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Accessibility and Inclusivity in Marine Science Education: A Suite of Collaborative Marine Science Lesson Plans

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Accessibility and Inclusivity in Marine Science Education

A Suite of Collaborative Marine Science Lesson Plans

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A capstone project in partial fulfillment of the requirements for the degree of Master of Arts in Marine Science at the Virginia Institute of Marine Science, William & Mary

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Background

Marine science education is oftentimes sparse in formal education. This is due to a myriad of factors, including but not limited to: minimal state marine science curricula standards, geographic restraints, and lack of resources. This problem is not just unique to marine science, either. In 2018, it was found that only two states required environmental science in secondary education, with just eight requiring general earth and space science (American Geosciences Institute 2018). To further this disparity, marine science curricula are often focused on upper grade levels, with most marine science curricula being focused on the 10th grade and above (Figure 1).

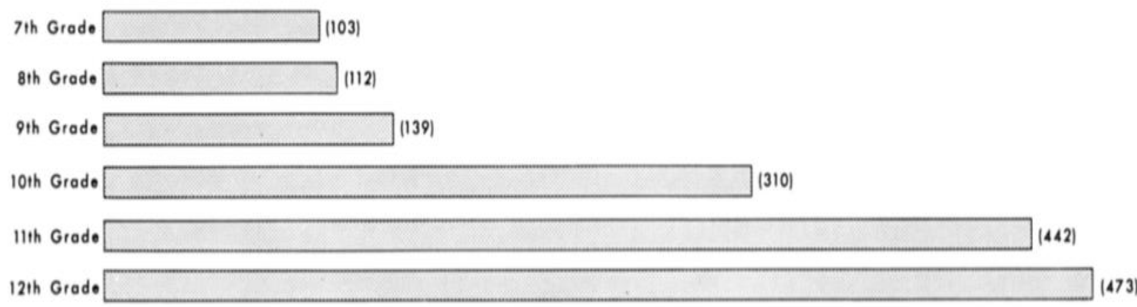


Figure 1: *Graph showing occurrences of marine science curriculum throughout various grade levels. Note that the highest occurrence is in 11th and 12th grade with a considerable drop in 7th-9th grades. This calls for curricula designed for all grade levels that can be implemented with ease (Schweitzer 1973). Marine science curricula are still mentioned very little in standards across many countries (Gough, 2017).*

This, partnered with the already large disparity in achievement and curricula between underprivileged and privileged children, exacerbates the issue of making robust science curricula available to all students, regardless of race, class, ethnicity, etc (Bradbury et al. 2015). While children in coastal areas may have more hands-on learning experiences available to them, children everywhere would benefit from marine science curricula, as it has shown success in helping students learn integrated science topics as well, including geology, physics, chemistry, and more (Lambert 2018).

Additionally, environmental justice curricula are even less prominent in schools, despite their success in empowering students. In one case study, students were shown to be socially enabled, with one student reporting that environmental justice curricula "actually teaches you compassion" (Dimick 2012). The success of environmental justice, environmental science, and marine science curricula in schools exemplifies the importance of making them more widely available to teachers.

In the local areas of Hampton Roads and Gloucester County, these issues persist. To provide more access to marine science education, the Virginia Scientists & Educators Alliance (VA SEA) at the Virginia Institute of Marine Science (VIMS) was formed in 2016. This program works both with students to create lesson plans based on their research and interests, but also with local educators to test these lesson plans in the classroom before publishing them.

Globally available on their online database, the VA SEA lesson plans have been downloaded directly from the database 15,300 times in 158 countries as of August 2023; these numbers are also likely underestimated due to their ability to only reflect direct downloads from one website. Due to the program's prominence in the field of marine science education, I wanted to identify gaps in the current marine science curricula. I explored lesson plans that have been published with VA SEA. Looking at the over 60 published lesson plans, a majority of the lesson plans are biology focused, with few physical science lesson plans. Furthermore, a majority of the lesson plans are designed for middle or high school standards, with only two being aimed for elementary school as of August, 2023. There are also no current VA SEA curricula with a direct focus on environmental justice (VA SEA 2023). Given this, I decided to create three lesson plans that focus on filling those current gaps.

Products

This capstone includes three lesson plans, all focusing on filling current gaps within marine science curricula based on statistics from VA SEA but also based on anecdotal requests from local educators. One lesson plan focuses on first grade life science, one lesson plan focuses on fourth grade physical science, and one lesson plan focuses on high school level environmental justice. Together, these lesson plans will add to the globally available database of marine science curricula and help even out the existing material. Each plan was run through an initial round of feedback from educators at VIMS. Then, all of these plans were tested with local educators, with the two elementary schools being tested through the VA SEA program and the high school plan being tested through an environmental justice workshop. Each lesson plan was then revised based on the feedback from these educators, and ran through another round of feedback with VIMS educators before being published to either the VA SEA database and shown at a lesson plan exposition with teachers throughout the state of Virginia or available on the VIMS website for free download. I want to note that although these lesson plans have a focus on local Virginia flora, fauna, and issues, they are also widely applicable and adaptable globally.

To ensure that lesson plans are appropriate for their respective age levels, I will be reviewing the Virginia Department of Education's Standards of Learning and aligning the content of the lesson plans with these standards. Each lesson plan will have standards of learning attached to them, and will oftentimes be interdisciplinary, crossing into life or physical science standards. The environmental justice lesson plan, because of its inherent interdisciplinary nature, falls into both high school environmental science and history curricula, so it can be expanded across a wider range of classes and learning opportunities and cultivate collaboration between teachers in both the social studies and sciences.

This project helps ensure that students are getting access to marine science curricula from an early age. Elementary level science education has been shown to have a variety of benefits, including increasing elementary age children's scientific literacy and critical thinking skills (Vieria & Vieria 2014). Science is performed to be read, digested, and used for the betterment of society and our understanding of it. However, if science fails to exit the world of academia, there can be a huge loss of potential use, appreciation, and inspiration occurring. This is why it is so important to communicate science effectively and to find creative ways to engage people of all ages in the world of science.

Conclusion

With the finality of this capstone, three lesson plans are now available to the public for download all across the globe. These lesson plans were developed as part of a collaborative effort between me, local teachers, and VIMS educators. Lesson plans were designed with accessibility and inclusivity in mind, aiming to fill the gaps that currently exist in available marine science curricula. Additionally, all lesson plans were presented through either a workshop and exposition. As a cumulation of this work, a presentation was given to the community showcasing the process and products of the project.

Sharing marine science through education is paramount in inspiring the next generation of environmental stewards. By breaking down the barriers of accessibility in marine science education and creating lesson plans that are available for any educator, anywhere, this project aims to cultivate a curiosity, wonder, love, and respect for our coasts, oceans, waters, and their resources.

Product One: 1st Grade Life Science Lesson Plan

Plants, Animals, and Others, Oh My!

Focus: Difference between biotic and abiotic ocean life

Subject: 1st Grade Science

Virginia Standards of Learning (all Standards of Learning can be found here):

1.1c The student with demonstrate an understanding of scientific and engineering practices by interpreting, analyzing, and evaluating data

- Use and share pictures, drawings, and/or writings of observations
- Describe patterns and relationships
- Classify and arrange objects based on a single physical characteristic or property
- Organize and represent various forms of data using tables, picture graphs, and object graphs
- Read and interpret data displayed in tables, picture graphs, and object graphs using vocabulary *more*, *less*, *fewer*, *greater than*, *less than*, *and equal to*

1.4c: The student will investigate and understand that plants have basic life needs and function parts that allow them to survive. Key ideas include plants can be classified based on a variety of characteristics.

1.5c: The student will investigate and understand that animals, including humans, have basic life needs and function parts that allow them to survive. Key ideas include animals can be classified based on a variety of characteristics.

Learning Objectives:

- Students will determine differences between marine plants and animals.
- Students will determine the differences between biotic and abiotic features.
- Students will create and read a pictograph.
- Students will become familiar with local marine flora and fauna.

Time Required: 45 min

Vocabulary:

- **Plant:** An organism that typically makes its own food through a chemical process called photosynthesis (which uses sun and water) (adapted from dictionary.com)
- **Animal:** An organism that typically cannot make its own food (will have to eat to survive) and can move by its own choice (adapted from dictionary.com)
- **Abiotic:** Something that is non-living (adapted from dictionary.com)
- **Biotic:** Something that is or is related to living things (adapted from dictionary.com)
- **Pictograph:** A pictorial representation of data using images or symbols (adapted from cuemath.com)
- **Marine:** Related to or living in the sea (adapted from dictionary.com)

Background Information: The Chesapeake Bay is home to a variety of diverse flora and fauna that dwell under the surface of our waters. However, because of that diversity, it can be a little hard to tell different underwater dwellers apart. Oftentimes, there are animals that look like rocks, fish that look like plants, plants that look like debris, and lots of other tricky critters. Using real research that highlights what is in the Bay, this lesson plan will teach students both essential math skills and sorting and categorization skills based on characteristics.

In the Chesapeake Bay, the Virginia Institute of Marine Science has been figuring out what's under the surface for many decades. From tiny, microscopic plankton that drift at the surface, to barely moving oysters that are delicious by the dozen, we have been surveying the Chesapeake Bay using a variety of methods. It is estimated that there are over 4,000 species that either call the Bay home all year round or are visitors of the Bay (Murdy and Musick 2007, Center for Coastal Resources Management). Even through a small class project in the bays of the Eastern Shore of Virginia, I was able to see the true diversity that lives under the water. Understanding what these underwater players are will create a sense of wonder and open up students to a whole new world, right below the surface.

Materials:

- Whiteboard (alternatively butcher paper)
- Dry erase markers (alternatively markers)
- Pre-printed photos
- Tape

Classroom Set-Up:

Students can work in pairs or small groups for this activity. There should be a large board (white board/smart board) for the entire class that you can draw on and add pictures to. Alternatively, large butcher paper would work if a whiteboard isn't available.

Procedure:

Activity Set-Up: 10 minutes

1) Print out photos provided in Appendix I.
2) Each group will need 2-3 cards, so ensure that you have enough cards for the amount of students in your class.
3) For better results and reusability, laminate photos.
4) On a whiteboard or piece of butcher paper, draw the axis of a pictograph with the left side labeled "Plant", "Animal", or "Non-Living" and the title saying "Types of Marine Life".
5) On the graph, add tape to the board so that students can easily stick on their pictures when ready.
6) Add a few more pieces than you think are needed to allow for sorting errors.
7) Ensure that all pictures are shuffled so students get a variety of cards.

Introduction: 20 minutes

1) Use the PowerPoint attached or create your own PowerPoint to talk briefly about the Chesapeake Bay and to discuss how you could distinguish between a plant, animal, and non-living creature including characteristics of each.
2) Have students think of some terrestrial examples before having them name some marine examples as well.
3) If students are not familiar, also take this time to introduce the idea of a pictograph.

Activity: 15 minutes

1) Break groups up into pairs or small groups depending on the size of the classroom.
2) Give each pair or group 3-4 pictures and tell them to discuss if they think it is an animal, plant, or non-living object. Some may be tricky!
3) After about 10 minutes or when students seem to be ready, invite groups up one at a time to come up to the board where the pictograph outline is and stick it in the correct category by having them attach it to the tape set up on the board.
4) Once all are added, go through and see which ones may need to be moved and discuss why. You can use questions such as "how do we feel about these categories?" and "do we think any of them need to be changed?"
5) Then, students can discuss what the overall trends are using words such as "greater than", "equal to", etc. You can use questions like "which group has the most amount of things in it?" and "do any groups have an equal amount to each other?".

Discussion and Assessment: 10 minutes

1) Once the activity has been completed, ask a few refresher questions such as "what traits do animals have?" or "what traits do plants have?" to refresh students' memory before the exit ticket assessment.

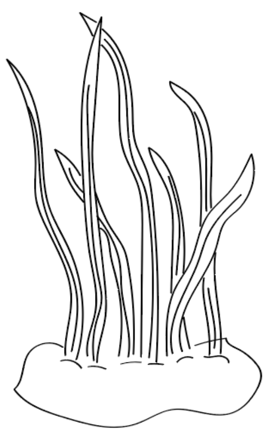
2) To assess their learning, use the exit ticket provided within this packet. This can be used as an exit ticket and will allow students to think critically but also creatively about what they have learned.

References

Fauna. Virginia Institute of Marine Science, Center for Coastal Resources Management. https://www.vims.edu/ccrm/research/ecology/fauna/index.php

Murdy, Edward O., et al. *Field Guide to Fishes of the Chesapeake Bay*. Johns Hopkins University Press, 2013.

Appendix 1: Illustrative cards



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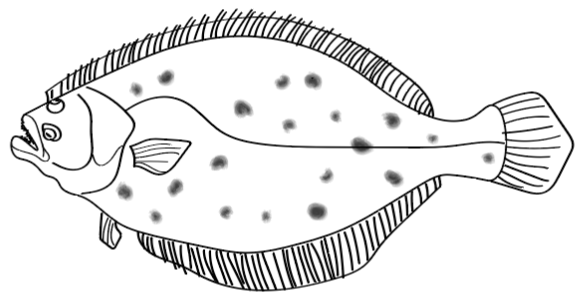

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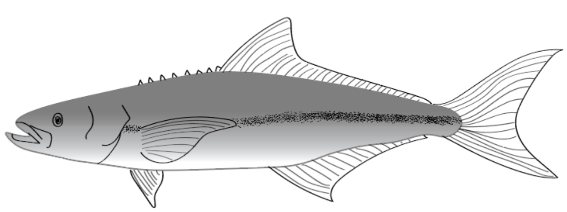

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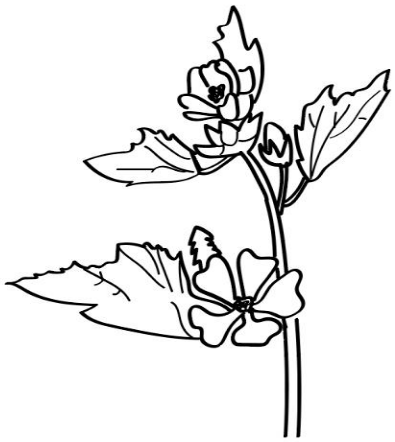

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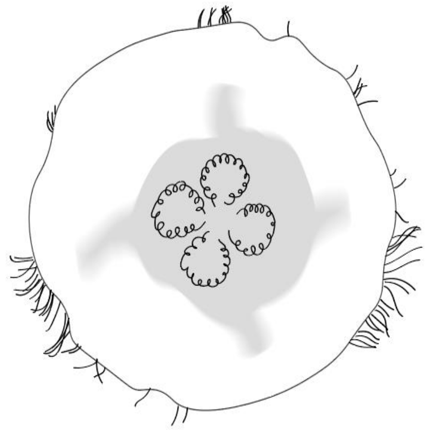

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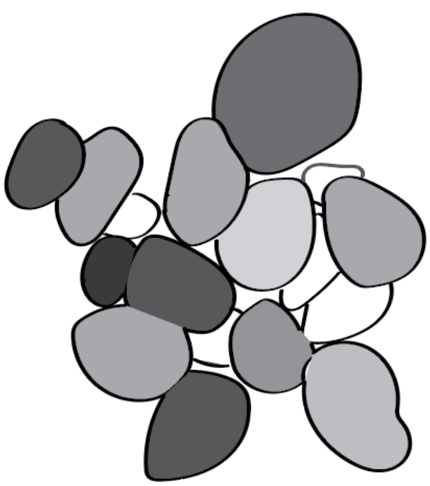

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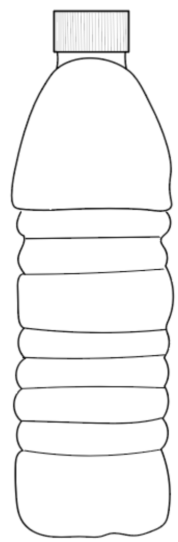

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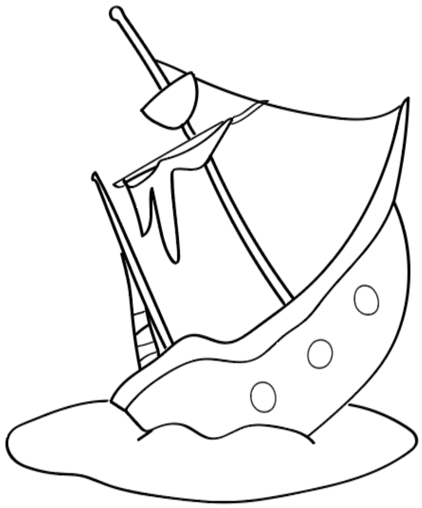

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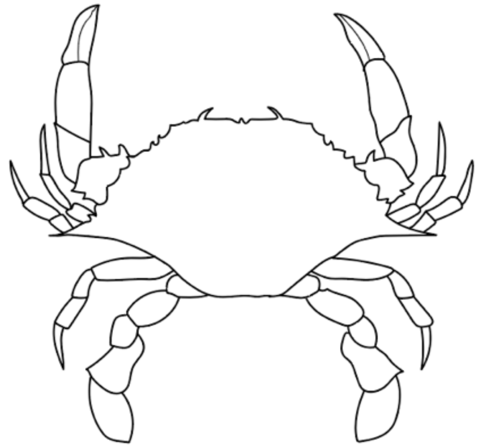

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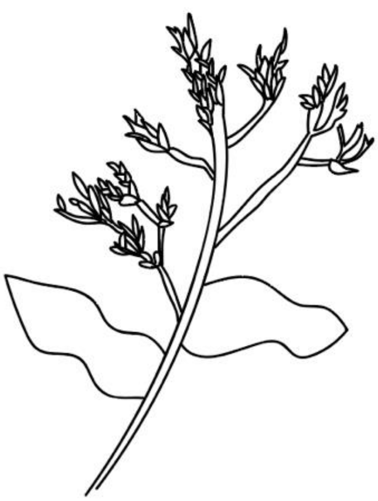

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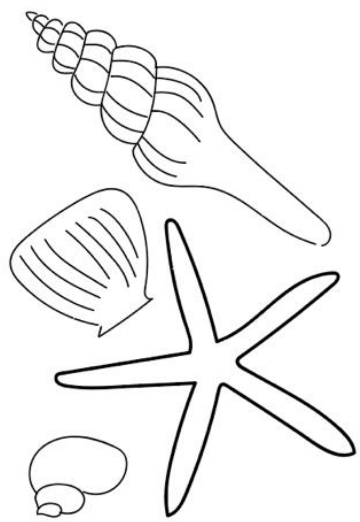

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Appendix 2: Exit Ticket

Name:
Date:

Instructions:

In the space below, draw one animal, one plant, and one non-living thing of your choosing. These can be made-up using the traits we talked about, or something that already exists. Get creative!

Animal:

Plant:

Non-living:

Appendix 3: Card IDs

1) Seagrass (plant), original drawing

2) Flounder (animal), original drawing based on this source

3) Cobia (animal), original drawing based on this source

4) Spartina alterniflora (plant), commonly known as saltmarsh cordgrass, original drawing based on this source

5) Marsh mallow (plant), original drawing based on this source

6) Moon jelly (animal), original drawing based on this source

7) Pebbles (non-living), original drawing based on this source

8) Plastic bottle (non-living), original drawing based on this source

9) Shipwreck (non-living), original drawing based on this source

Product Two: 4^{th} Grade Physical Science Lesson Plan

Deeper and Deeper: An introduction to seafloor geology

Focus: Identifying seafloor features and reading bathymetric profiles

Grade Level: 4th Grade Science

VA Standards of Learning:

4.1c The student will demonstrate an understanding of scientific and engineering practices by c) interpreting analyzing and evaluating data

- Organize and represent data in bar graphs and line graphs
- Interpret and analyze data represented in bar graphs and line graphs
- Compare two different representations of the same data (e.g., a set of data displayed on a chart and on a graph)
- Analyze data from tests of an object of tool to determine whether it works as intended

4.7 The student will investigate and understand that the ocean environment has characteristics. Key characteristics include

a) Geology of the ocean floor;
b) Physical properties and movement of ocean water; and
c) Interaction of organisms in the ocean.

Learning Objectives:

- Students will identify features and basic geology of the seafloor by learning and identifying 3 key features of the ocean floor.
- Students will create a bathymetric profile.
- Students will read and create line graphs.

Total length of time required for the lesson: 1hr (1h30m with preparation time)

Vocabulary:

Geology: The science that deals with the dynamics and physical history of the earth, the rocks of which it is composed, and the changes Earth is undergoing. (Adapted from dictionary.com)

Bathymetry: “The measurement of the depths of oceans, seas, or other large bodies of water” (dictionary.com)

Trench: Long depressions in the seafloor that form at the boundary of tectonic plates. (Adapted from whoi.edu)

Ridge: A long elevated landform separated by the terrain with steep sides. (Adapted from wikipedia.com)

Background Information:

Not mapped or explored until the late 1800s, the ocean seafloor is a vast and mysterious part of our planet. However, when you look a little closer at the surface of the seafloor, you realize that it is just as rolling and diverse as our own terrestrial landscapes. The bathymetry, or measurement of the depth of the seafloor, highlights ridges, trenches, volcanoes, plains, slopes, and even more landforms all out of our sight and under the surface.

Just like throughout the rest of Earth, the seafloor is made of plates, called tectonic plates, that have been active for all of Earth's history that we know of. These plates move at very slow rates, which in turn create the features we see around us such as those trenches, ridges, slopes, volcanoes, mountains, and more. When these plates collide, slide, or move apart, that is when we get the unique features all around us.

In this lesson plan, we will be focusing on three common features: ridges, trenches, and slopes. Ridges are like hills or mountains in the ocean, and they occur when the seafloor plates spread, or move away from each other.

Ridges can look differently depending on the speed of the spreading, but in general they are a large peak on the ocean floor.

Trenches are like valleys or canyons on the ocean floor. These occur when plates collide, or crash with each other. These are where we find the deepest parts of the ocean, and almost alien-like sea life.

Lastly, slopes are like one side of a hill in the ocean. These are less related to tectonic plates moving and more related to sediment, like sand, moving due to the energy of the ocean and building on top of itself. These slopes connect the shallow part of the ocean, where we often swim and snorkel, to the deepest parts where no light reaches.

But how do we even know all of this? Mapping the seafloor first started with what would now be considered pretty rudimentary techniques. On ships out in the open ocean, scientists would cast very long anchors down to the bottom of the ocean and measure how much chain was let out, which would in turn estimate the depth of the ocean. They would do this in certain increments throughout an area to eventually get a comprehensive picture of what the ocean floor would've looked like. Of course, this was incredibly time-consuming and luckily methods improved in the coming decades.

In the midst of World War II, sonar became a much bigger technology that was used to map the seafloor (originally designed to detect submarines) and around this time the study of seafloor geology took off. Now, we have very advanced technologies to map the seafloor and we even have submersibles that can take scientists to it to see it either in person or through a camera! All of this technology has allowed us to gain a comprehensive view of its traits and features.

Understanding the geology that drives the creation of our seafloor's features is a great way to begin to understand the geology that drives the dynamic nature of our whole planet.

Materials & Supplies:

- Play-doh (any color, enough for each student to get a roughly 3x2 slab roughly 1 inch thick)
- Pencils (for the worksheet, per student)
- Laminated bathymetric profiles (per group)

Teacher Preparation:
Students should be in small groups of 2-4 depending on the amount of students. There should be enough room at their station to perform a hands-on activity and write on a worksheet. Most typical seating arrangements should fulfill these needs, but it is something to be cognizant of because this lesson plan will require some play space at their desks.

Procedure:

Activity Set-Up: 30 minutes

1) Before starting the activity, print out and laminate bathymetric profile cards to hand out to students. Each pair or group of students should get one bathymetric profile, so print out as many as needed for the classroom. Alternatively, students can work on this activity individually if the classroom is small.
2) Additionally, print out one worksheet per student to work on throughout the lesson plan.

PowerPoint: 30 minutes

Activity: 30 minutes

1) Hand out the lesson plan worksheets to students along with a tub of Play-Doh.
2) Explain that today, they are going to get to make their very own seafloor.
3) Students can then be instructed to break up into pairs/small groups and each group will then be distributed a laminated bathymetric profile card.
4) Students will then work through the worksheet and use the provided Play-Doh to match the bathymetric profile they received.

5) Ask students to raise their hand and show you their work after they complete question two. This will allow you to ensure that they have an understanding of how to read a depth profile before moving on to the last question.
6) Give them the go ahead to start the last question on the worksheet. If they'd like, they can use their play-doh to mimic that one as well!
7) At the end of the activity, if time allows, you may also have a discussion about what students found and on any questions they may have.

Assessment:
The worksheet given out to students that accompanies the lesson plan can be used as an assessment.
Handouts/Worksheets:

1 Appendix 1: Profile cards
2 Appendix 2: Activity worksheet
3 Appendix 3: Activity worksheet answer key

References:

Bradford E. Prather, Mark E. Deptuck, David Mohrig, Berend Van Hoorn, Russell B. Wynn, 2012. "Application of the Principles of Seismic Geomorphology to Continental-Slope and Base-of-Slope Systems: Case Studies from Seafloor and Near-Seafloor Analogues", Application of the Principles of Seismic Geomorphology to Continental Slope and Base-of-Slope Systems: Case Studies from SeaFloor and Near-Sea Floor Analogues, Bradford E. Prather, Mark E. Deptuck, David Mohrig, Berend Van Hoorn, Russell B. Wynn

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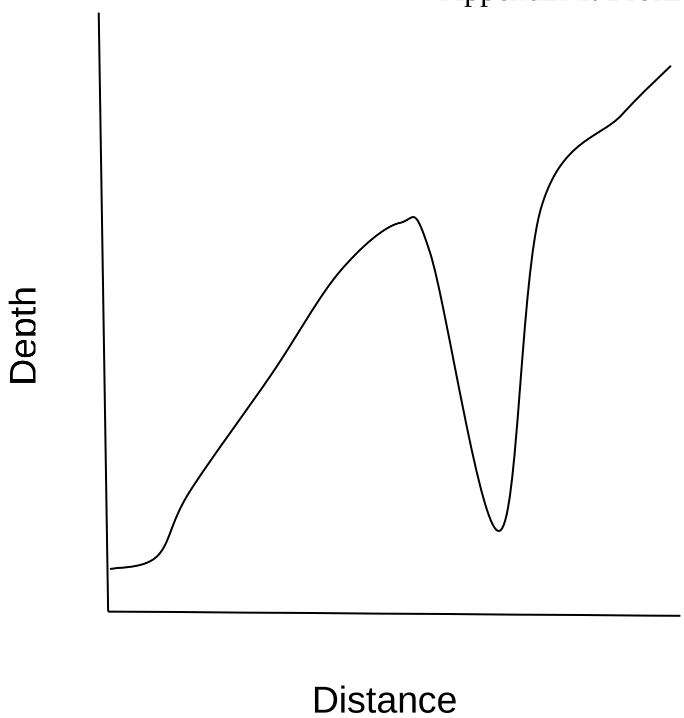
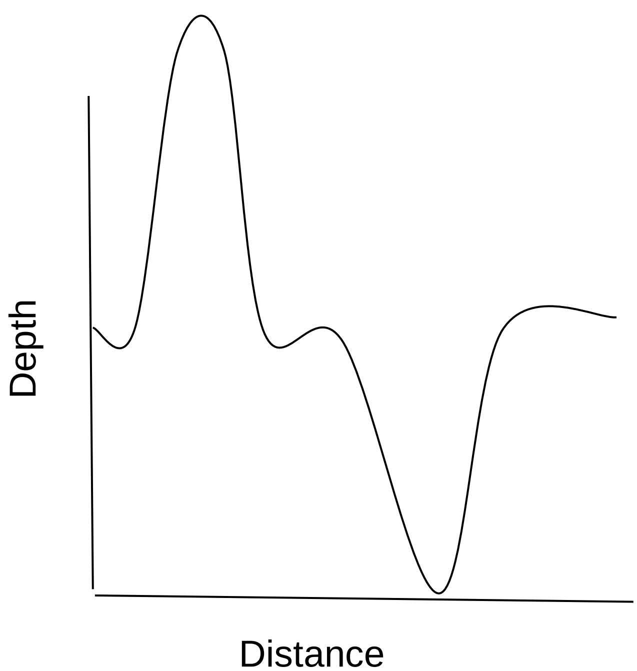
Wang, W. Geological structures of ridges with relation to the definition of three types of seafloor highs stipulated in Article 76. *Acta Oceanol. Sin.* **30**, 125–140 (2011). https://doi.org/10.1007/s13131-011-0154-z

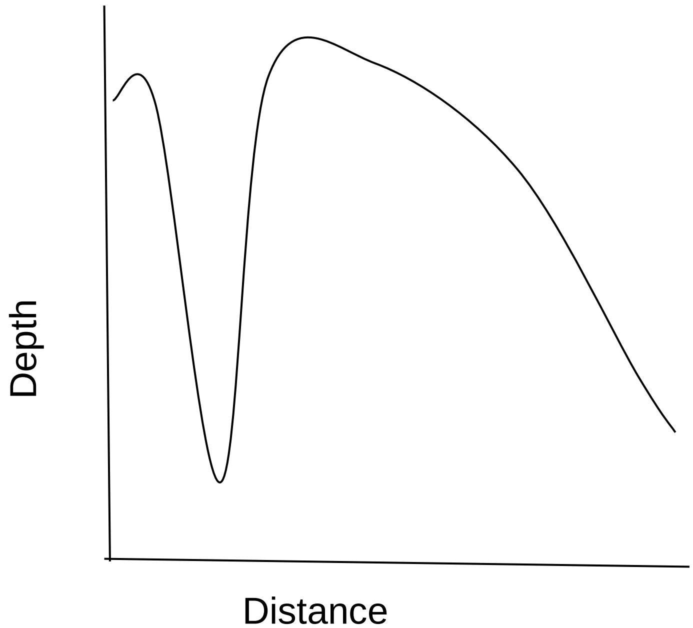
Appendix 1: Profile cards



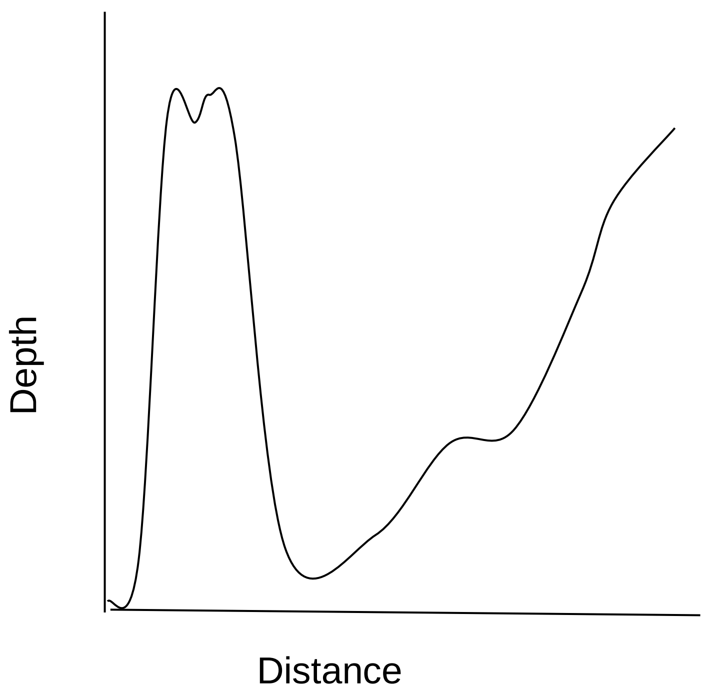
Bathymetric Profile 1 - Slope and Trench



Bathymetric Profile 2 - Ridge and Trench



Bathymetric Profile 3 - Slope and a trench



Bathymetric Profile 4 - Ridge and a slope

Appendix 2: Activity Worksheet

Name:

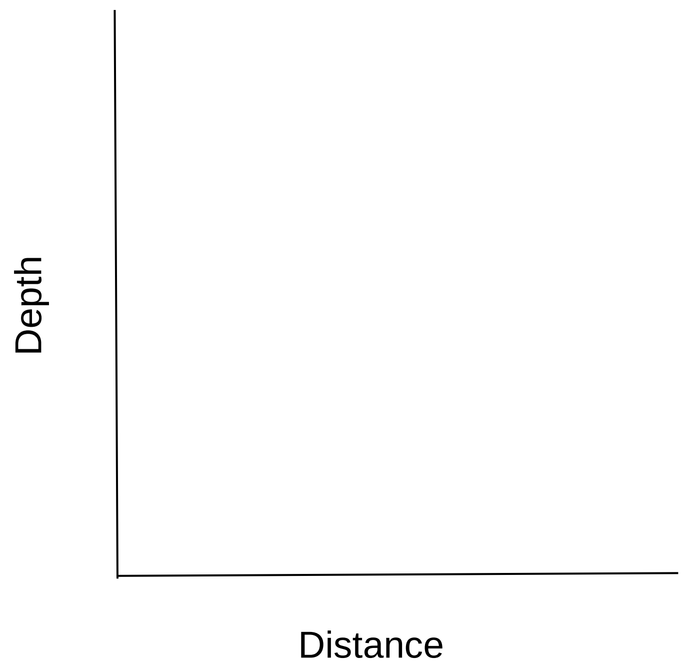
Date:

Seafloor Geology Worksheet

1. Re-draw your seafloor profile in the space below and label any key features (ridges, trenches, slopes)

2. Now take your play-doh and mold it into the bathymetric profile that you received!

3. Taking what you've learned, draw your own bathymetric profile including and labeling two or more key features that we learned about.



Appendix 3: Activity Worksheet Answer Key

Name:

Date:

Seafloor Geology Worksheet

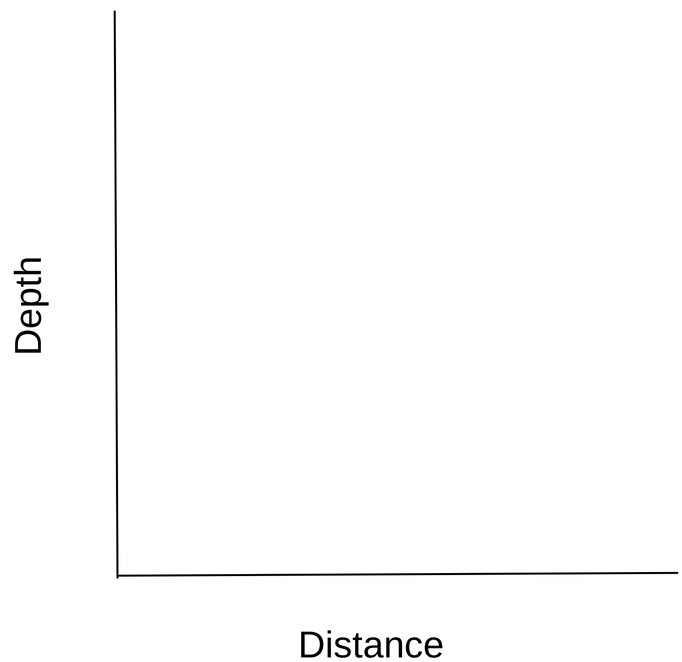
1. Re-draw your seafloor profile in the space below and label any key features (ridges, trenches, slopes)

Students should have a graph with x-axis distance and y-axis depth with a drawing of their own profile that they received.

2. Now take your play-doh and mold it into the bathymetric profile that you received!

Teachers will need to go around the classroom and check for completion for this portion. Have students raise their hand once they are done with this part before they move on.

3. Taking what you've learned, draw your own bathymetric profile below including and labeling two or more key features that we learned about.



Students can have many different creative profiles here. Most importantly, they must include two of the three features they learned about and label them.

Product Three: High School Environmental Justice Lesson Plan

And (Environmental) Justice For All

Focus: Exploring environmental justice in Virginia using a digital tool

Subject: High School Earth Science OR High School US History 1865-Present

Virginia Standards of Learning (all Standards of Learning can be found here):

Environmental Science

ENV.12 The student will investigate and understand that their actions as an environmentally literate citizen will play a role in environmental policies. Key content includes

a) consumer choices in Virginia impact jobs, resources, pollution, and waste here and around the world;
b) environmental justice is the study of the impact of environmental policy including resource allocation, pollution regulations, and waste disposal across all communities;
c) political, legal, social, and economic decisions may affect global and local ecosystems;
d) the media impacts public opinion and public policy;
e) individuals and interest groups influence public policy;
f) environmental decisions should include a cost-benefit analysis and may lead to trade-offs in conservation policy; and
g) different methods are used by local, state, national, and international governments and organizations with varying results to protect the environment.

Earth Science

ES.6 The student will investigate and understand that resource use is complex. Key ideas include

a) global resource use has environmental liabilities and benefits;
b) availability, renewal rates, and economic effects are considerations when using resources;
c) use of Virginia resources has an effect on the environment and economy; and
d) all energy sources have environmental and economic effects

US History 1865-Present

VUS.8 The student will apply social science skills to understand how the nation grew and changed from the end of Reconstruction through the early twentieth century by

a) explaining the westward movement of the population in the United States, with emphasis on the role of the railroads, communication systems, admission of new states to the Union, and the impact on American Indians;
b) analyzing the factors that transformed the American economy from agrarian to industrial and explaining how major inventions transformed life in the United States, including the emergence of leisure activities;
c) examining the contributions of new immigrants and evaluating the challenges they faced, including anti-immigration legislation;

d) analyzing the impact of prejudice and discrimination, including "Jim Crow" laws, the responses of Booker T. Washington and W.E.B. DuBois, and the practice of eugenics in Virginia;
e) evaluating and explaining the social and cultural impact of industrialization, including rapid urbanization; and
f) evaluating and explaining the economic outcomes and the political, cultural and social developments of the Progressive Movement and the impact of its legislation.

Learning Objectives:

- Students will operate an online tool
- Students will interpret results from this tool
- Students will create and explore their own research questions related to environmental justice

Time Required: 1.5hr

Vocabulary:
Systemic: An issue that is fundamental to social, economic, or political practice (adapted from merriam-webster.com)
Watershed: A region bounded by a divide that marks where all drainage goes to a particular body of water (adapted from merriam-webster.com)
Pollution: The action of making the environment unsafe through man-made waste (adapted from merriam-webster.com)
Superfund Site: A site designated by the Environmental Protection Agency as needed to be cleansed of contaminants (adapted from epa.gov)
Redlining: The act of refusing a service to someone because they live in an area that is perceived to be a financial risk (adapted from Oxford Languages)
Socioeconomics: The interaction between social and economic factors (adapted from Oxford Languages)

Background Information:

Environmental justice is a wicked problem. As a systemic issue that is rooted in centuries of history, it can be difficult to understand how all of the confounding factors influence one another and create the whole picture.

Historically underserved and underrepresented communities face a variety of unique problems that are important to understand. Especially in the face of climate change, we are already seeing unprecedented issues that are only being exaggerated with changing climate such as sea level rise. Additionally, coastal communities face unique issues simply because of their geographic position. Coastal communities may face issues like sea level rise, increased coastal flooding, coastal erosion, increased extreme weather events, and more.

Some of the issues that this lesson plan will highlight are demographics, coastal flooding, and lack of green space.

You may be wondering why underserved and underrepresented communities are often at a higher risk for being subjected to these issues. One of the things that is often used to explain this is an occurrence called redlining. Redlining is a practice in which neighborhoods, often in large cities, are categorized by their "riskiness" for mortgage loans. Neighborhoods that are considered "hazardous" are often BIPOC populations - which also leads to inequities in instances like healthcare access, school funding, and in many cases, environmental injustices. Redlining is a historical issue that has been around for almost a century, and is a large reason why you often see certain neighborhoods with higher demographic homogeneity.

The Elizabeth River Project Environmental Justice Tool aims to ameliorate that issue by including a variety of factors into one tool. By narrowing down the study area to Virginia's Elizabeth River watershed, or area that drains into the Elizabeth River, the tool has a wide range of data and visualizes how those data interact with one another. Between demographics, public green space, temperature, pollution, and more, the tool attempts to view environmental justice as it is: a holistic, non-isolated, and wicked problem.

This lesson plan will instruct both the educator on how to use and teach the tool, as well as pose a series of questions and prompts for students to explore with the tool. Included are resources for the teacher to become familiar with the tool, as well as a guide for how to teach the tool to students.

Materials:

- Worksheets (Appendix), one per student. These can be printed out or provided and submitted virtually depending on preference. Please note that although the worksheet features color, it does not need to be printed in color.
- Writing utensils (if printed worksheet), one per student
- Laptops, one per student

Classroom Set-Up: Students should be at their desk, with a laptop and worksheet for each student. Students can be encouraged to collaborate and discuss parts of the worksheet, but it is not required to pair or group up students.

Procedure:

Introduction - 20 minutes: Introduce the Elizabeth River Project Tool using the video provided. At the end of the video, have students open up the tool on their computers.

Activity - 60 minutes: Hand out a worksheet to each student or have them open it up on their laptop (depending on the educator's preferred method). Have students work through lesson plans on their own, or if needed work through the first question or two as a group before starting independent work. Assist students with any questions they may have.

Wrap-up: 10 minutes: Collect worksheets at this time and ask students if they have any questions. Encourage students to share what their individual research question was and what they found interesting about the tool.

References:

Nelson, R.L., Winline, L, et al. (2023). *Mapping Inequality: Redlining in New Deal America*. Digital Scholarship Lab. https://dsl.richmond.edu/panorama/redlining

Environmental Justice Tool Assignment

Name: ___________________

Date: __________

For this assignment, you will be using the Elizabeth River Project Environmental Justice Tool to explore certain environmental justice topics and create a question of your own. Please follow the directions below and answer the questions when prompted. The questions you need to answer will be **bolded**.

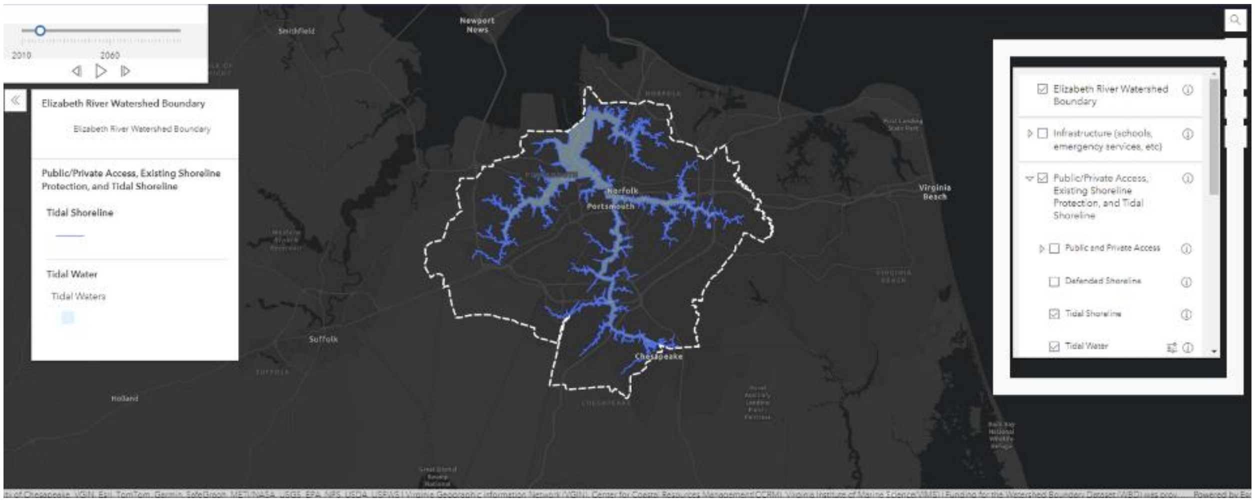
1. Open up your laptops and go to this link: https://cmap22.vims.edu/EREJTool/

2. Scroll down to the map. Zoom out using the + and - buttons in the top left corner of the map. **What state is this map focusing on?**

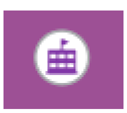
3. Zoom back in to the area where the data is highlighted (see picture below)

4. Right now you are looking at the Elizabeth River watershed boundary. Find the layer titled "Public/Private Access, Existing Shoreline Protection, and Tidal Shoreline". Turn it on. Then deselect Public and Private Access and Defended Shoreline so you can see the water bodies in the area. **In your own words, what is a watershed?**

5. On the right side of the map, you can see all of the different data that are included in the tool (see picture below, highlighted in white). Then check the box that says "Infrastructure".

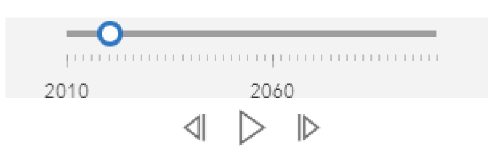


6. On the left side of the map, there is a legend that shows what each symbol means. What does the symbol below represent?



7. Go ahead and deselect infrastructure. Scroll back down to socioeconomics and select it again. Click the sideways arrow to see which options are selected. **Below, identify two socioeconomic layers included in the tool.**

8. Select "Percent People of Color". Then scroll up and select the "Sea Level Rise & Storm Surge" box. You should now notice a bar at the top left of the screen with years (see picture below)

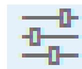


9. Take a look at the legend. Note that lighter colors are less intense sea level rise and darker colors are more intense sea level rise. Using the + button at the top left, zoom into the area between Portsmouth and Norfolk. **Without moving the scrollbar at the bottom of the page (it should be at year 2020), what do you notice about the relationship between Sea Level Rise and Percent People of Color?** (Hint: Look at the relationship between the red colors and the blue colors. Are darker sea level rise areas in darker percent people of color areas? What about the reverse?)

10. Now use the scrollbar at the bottom to go to year 2100. **How did the sea level rise distribution change?**

11. What do you notice about the relationship between Sea Level Rise and Percent People of Color now?

12. Zoom back out to the original extend of the map. Keep Percent of People of Color selected but deselect Sea Level Rise. Select Public Green Space. **What do you notice about this relationship and based on historical factors you are aware of, why might this relationship exist?** Is there green space in areas with a high percentage of people of color? (Hint: You may need to increase Public Green Space transparency using the icon pictured below)



(To increase transparency, use the slider bar to move transparency up or down)

13. Now that you are a little more familiar with the tool, you are going to create and explore a question of your own. Look at the different options and choose two to select to see how they work together (Hint: A socioeconomic selection is a great choice for one of your options!) **Which two are you selecting?**

14. **Now, write a research question to explore** (Hint: for the Percent People of Color and Sea Level Rise example, a question would look something like: What is the relationship between Percent People of Color and Sea Level Rise over time?)

15. Now that you have your research question, explore the area. You may explain trends throughout the whole map extend or zoom into a smaller area. **What is the answer to your research question? If it isn't answerable or if there isn't a relationship, explain why you think so.**

Environmental Justice Tool Assignment Answer Key

Name: ___________________

Date: __________

For this assignment, you will be using the Elizabeth River Project Environmental Justice Tool to explore certain environmental justice topics and create a question of your own. Please follow the directions below and answer the questions when prompted. The questions you need to answer will be **bolded**.

1. Open up your laptops and go to this link: https://cmap22.vims.edu/EREJTool/

2. Scroll down to the map. Zoom out using the + and - buttons in the top left corner of the map. **What state is this map focusing on?**

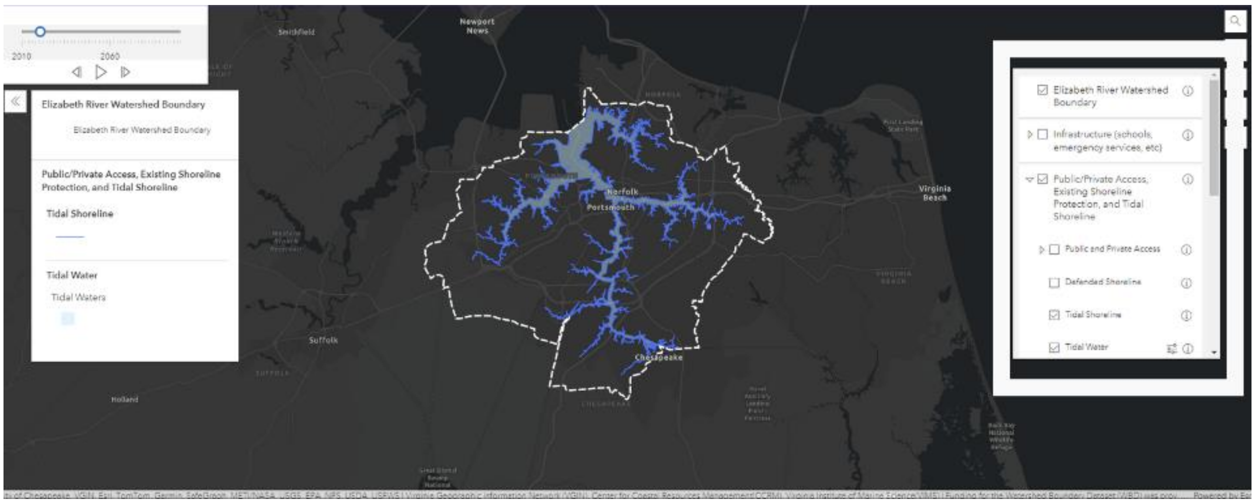
Virginia

3. Zoom back in to the area where the data is highlighted (see picture below)

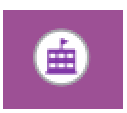
4. Right now you are looking at the Elizabeth River watershed boundary. Find the layer titled "Public/Private Access, Existing Shoreline Protection, and Tidal Shoreline". Turn it on. Then deselect Public and Private Access and Defended Shoreline so you can see the water bodies in the area. **In your own words, what is a watershed?**

A region bounded by a divide that marks where all drainage goes to a particular body of water (any answer similar to this is acceptable)

5. On the right side of the map, you can see all of the different data that are included in the tool (see picture below, highlighted in white). Then check the box that says "Infrastructure".



6. On the left side of the map, there is a legend that shows what each symbol means. What does the symbol below represent?


School

7. Go ahead and deselect infrastructure. Scroll back down to socioeconomics and select it again. Click the sideways arrow to see which options are selected. **Below, identify two socioeconomic layers included in the tool.**

Any combination of two of the socioeconomic layers is correct. Layers include: Demographic index, Supplemental demographic index, percent people of color & race/ethnicity, percent low income, percent unemployment rate, percent limited English speaking, percent less than high school education, percent individuals under age 5, percent individuals over age 64

8. Select “Percent People of Color”. Then scroll up and select the “Sea Level Rise & Storm Surge” box. You should now notice a bar at the top left of the screen with years (see picture below)

9. Take a look at the legend. Note that lighter colors are less intense sea level rise and darker colors are more intense sea level rise. Using the + button at the top left, zoom into the area between Portsmouth and Norfolk. **Without moving the scrollbar at the bottom of the page (it should be at year 2020), what do you notice about the relationship between Sea Level Rise and Percent People of Color?** (Hint: Look at the relationship between the red colors and the blue colors. Are darker sea level rise areas in darker percent people of color areas? What about the reverse?)

There are many acceptable answers here. They may note that in many areas, sea level rise seems to be impacting communities with a higher percentage of people of color. They may also note that there are a variety of impacts for a variety of communities. Any observation with proper reasoning is valid.

10. Now use the scrollbar at the bottom to go to year 2100. **How did the sea level rise distribution change?**

Sea level and storm surge impacts worsen over time.

11. **What do you notice about the relationship between Sea Level Rise and Percent People of Color now?**

There are many acceptable answers here. They may note that more communities in general are impacted by sea level rise, that more communities of color are impacted by sea level rise, or that sea level rise is impacting all communities regardless of percent of people of color.

12. Zoom back out to the original extend of the map. Keep Percent of People of Color selected but deselect Sea Level Rise. Select Public Green Space. **What do you notice about this relationship and based on historical factors you are aware of, why might this relationship exist?** Is there green space in areas with a high percentage of people of color? (Hint: You may need to increase Public Green Space transparency using the icon pictured below)

(To increase transparency, use the slider bar to move transparency up or down)

This answer is a little more cut and dry but there are still a variety of interpretations. Students should notice that public green space tends to be seen primarily in areas with a low percentage of people of color. They may also note that in this more urban area, there is not much public green space at all except for in one area. They may have a variety for reasons of why this is though, such as redlining, military bases, urbanization, etc.

13. Now that you are a little more familiar with the tool, you are going to create and explore a question of your own. Look at the different options and choose two to select to see how they work together (Hint: A socioeconomic selection is a great choice for one of your options!) **Which two are you selecting?**

Many acceptable answers here. Examples: Percent linguistic isolation and Superfunds, Natural Resources and Percent individuals under the age of 5, etc

14. **Now, write a research question to explore** (Hint: for the Percent People of Color and Sea Level Rise example, a question would look something like: What is the relationship between Percent People of Color and Sea Level Rise over time?)

Again, many acceptable answers here. Any question that relates to their two selected criteria is acceptable.

15. Now that you have your research question, explore the area. You may explain trends throughout the whole map extend or zoom into a smaller area. **What is the answer to your research question? If it isn't answerable or if there isn't a relationship, explain why you think so.**

Their interpretations may vary, which is okay. If there is no relationship, it is important that they answer the "explain why you think so" with an inference for why their two selected criteria may not correlate. They should be able to write three sentences for this question that explains what they see represented by the tool and how their criteria may overlap.