SMITHSONIAN MARINE ECOSYSTEMS EXHIBIT

OCEAN EXPLORERS AT-HOME

AGES (12-13)

Smithsonian
Marine Station Fort Pierce

CONTENTS

MODULE I: INDIAN RIVER LAGOON TRIVIA

Florida's coasts have a great diversity of dynamic ***habitats*** (the natural homes of living organisms) and ***ecosystems*** (the combination of interactions that happen between living and non-living things in a habitat). At the Smithsonian Marine Ecosystems Exhibit (SMEE) we love highlighting these ecosystems and our mission is to share information about the Indian River Lagoon, an estuary that covers about 40% of the state's eastern coast. Learn some facts about the Lagoon before jumping into a trivia session:

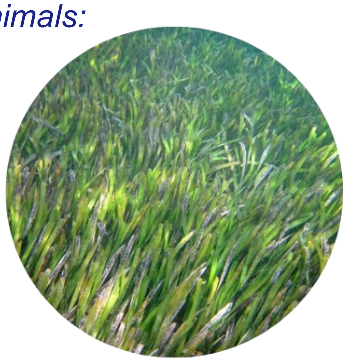
The IRL is an estuary, not a river.

- ***Estuaries*** are bodies of water where saltwater from the ocean and freshwater from rivers and tributaries mix, creating ***brackish*** water.
- ***Lagoons*** are a type of estuary separated from the ocean by barrier islands or reefs.

Did you know?

The Indian River Lagoon (IRL) is part of the longest barrier island complex in the United States. Starting at the Ponce de Leon Inlet, it extends for a total of **156 miles** and ends at the Jupiter Inlet. The IRL is the most biodiverse estuary in North America. It is home to 2,200 animals, 2,100 plants, and so much more!

The following IRL ecosystems are essential for the healthy development of many species of aquatic animals:



Pictured: Seagrass Bed

Pictured: Mangrove Forest

Pictured: Hardbottom Ecosystem

- Seagrass beds provide shelter and food for small and young animals, making them great nursery habitats for fish and invertebrates.
- Mangrove forests are not only nursery habitats. They also help to stabilize the coastline by reducing erosion from storms, currents, waves, and tides.
- Hardbottom habitats provide hiding nooks for organisms transitioning out of their nurseries and on their way to the ocean, many of which are commercially relevant. That means you might find them on your dinner plate!

Indian River Lagoon Trivia Time!

- You will need access to at least two different screens to play this game of trivia.
- A computer screen can be used to display the quiz questions. A phone, tablet or another computer can be used as a controller to submit answers.
- Others will be able to join you for the game if they also have their own phone!

HERE ARE THE STEPS TO ACCESS THE TRIVIA QUIZ:

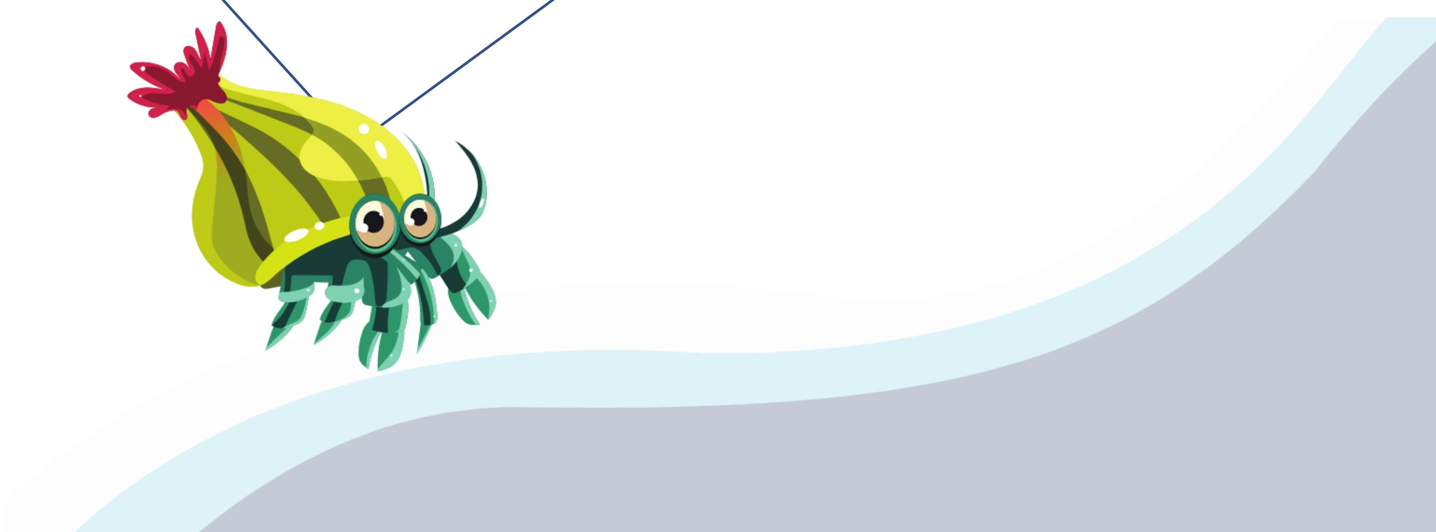
1. If using a tablet or phone, download the free Kahoot app from your app store.
2. Copy this link and paste it into your computer´s browser to access the trivia quiz.
3. A screen including a preview to the quiz will open. Press ¨Play as guest¨ if you do not wish to sign up for an account.
4. Select the green ¨Classic¨ game button for single player games or the blue ¨Team mode¨ button so various individuals can share one phone as a controller to battle another team using another phone.
5. Submit the pin that will appear on the screen on the Kahoot app. The same pin can be used for all the players that wish to join the game.
6. Start playing!

Some other resources in case you need to sharpen your Indian River Lagoon facts before trivia time:

Indian River Lagoon Inventory

One Lagoon Program (biodiversity facts)

Look us up on Youtube for quick and informative aquarium videos!



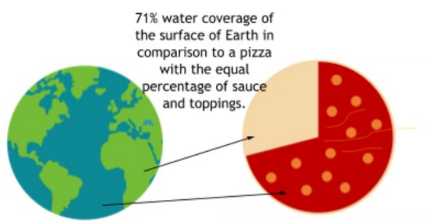
MODULE II: INTRODUCING OUR OCEANS

OVERVIEW
This activity will introduce you to ocean circulation currents (surface, convection, and thermohaline).

BACKGROUND KNOWLEDGE NEEDED
Physical differences between saltwater and freshwater

LEARNING OBJECTIVES
After completing this module, you will have a basic understanding of ocean currents.

INTRODUCTION
Planet Earth is mainly made of rock, but when we look at it from space, it seems to be mostly blue. A total of 71% of the rocky coating of Earth is covered by water! Imagine if our planet was a deep-dish pizza, and water was the sauce covering a major part of the pizza. It would look like the picture on the right:



The ocean is connected to every animal and plant in our planet in some way. Approximately half of the oxygen we breathe comes from the ***photosynthesis*** (the use of sunlight to produce food) of marine algae and plants with tiny ***phytoplankton*** (microscopic photosynthetic drifters) producing most of it. The oceans play a major role in creating and regulating weather systems, long-term temperature trends, rain patterns and hurricane formation. Disruptions in ocean currents can negatively affect the health of ecosystems and the livelihoods of people who depend on them (see El Niño and La Niña).

You might have learned there are seven oceans in the world which are differentiated for geographical and political purposes, but they are all connected. The average depth of the ocean is about 12,100 feet, yet a drop of water found on the surface of the Atlantic Ocean will eventually travel to the depths of the sea and make its way to the Pacific Ocean. Isn't that fascinating? Although the ocean may seem uniform from the surface, the ***water column*** (a conceptual column of water going from the surface of the ocean to the seafloor) can be divided into masses with differing chemical and physical characteristics. These masses interact by pushing one another horizontally along the upper 10% of the ocean as a result of the forces of the wind. Deep water currents, on the other hand, are mainly driven by differences in salinity and temperature between water masses. This module will help you get acquainted with this idea through a series of hands-on activities. *Ted-Ed introduces ocean currents in a concise and visually appealing animated video! Please check it out before moving on.*

ACTIVITY I: WATER DENSITY EXPLORATION

This activity will demonstrate that water's density can influence water movement and mixing.
Integrated from Foras na Mara Marine Institute

INTRODUCTION

There is a special property of ***matter*** (everything that has mass and takes up space) called ***density***. Water is a type of matter; therefore, it has density. Density can be calculated when we compare mass or the amount of "stuff" something has versus the ***volume*** (the amount of space it occupies). In other words, density describes how compact or tightly packed something is.

Have you ever held a golf ball and a ping pong ball side-by-side? From a distance, they seem to be very similar, but the golf ball feels significantly heavier than the ping-pong ball because it is denser! Can you think of any other pair of things that are the same size and might seem like they would have the same type of density, but end up weighing extremely different amounts (having different mass)?

If you understand the idea behind this concept, you are ready for the fun part of this activity! Otherwise, check out this video Why does ice float in water?

MATERIALS

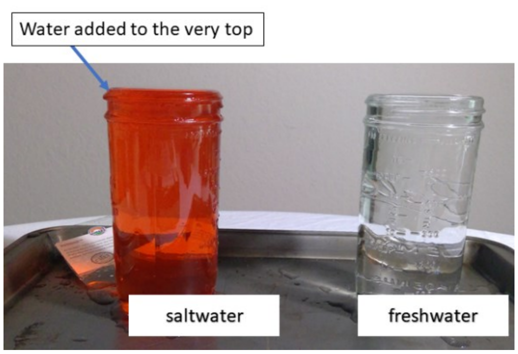
- 2 tall glasses or mason jars (same size)
- 1 Piece of plastic wide enough to cover the mouth of the mason jars (look through your recycling bin to find a piece of plastic that fits this description or cut it out from a bigger piece).
- Table salt
- Food coloring
- Paper towels
- Baking tray

SET-UP INSTRUCTIONS

- Set-up this activity in an area that can get wet. The kitchen counter or a table outside might be best.

INSTRUCTIONS

1. Fill one jar with freshwater (from the tap is fine). Fill the other jar with saltwater (mix table salt with tap water to a point where you can notice it is no longer dissolving). Add food coloring to the saltwater. Place both the jars in the tray.



2. Place a piece of plastic on top of the jar with the saltwater and turn the jar upside down, holding the card in place. When you remove your hand, the upward pressure of air will hold the card in place (most of the time).
3. Place the saltwater jar on top of the freshwater jar. Then carefully remove the plastic. Do this over the tray in case of spillages. Observe the results. (What happened with the saltwater? Why?)
4. Repeat steps 1 to 3 – this time put the freshwater on top of the salt water, remove the card and observe the results. (What happened? Why?)
5. Repeat steps 1 to 3 – this time with warm freshwater and cold freshwater to see which is denser.
6. Based on the observations above, make inferences about what would happen if you were to mix warm and cold saltwater.

INTERPRETATION

Do not read until you are done with your own experiment

Answers:

- First experiment: Saltwater is denser than freshwater. This means that saltwater will sink and mix with the freshwater on the bottom.
- Second experiment: Because the freshwater (less dense) is on top, it will remain there. No significant amount of mixing will be observed.

Experiment 1

Experiment 2

ACTIVITY II: WIND-DRIVEN SURFACE CURRENTS

Construct an ocean model with a series of "islands" and see how wind-driven currents move when they encounter land. Activity originally sourced from California State University.

MATERIALS

- One 6 Qt. plastic storage container or glass container
- One small cereal bowl, mason jar or any container small enough to fit in the storage container and dense enough to remain on the bottom. This will be your island.
- Objects of different shapes that will remain submerged. Make sure they don't break the surface.
- Cinnamon, pepper or other dry herb that will float and make it easier to track your wind-driven currents.

SET-UP INSTRUCTIONS

- Set-up your experiment over a flat surface that can get wet. The kitchen counter or table might be best.
- Fill up your container ½ way with room temperature water

INSTRUCTIONS

First Observation:

1. Sprinkle pepper on one end of the larger container. Gently blow across the container in a single direction. Observe what happens.
2. Empty the container and add new water for the next observation.

Question: *What happens as the water moves away from the source of wind?*

Second Observation:

1. Place the smallest bowl upside down in the center of the larger container. Make sure it sticks out of the water so that it resembles an island.
2. Sprinkle the dry spice in front of the island and gently blow across the container. Observe what happens.
3. Empty the container and add new water for the next observation.

Question: *What effects did the island have on the current?*

Third Observation:

Question*: Can you predict how the pepper will react when it passes over a submerged object?*

1. Find a few irregularly shaped objects to submerge and repeat the procedure and observe.

INTERPRETATION

We have prepared a video including the results for all three demonstrations in this activity.

REAL LIFE SCIENCE

- Natural ocean gyre movement creates the harmful accumulation of garbage patches found along the Pacific Ocean. NOAA's Marine Debris Program works to research and prevent the impacts of marine debris and shares accurate information about oceanic garbage patches. Consider reducing your garbage production by making reusable products a part of your life!

ACTIVITY III: CONVECTION CURRENTS AND THE THERMOHALINE

Watch what happens when a mass of dense, cold water interacts with a mass of less dense and warmer water. This activity creates a small-scale model of the oceanic convection currents that drive ***thermohaline*** *(temperature and salinity dependent) circulation in the ocean.*

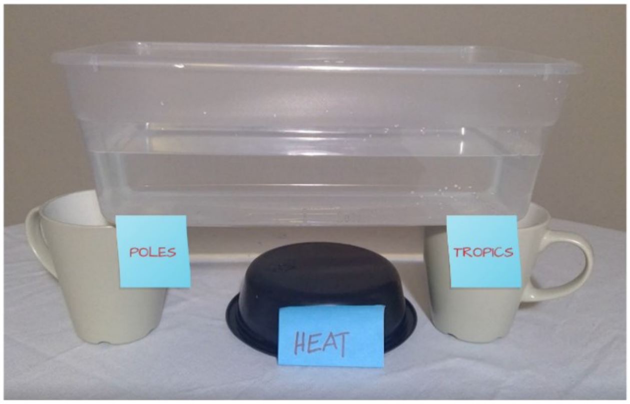
MATERIALS

- **Prepare the night before:** 1 big chunk of ice (about 3-4 inches long). The model worked well with freshwater for us. As you should have observed in the previous experiment, saltwater is denser than freshwater. So, it will be even better if you can fill a 6 oz cup made of a flexible plastic or silicone with water, add a few drops of blue food coloring and a tablespoon of salt. Then let it freeze overnight. Remove the ice from the cup when you are ready to run the model. Putting the cup under running of water briefly (just enough to detach the sides of the ice from the cup) might make this process easier.
- One 6 Qt. plastic storage container or glass container
- 2 mugs of the same size
- 1 small glass or ceramic bowl that is shorter than the mugs (this will hold hot water after it has been boiled, so it should be heat resistant).
- Sticky notes to label the parts of your model:
    - one labeled "heat"
    - one labeled "poles"
    - one labelled "tropics"

As you may have noticed, this represents the different climatological regions of the planet.

- Access to water to fill the storage container ½ to ¾ of the way.
- Access to a microwave, kettle, or stovetop for heating water (**make sure to have a parent or guardian help!**)
- Blue and red food coloring

SET-UP INSTRUCTIONS

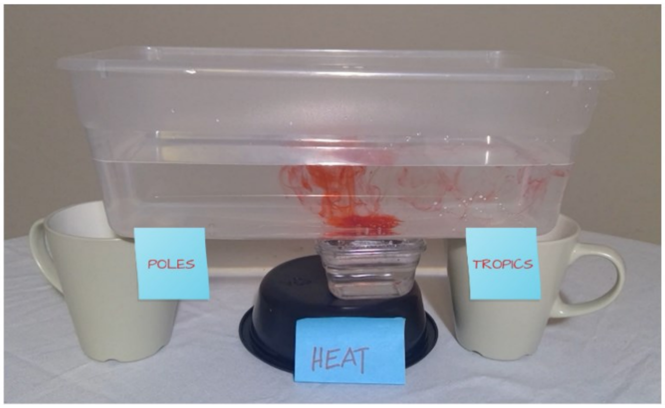


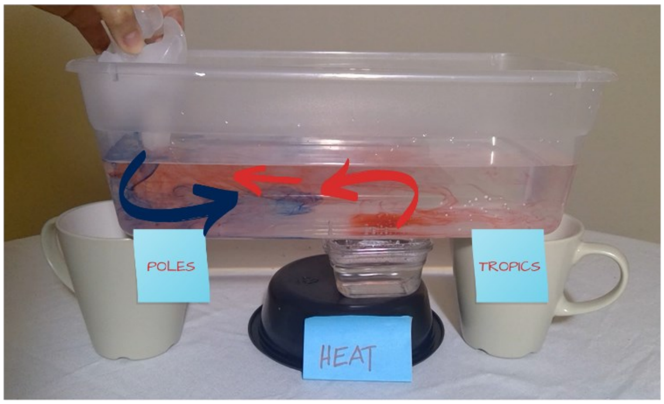
- Set up your experiment over a flat surface that can get wet. The kitchen counter or table might be best.

- Fill up your container ½ - ¾ of the way with room temperature water
- Use the two mugs to prop the container up by placing one on each side. Make sure that everything is stable!
- Make sure that your smaller container fits under the big one without leaving too much of a gap in between. Approximately ½ inch of space in between is fine. Note our example has an upside-down heat resistant bowl on the bottom to prop up the smaller container. Adjust as needed.
- Get the red and blue food coloring and have them close by.
- Have the chunk of ice accessible.
- Boil enough water to fill up ¾ of the smaller bowl. **Ask for help or use a baking mitten to handle hot instruments.**
- Pour the boiling water inside the smaller bowl.

MODEL INSTRUCTIONS

1. Add about 5 drops of red dye over the space where the "heat" sticky note is located.
2. Place the small bowl with hot water under the red dye.
3. Observe what happens. *Does the red dye start moving, or does it remain static? If it moves, in what direction? Is there a pattern?*
4. After a few seconds of looking at the red dye, when you start noticing the movement, get your ice and gently place it on top of the "poles" area of your model.
5. Put about 5 drops of blue dye on your ice, almost at the water level. Do this for either of the two possible scenarios (plain freshwater ice or blue, saltwater ice).
6. Watch as the blue dye and the cold water move. *How does the cold, blue water behave in relation to the red, warm water? Are they mixing or remaining separate?*





Important note: Planet Earth has two poles and the tropics are found in between. For this model, we are only presenting one cold and one warm area to produce one convection current which is why the left side of the model is representing both poles and the right side both tropics.

INTERPRETATION

Do not read until you are done with your own experiment

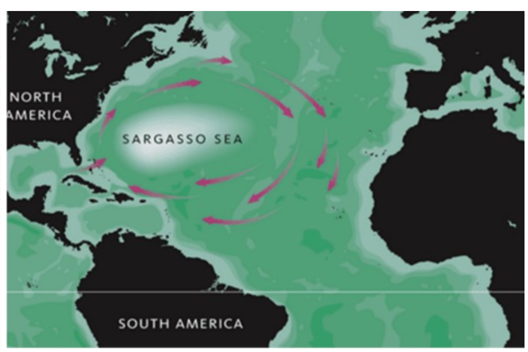
- The water initially located over the container of hot water starts getting warmer and losing density. The hot water rises, bringing the red food coloring with it and once on top, moves away from the heat source (either left or right).
- When the chunk of ice meets water, it starts melting. Cold water is denser than room temperature water and hot water, so it sinks and takes over the space left by the rising warm water. If you added salt to your ice sheet, the salt would have remained outside the ice. Stuck to the surface. So, it will be carried with that already denser mass of cold water, making it even heavier and the movement more apparent.
- The sources of heat and cold are much more powerful and consistent in real life, so this pattern continues, forming what is known as **convection currents**. When the displacement of hot and cold/saltier and less salty water is seen in a global scale, we get the **thermohaline system**.
- To understand how the observations of both of the previous activities play out in real life, check out this video about the ocean conveyor belt!
- Watch a teacher set up a system of convection currents in a similar way to this experiment.

Sargassum is the name of a group of brown algae (also known as "seaweed") with golden coloration, serrated leaves, and spherical air bladders.

Located to the east of Florida, the Sargasso Sea is a vast expanse of floating Sargassum and a great example of how wind-driven currents can create significant accumulations of floating materials. The Northern Atlantic Subtropical Gyre, a sum of multiple oceanic currents, creates this massive accumulation of *Sargassum*. This area of the Atlantic Ocean has been popularly regarded as a floating rain forest due to the great biodiversity it attracts.

The action of currents, waves, and tides occasionally brings this algae to Florida's shorelines including the Indian River Lagoon. *Sargassum* provides habitat for different types of juvenile fish, sea turtles, and invertebrates, making the coasts of Florida a great outdoor laboratory for exploring the animals associated with it.

Since 2011 countries along the Atlantic coasts and Caribbean have been receiving an excessive amount of Sargassum on their coasts. NOAA scientists believe this is due to a change in wind patterns that took place during the winter of 2009-2010. They think wind pushed a patch of the algae from the *Sargasso* Sea towards West Africa, after which it entered the tropics. The favorable water temperatures, nutrients, and exposure to sunlight are thought to have sparked reproductive success and the formation of a "belt" of *Sargassum* in new areas of the Atlantic. Although the presence of *Sargassum* in coastal areas is beneficial within specific margins, an excess can push tourists away as the algae take over the intertidal region and start to decompose, producing a strong smell and attracting insects. The algae can also affect coral reefs and seagrass beds as it floats preventing access to sunlight and "smothering" them.



Photos left to right on top: Patch of *Sargassum* algae (Flickr.com); Map of the Sargasso Sea (Wikipedia)

Bottom left: *Sargassum* inundates the coast of Ceiba Puerto Rico in June 2018 (Marine Biologist Neishmarie Soto)

INSTRUCTIONS

For this activity bring your curiosity, a small hand net (only if you have it available), a notebook and any camera. You can also bring a small bucket and partially fill it with water to put small clumps of Sargassum in it.

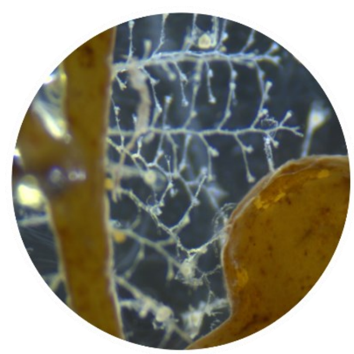
Drive or walk to a beach close to home. Walk along a section of coast and commit to exploring as many clumps of Sargassum as you can. Consider the ones that are already washed up on shore as well as those floating along the water. The Sargassum washed up on shore forms part of what is known as the "wrack" community. Dawn Witherington developed a great illustration of the animals associated with the wrack community.

Gently handle the clumps of algae as you try to identify the great diversity of animals that either grow, feed, or camouflage on the algae. Be careful when handling clumps of algae found floating as there might be small juvenile fish hiding along them. If you happen to catch fish, keep the net submerged in the water to decrease stress and allow them to breathe. You can sort through the Sargassum in the bucket and once done, take the algae out. Leave the tiny animals in the bucket to observe them for a short period of time. Return them to the area where you found them afterwards. Take notes and pictures to assess your observations at the end of the visit.

Recommendation: Download the **FREE iNaturalist app** on your phone, register and share your observations with the rest of the community! Take a clear picture of the animals you find and upload them as observations. iNaturalist has a feature where it suggests species identification for your observations. Bring any coastal, crustacean or fish species identification books available at home in case iNaturalist isn't able to accurately identify animals. Check out the app's video tutorials if needed

bryozoans (mesh-like pattern)
Picture: MBARI, mbari.org

gooseneck barnacle
Picture: Wikipedia commons



hydroids
Picture: Seamester, www.sea.edu

MODULE III: OCEAN EXPLORATION

The field of ocean exploration incorporates the use of scientific tools to observe and gather data about areas of the water column and seafloor that have never been seen by humans. Ocean explorers collect what is known as "baseline information" and make it available to researchers around the world for subsequent study. The National Oceanic and Atmospheric Administration (NOAA), the Ocean Exploration Trust (OET), and Schmidt Ocean Institute are the only organizations with vessels equipped to conduct oceanic exploration missions. They collaborate amongst each other and collect as much data as possible to increase the comprehension of our blue planet using ***sonar mapping technologies***, ***remotely operated vehicles (ROVs)***, and ***telepresence***.

In 2020 humans know more about the surface of the moon and Mars than they know about Earth´s seafloor. At the time this is being written only 19% of the seafloor has been mapped in high resolution and a great part of the ocean at large is yet to be explored and seen by human eyes. The above-mentioned organizations create high resolution maps of the seafloor because the shape of the bottom of the ocean has the potential to influence ocean circulation, weather systems, tides, climate change and even tsunami propagation. Mapping the seafloor also provides insights into underwater hazards, making navigation and underwater pipeline constructions safer for everyone. In terms of biology, identifying the underwater mountains known as seamounts, deep water coral reefs, and any other "hot spots" for marine organisms can inform the best practices for the management of fisheries and ecosystem conservation long term. Add remotely operated vehicles to the mix and you get another level of precision. Using robots to collect video and physical samples provides an opportunity to "ground truth" the ***bathymetric*** (shape of the seafloor) data from the sonar. Robots allow scientists to sample marine organisms, sediment, or even water to track chemical properties, including organismal DNA. These are only a few of the benefits of ocean exploration.

This module will introduce two engineering challenges related to the ROVs used for ocean exploration. You are also encouraged to use telepresence as a means of exploring the sea remotely.

Visit OET's E/V Nautilus, NOAA's Okeanos, and Schmidt Ocean Institution's R/V Falkor official websites for more information.

Key concepts

- **sonar mapping:** This mapping technology sends acoustic signals to the seafloor from the hull of a ship and calculates how long it takes for that signal (called a ping) to come back. The calculations are then processed through a computer program and turned into a collection of altitude points that together create a colorful map of the seafloor. Lean more.
- **remotely operated vehicles (ROV):** Vehicles that can be piloted from afar using fiber optics cables for information exchanges between piloting technologies and the vehicle. These robots are deployed thousands of meters below the waves to get data including video, temperature, depth, and even geological, chemical, and biological samples.
- **telepresence:** The use of satellites to stream live video from the bottom of the sea to people's computers at home in almost real time.

Activity sourced from OET and shortened for at-home use

CHALLENGE

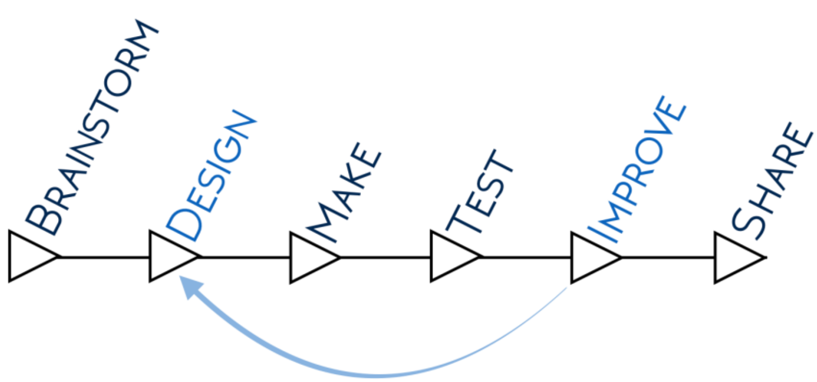
You must build a neutrally buoyant ROV prototype using household items. Extra kudos if you can make it out of reusable items or items rescued from the recycling bin!

INTRODUCTION

To successfully complete this challenge, you will explore the principles of **buoyancy** - what makes something sink or makes it float? An object that floats in water is said to be *positively buoyant*, an object that sinks is *negatively buoyant*, and an object that is fully submerged without sinking completely is *neutrally buoyant*. Greek scientist Archimedes (BC 287 - BC 212) discovered that the buoyant force on an object in liquid is equal to the weight of the liquid displaced by the object. When the weight of an object is less than the weight of the fluid displaced, **it will float (positively buoyant)**. When the weight of an object is greater than the weight of the fluid displaced, **it will sink (negatively buoyant)**. When these values are equal, **neutral buoyancy is achieved**.

Engineers aboard the E/V Nautilus use these principles when designing and preparing ROV Hercules and ROV Argus for deep-water exploration. Both ROVs work as a tethered system. ROV Hercules is the main tool and "eyes" during operations, gathering video, chemical, and bathymetric data that is streamed back to the E/V Nautilus through a series of fiber optic cables. ROV Argus always remains slightly more elevated, providing a birds-eye view of Hercules and light for Hercules' pilots. Argus also buffers the push and pull of the ship as it moves with the ocean waves, keeping Hercules stable during delicate operations. Check this video to see how buoyancy applies to these essential pieces of equipment.

You will use the design process to accomplish the challenge:



MATERIALS

- Large clear container to fill with water
- Any combination of the following materials:
    - tape, rubber bands, string
    - modeling clay
    - airtight containers (sealed straws, ketchup packets, small water bottles, etc.)
    - cork, aluminum foil, Styrofoam
    - sand, small pebbles, pennies, washers, paper clips
    - other common household items
- A notepad and pencil for prototype design.

SET-UP INSTRUCTIONS

- Fill up your clear container and put it on top of a surface that can get wet.
- Organize the assortment of materials so all of them are visible. Sorting them by guessing their buoyancy (will it sink or float?) might be helpful for the challenge.

ACTIVITY INSTRUCTIONS

BRAINSTORM

1. Get your notepad and pencil.
2. Think about the following questions:
    a. What causes some objects to float and others to sink?
    b. What effects do different variables (e.g. surface area, mass) have on your design?
3. Evaluate the materials you have available for the construction of your prototype. If you are not sure whether some will float or sink in water, feel free to test them now.

DESIGN

4. Sketch out the first version of your prototype.

MAKE

5. Bring your ideas to real life by using the available materials to make your prototype.

TEST

6. Test the prototype by putting it in the water. Does it have positive, neutral, or negative buoyancy?
7. If your prototype sinks or floats, answer the following questions: Does it need more weight or less? Do you need to increase drag by adding surface area or decrease it by removing some materials? Are your materials absorbing water and eventually sinking your design? Take any observations into consideration for enhancing the next version of the model.

IMPROVE

8. Sketch out the next version of your prototype and add annotations about anything that might need to be changed to the sketch.

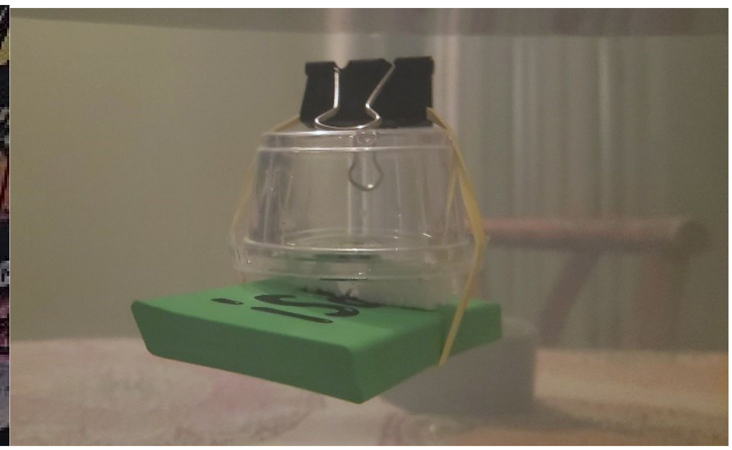
REDESIGN

9. Make any adjustments necessary and test the prototype and TEST again.

SHARE

10. Once your design works, share with your family and friends. In the professional world, the engineers designing an ROV would share technological and design advancements with their colleagues.

Have your friends or family members make their own ROV prototypes and compete!

Pictured left: Example of ROV prototype. Credit: Yashira A. Cruz

Pictured right: Example of neutrally buoyant prototype. Credit: Yashira A. Cruz

ACTIVITY II: GIVE HERCULES A HELPING CLAW

Activity sourced from OET and shortened for at-home use:

CHALLENGE

You must build a ROV mechanical arm prototype using household and crafting items. Extra points for making it out of reusable items or items rescued from the recycling bin!

INTRODUCTION

ROV Hercules is equipped with two manipulator arms designed for collecting samples and recovering artifacts. The arms have claws or "hands" to handle tools, grab samples, and place recovered items into sample drawers or onto elevators dropped to the seafloor from the ship above. The claws' ability to grab and release objects in a highly controlled way is critical to the success of E/V Nautilus's mission to explore parts of the ocean never seen before.

While on expedition, ROV dives with different goals require Hercules to be able to pick, use, and release many tools. This multifunctional ability is essential to collect the variety of samples scientists need study the ocean and its unique geology, chemistry, and biology.

In this challenge you will build an arm with grasping claws that can be used to pick up and release a variety of different objects. Your arm must be able to reach out at least 2 feet (0.6 meters).

Key concepts

- **fulcrum:** the point around which a lever turns, or pivots.
- **lever:** a strong bar that is used to lift and move something heavy

MATERIALS

-Objects to pick up with your device (i.e. tennis balls, cotton balls, paper cups)

-Here are some materials you can use to build an ROV hand:

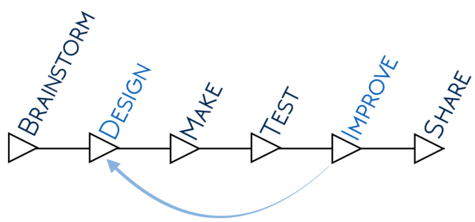
- brass fasteners
- binder clips paperclips
- clothespins
- corrugated cardboard
- hole punch
- 2–6 paint stirrers
- 2 paper cups
- rubber bands
- ruler
- sandpaper

MATERIALS (CONTINUATION)

- scissors
- string
- tape (duct or masking)
- wooden dowels
- fishing line
- pencils
- other common household supplies

ACTIVITY INSTRUCTIONS

Remember the design process used in the previous activity? It will also be very useful for this design challenge.



THINK ABOUT THE CHALLENGE

Think about the differences between grabbing, scooping, and the kind of motion you use to squeeze something. When you grab something, you collect a smaller number of objects than you would if you scooped objects as a group. But the grabbing motion allows you to handle objects with more control than scooping. To grab objects with your hand you use your thumb and fingers to hold the object in place on two sides. The muscles in your fingers can apply pressure towards the objects to hold them. More pressure equals a tighter hold.

WRITE DOWN YOUR IDEAS

1. Consider how to make the arm long enough to reach 2 feet. What materials do you have to make long, sturdy arms?
2. To grab something a device needs two parts that go on either side of the item being grabbed. A grabber also needs a way to press the two parts together to make a pinching motion. Some devices, like pliers, act as ***levers***. Levers are the rigid bar that turns around a ***fulcrum***. A fulcrum is the point around which the two parts swivel (think about a seesaw). How will you make the parts press together? What materials will you use to make the jaws grip items tightly?

DESIGN

1. Sketch your arm including the proportions for each part. This is when you should think about how the different parts of your arm will be pressed together. Also, consider how the claws will be attached to the arm and how they will maintain grip against objects.

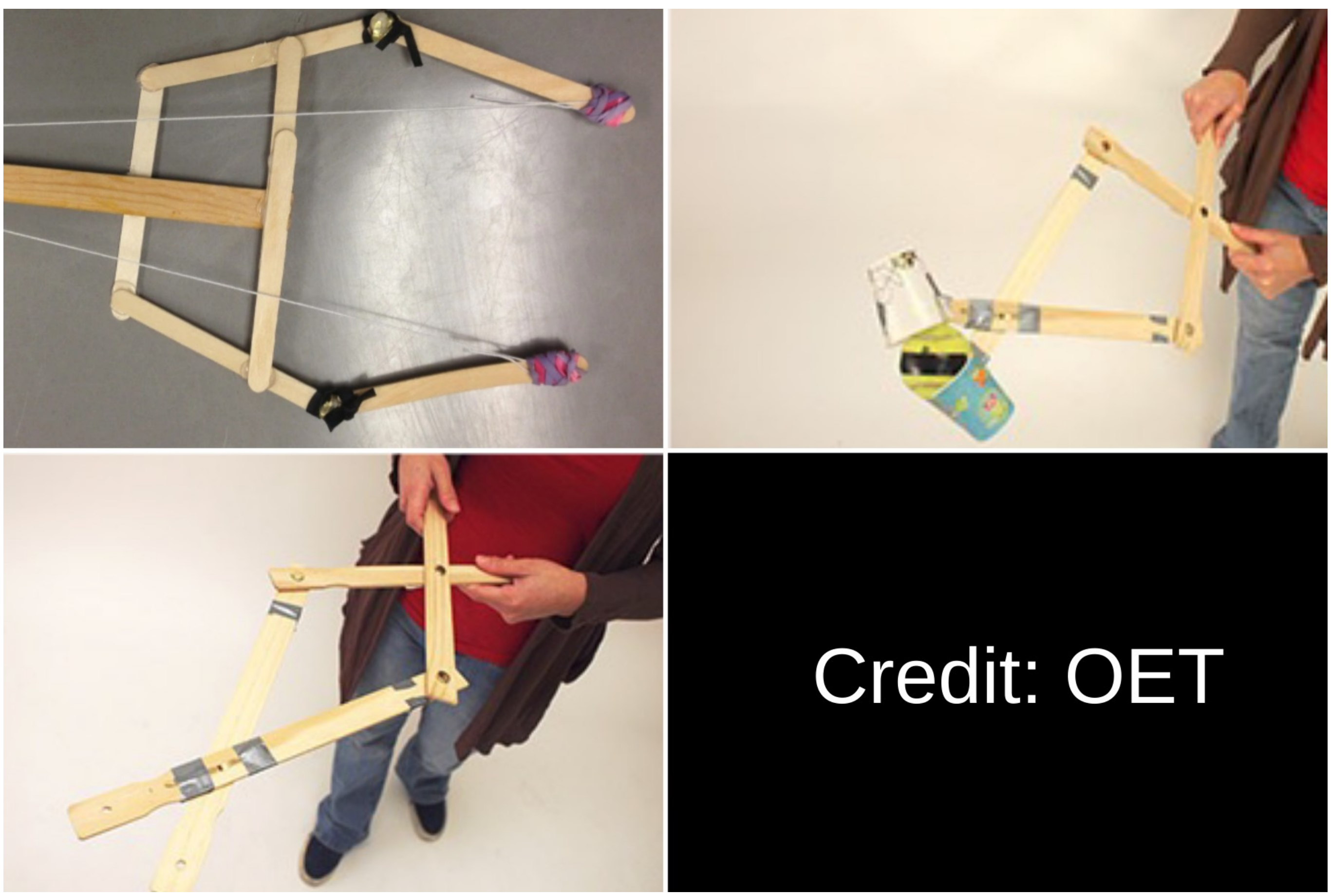
MAKE, TEST, IMPROVE

2. Decide how you will connect the different parts that extend the arm.
3. Choose your materials and build the arm.
4. Open and close the arm to make sure it moves smoothly. REDESIGN if necessary.
5. Decide how the claws will grip an object and hold on to it.
6. Choose materials and build the claws.
7. Place an object about 2 feet away from you. Grab it with your arm! Lift the object, lower it, and then release it.

CONGRATULATIONS! YOU HAVE CREATED A FUNCITONING ARM PROTOTYPE.

SHARE

Option to keep on improving your arm so it grabs heaver, smaller, or bigger objects. Inventing a competition to find the best design is also fun, so invite family and friends to join in on the fun.



EXPLORE LIVE THROUGH TELEPRESENCE

You can join the explorers aboard the E/V Nautilus, Okeanos Explorer, and R/V Falkor via live stream from the comfort of your home! You can also submit questions and comments live on their websites. Each of the organizations have their own exploration season, so make sure to visit their websites to schedule when to watch live!

Schmidt Ocean Institute's R/V Falkor 2020 season: August – December
Tune in for live exploration

Ocean Exploration Trust's 2020 season: Pending July start due to Covid-19
Find videos from previous exploration missions and check their official website for updates!

NOAA's Okeanos Explorer 2020 season: On Hold due to Covid-19
Find videos from previous exploration missions and check their official website for updates!

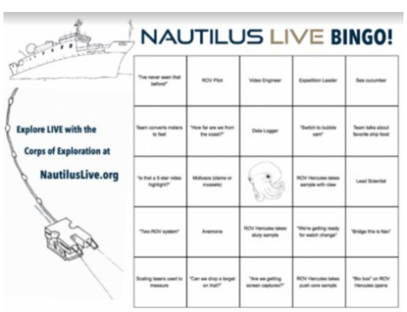
Credit: NOAA/OER

Credit: R/V Falkor

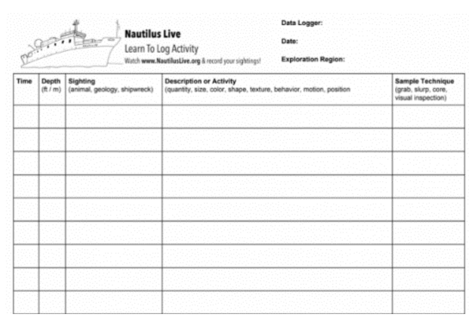
Credit: OET

ACTIVITIES TO DO WHILE WATCHING EXPLORATION LIVE STREAMS:

NAUTILUS LIVE BINGO



** DATA LOGGING**



BATHYMETRY CUPCAKES!

MODULE IV: EXPLORING THE BIODIVERSITY AROUND YOU

LEARNING OBJECTIVES

After completing this activity, you will learn about different methods of observing and identifying living organisms. You will build a **biocube** to figure out what types of organisms can be found within one cubic foot. You will also learn to use a **dichotomous key**, a common tool in organism identification, and will start building your very own **herbarium**.

INTRODUCTION

For marine scientists, meticulous observation is necessary during data collection and analysis. For example, telling the difference between two species of fish while doing a transect or analyzing DNA sequences in the lab both require the use of careful and informed observation. No matter what step of science you find yourself in, it is always present.

Learning to observe, identify, classify, and document the natural world are basic skills for a good marine biologist. The following three activities will focus on getting you out in nature to practice observation from different perspectives.

A WORLD IN ONE CUBIC FOOT – LIFE IN A BIOCUBE

Activity from the Smithsonian National Museum of Natural History

INTRODUCTION

What life can be discovered in a cubic foot over one day? This is the question that photographer David Liittschwager and Smithsonian scientists wanted to answer when they were working on the book titled "A World in One Cubic Foot: Portraits of Biodiversity". This is how the biocube was born. The authors discovered many organisms within 1 cubic foot of space in many different parts of the world.

The idea behind a biocube (any hollow cube made from 1-foot sides) is making biodiversity observation accessible and manageable to everyone. By learning about the natural areas around us at a small scale, we can eventually connect bits and pieces of ecosystems and see why they are important for the survival of many organisms. At the same time, the detailed collection of data makes our knowledge more specific, allowing us to appreciate the characteristics of each species and their role within the system. Almost anywhere you go on Earth, be it a creek, river, ocean, beach, or forest, you will most likely find a variety of fascinating critters. You just need to get yourself out there and observing!

Watch Biocubes: A World in Once Cubic Foot before starting.

Download the documents titled "*Biocube At Home – Activity at a Glance*" and "*Biocube At Home – Explorer Directions*" for instructions and procedures.

HAVE FUN EXPLORING!

ORGANISM IDENTIFICATION – USING A DYCHOTOMOUS KEY

INTRODUCTION

Scientists who study organisms often spend a lot of time trying to identify them and grouping them based on shared characteristics. A dichotomous key is a tool used in science to classify organisms by following a list of paired, descriptive statements. The key begins with very general physical characteristics about a group of organisms (let's say crabs) and progressively gets more specific as we get closer to identifying a species by its scientific name. Watch this lesson by educator Erin Lomax to learn more about dichotomous keys.

Download the "SMEE Dichotomous Key Worksheet" and "SMEE Dichotomous Key Answer Sheet" to complete the activity.

CREATE YOUR OWN PLANT PRESS

Activity from the National Museum of Natural History

INTRODUCTION

Plant pressing is a method used by scientists for preserving plants over long periods of time. They might want to keep the plants for cataloging them into museum or research collections or for later study. A collection of many classified, pressed plants is known as an herbarium. These can be valuable resources for museum scientists as they study the natural history of their region, including the introduction of new species or the disappearance of others over time.

Creating your own herbarium collection might be a good way to get acquainted with the coastal plants around your area. Smithsonian scientists will teach you the basics of plant pressing. This activity can also be a way of making beautiful pieces of art reminiscent of your favorite natural environments.

CAUTION

Some plants are protected, others are poisonous or produce allergic reactions. Conduct an internet search, or better yet, get a plant identification guide to find this information before collecting plants that are not familiar to you.

ADDITIONAL RESOURCES

Check out how scientists at the Smithsonian Tropical Research Institute prepare algae presses for preservation.

Science on the SPOT: Preserving the Forest of the Sea by KQED Science

University of Florida IFAS Extension (website): Florida native plant identification and video identification of other plants.

OVERVIEW

Learn about the sea turtles of the world and discover the species found nesting on the Florida coast.

Plan an early morning beach walk to identify the tracks of nesting sea turtles.

LEARNING OBJECTIVES

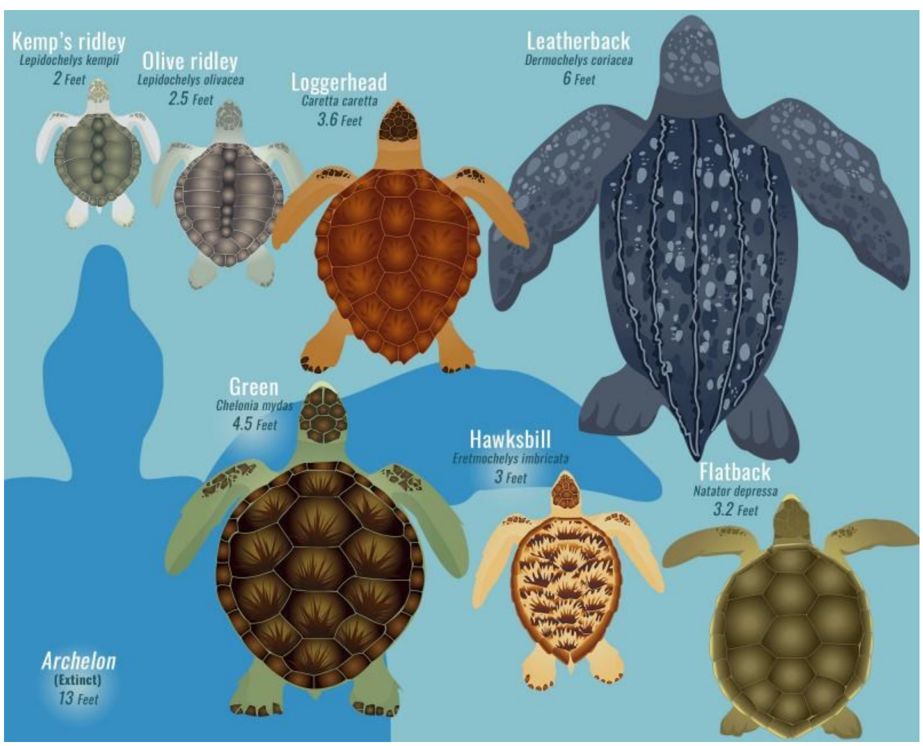
After completing this module, you will be able to identify the sea turtles found in the Atlantic Ocean, recognize their nests and identify the types of tracks produced by three species.

INTRODUCTION

Sea turtles are marine reptiles that outlived the dinosaurs, having survived on Earth for approximately 110 million years. They swim all over the Earth's oceans, with the exception of the polar seas, and migrate for hundreds of miles between feeding and breeding areas (where they have babies). Sea turtles can hold their breath for several hours depending on their rate of activity! For example, they will catch a quick snooze under rocky ledges before coming up for air (they are air breathers after all). According to the Sea Turtle Conservancy, resting sea turtles can stay submerged for 4-7 hours.

Wondering what makes them different to the terrestrial gopher tortoises or aquatic terrapin turtles found in Florida? Instead of legs, sea turtles have powerful fins for swimming and live exclusively in ocean water. Females will come up to the beach to nest, but they spend most of their lives out at sea.

Illustrated: The seven species of sea turtles currently alive. The blue outline is one of their ancient relatives: Archelon. Diagram belongs to Smithsonian Ocean.



There are seven species of sea turtles in the world. Look at the following diagram to learn how to identify the five species found in Florida waters. Look at the prefrontal scales, carapace (top of the shell), plastron (bottom of the shell) and the amount of scutes (or plates) on the carapace:

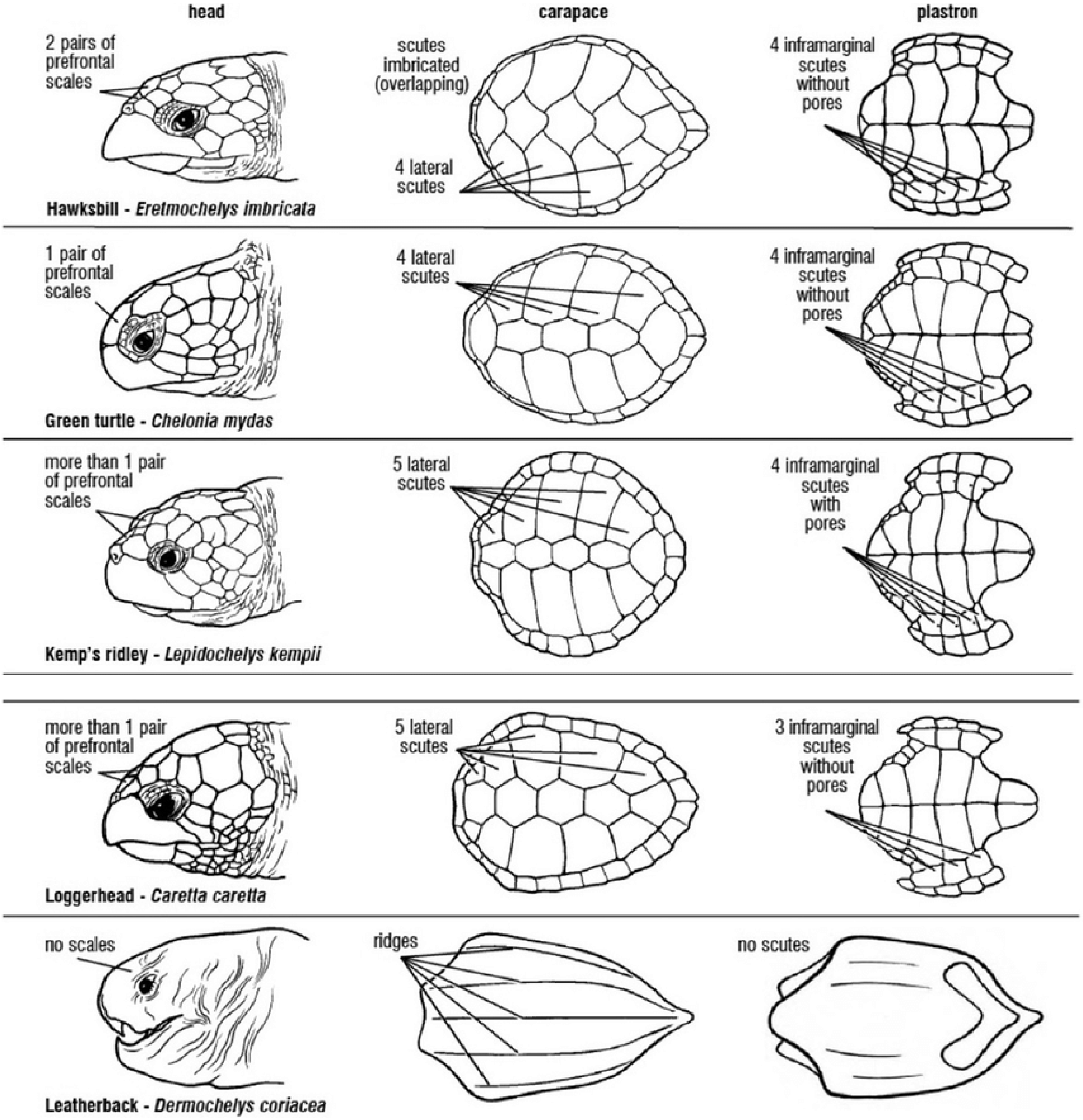
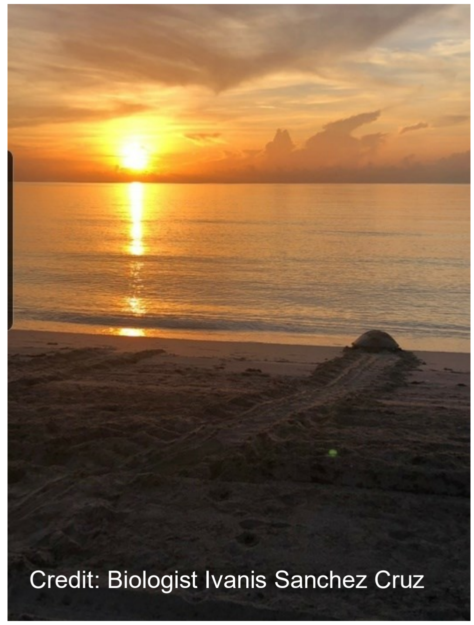


Diagram: [Shigenaka, Gary & Milton, Sarah & Lutz, Peter & Hoff, Rebecca & Yender, Ruth & Mearns, Alan. (2003). Oil and Sea Turtles: Biology, Planning, and Response.]



Female green, loggerhead, and leatherback sea turtles visit the sandy beaches located along Florida's coasts to lay their eggs at night between the months of March and October. They build nests, lay their eggs, and go back into the ocean, leaving the eggs to develop and hatch on their own. This makes it hard to keep track of the nesting females, which can swim up and down a stretch of beach multiple times in one night waiting for the perfect moment and place to crawl out of the water and lay their eggs.

How do sea turtle specialists keep track of the species of turtles nesting on and hatching from our beaches? One of the methods commonly used is simply observing!

Each of the nesting species found in Florida leaves a different type of track behind, just like we leave footprints in the sand. The tracks left by a female can be correlated (matched) to the average size of the species, the shape of their bodies and the order in which they move their fins as they climb up and down the sand. Just like turtle scientists and citizen scientists that help care for these endangered species every single day, you too can learn how to identify the tracks left on the sand by nesting sea turtles! Ready to go out on a sea turtle track walk? Be mindful! Sea turtles are protected by the law, so remember to walk respectfully and at a safe distance from the nests.

MATERIALS

1. One good alarm clock! In order to have a successful mission, you and an adult will have to arrive at the beach before other beachgoers start walking over the tracks, consequently erasing them. Try to be at the beach between 6am-7am.
2. Print out this guide by the Florida Fish and Wildlife Conservation Commission (FWC) for your walk.
3. If you wish to have an extended version of the guide above, FWC website and learn the differences between the tracks made by a sea turtle that left the beach before nesting (a false crawl) and one that completed the process. (Optional)
4. To go even deeper, check out this older but great 30-minute video titled "A Beachcomber's Guide to Turtle Tracks", also by FWC. (Optional)

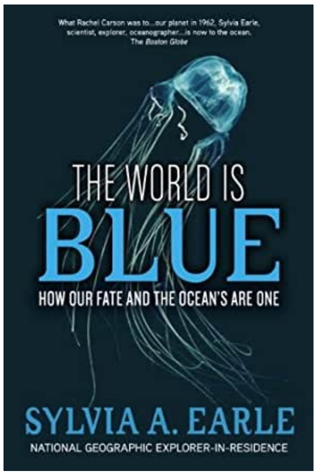
RECOMMENDATIONS

- To make sure you are not trampling any unmarked nests, please keep your walk as close to the water line as possible. The waterline can be easily identified by a long line of clumps of algae, seagrass, and shells that waves bring up to the shore.
- If there happens to be a female nesting, please DO NOT approach. Keep a good distance from her, as your presence could be a stressor.

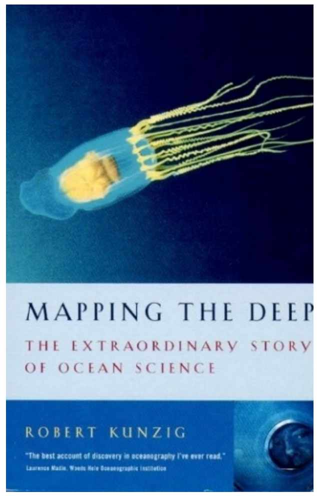
ADITTIONAL ACTIVITIES – READ, WATCH, LISTEN!

Learn about our oceans by reading a book, watching a documentary, or listening to a podcast. Here is a list of options to aim for whenever you are missing the waves this summer. There are many more great audio-visual resources about the sea out there. Give them a try and keep on learning!

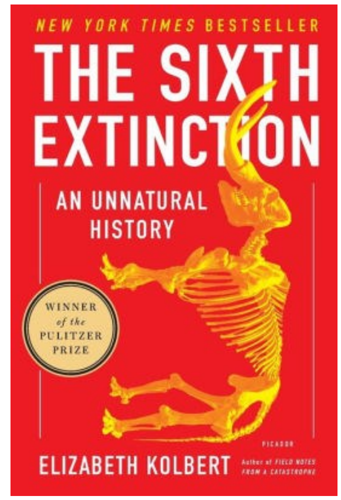
BOOKS



The World is Blue



Mapping the Deep



The Sixth Extinction

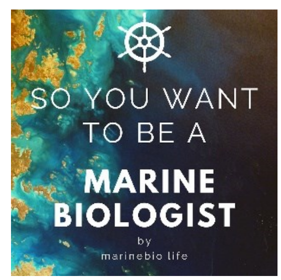
PODCASTS

ORCA

Podcast

Two Sea Fans

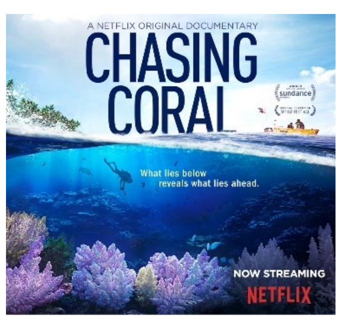
Ocean Science Radio



So You Want to Be a Marine Biologist

DOCUMENTARIES

A Plastic Ocean (Trailer)



Chasing Coral

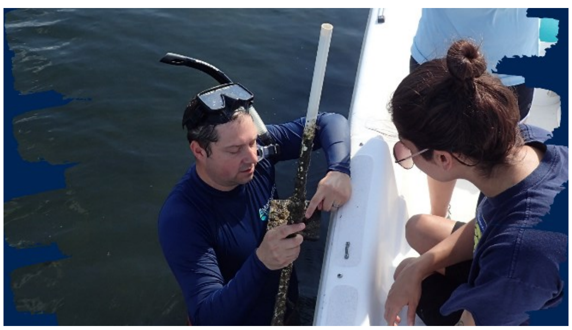
(Full documentary)

Mission Blue (Trailer)

CAREER DIVES: CONVERSATIONS IN MARINE SCIENCE SCHEDULE

Learn how Smithsonian marine science professionals earned their fins through this weekly summer series. Discussions will include how they found their paths into the marine sciences, interests, and research. Bring your questions for live Q&A sessions! Thursdays at 10 AM.

June 25
Bill Hoffman,
Aquarium manager and Head aquarist
Smithsonian Marine Ecosystems Exhibit
Registration: https://bit.ly/3c5oXmF



July 2
Dean Janiak, Biologist
Smithsonian Marine Station & Marine Geo Project
Registration: https://bit.ly/3cuMM7O

July 9
Kelly Pitts, Research technician
Coral Health and Marine Probiotics Lab,
Smithsonian Marine Ecosystems Exhibit
Registration: https://bit.ly/2U9418q

July 16
Michelle Donahue
Science writer and Communications specialist, Smithsonian Marine Station
Registration: https://bit.ly/2ACira8

July 23
Holly Sweat (Ph.D.),
Marine community ecologist
Smithsonian Marine Station
Registration: https://bit.ly/2U8eUas

July 30
Woody Lee,
Captain and Research technician
Smithsonian Marine Station
Registration: https://bit.ly/2ULwX6y