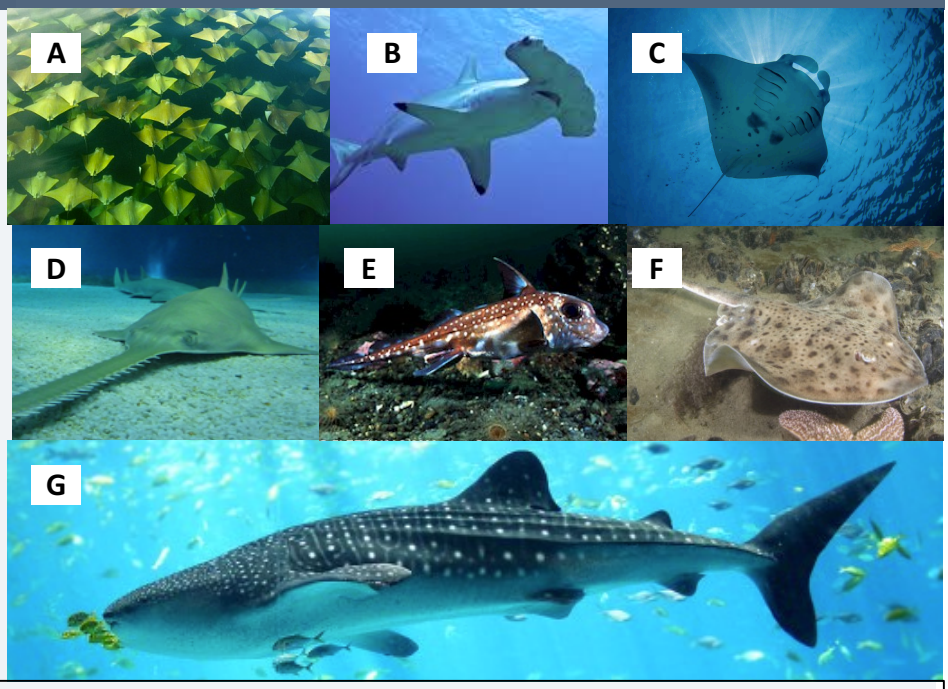
_____

13. What did you find interesting about this dissection and why? _____

_____

Cartilaginous Fish

The cartilaginous fish class contains over 1,100 known species of sharks, rays, skates, sawfish and mysterious chimaeras. These species vary in size, shape, color and behavior, but all feature a skeleton made of cartilage, gills, nostrils, and tiny, tooth-like scales that protect their skin and feel like sandpaper. Cartilaginous fish play an essential role in the ecosystem, but many are endangered.



Identify the species in the above photos:

1. _____ The large-toothed sawfish can use its long snout to dig through sediment or cut prey in half.
2. _____ The majestic manta ray can have a wingspan of 15 ft. and live up to a hundred years.
3. _____ The little skate lives in the Atlantic and is often used for medical research.
4. _____ Despite being the world's largest fish, the whale shark's diet consists of the ocean's smallest organisms, filtering plankton through its mouth.
5. _____ The spotted chimaera hunts small fish and crustaceans off the Pacific coast of North America.
6. _____ Because its eyes are on both sides of its unusual head, the hammerhead is able to scan more of the ocean for its favorite food: stingrays.
7. _____The golden cow-nose ray migrates annually from Mexico to Florida in groups of over 10,000.

8. Why are cartilaginous fish important? _____

9. What are some of the threats that are affecting cartilaginous fish? _____

_____

10. What can you do to help protect these fascinating and important creatures? _____

_____

