Supplement B: Background Information: **Environmental Observation**

Changing Climate and Maryland's Land Changes in the Chesapeake Region

The Chesapeake Bay is rising at two to three times the rate of worldwide sea levels. It rose more than a foot over the past 100 years compared to an average 4 to 8 inches during the same amount of time in other regions. *Rising water is frequently attributed to "climate change". Whatever the cause, there is no question that the water level in the Chesapeake Bay is getting higher. This is caused by a combination of the sea rising 3 to 4 millimeters per year and subsidence, otherwise known as "land sinking", at about 1.3-7 millimeters per year. There are several technical reasons for subsidence to occur. However, 80 % of the time it is caused when we remove water and other materials from the earth, leaving a void underground, which can cause land to sink under the right circumstances. Erosion from the land that is then redeposited in other areas in large amounts also contributes to subsidence.*

The land in the Chesapeake region has been sinking over the past 1,000 to 2,000 years. The rise in sea levels is a relatively new phenomenon and part of a global trend. As the earth warms, polar ice caps melt, the volume of water in the oceans expands, and sea levels rise.

Maryland has 7,700 miles of coastline. The effect of local man-made structures, such as seawalls, bulkheads and homes on the shoreline is difficult to determine. It is already easy to observe areas of land on the eastern shore in homeowners' yards that are now wet most of the year that would not have been 35 years before. More than 13 islands in the bay have disappeared as of 2017.

According to scientific studies, sea level rise appears to be accelerating. The bay is very likely to rise 2 to 5 feet more by the end of this century. Scientists also predict more intense storms, bigger water surges during storms, and higher high tides. Policymakers need to make tough decisions on where to spend limited resources to protect the shoreline.

Reference:

Sea level Rise (Rising Seas Part 1: Sea level, sinking land put Maryland's waterfront communities at risk.)By Len Lazarick July 28, 2013)

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Climate Change and the Chesapeake Bay The ... 25,000 copies of the map are being © 2017 The Conservation Fund

Erosion and Shoreline Background Information

Erosion is the process of wind, rain, and waves moving soil from one place to another, such as from the land to the water. While erosion is a natural process, it can be made worse by human development. Clearing land, for example, quickens the pace of erosion by removing trees and other plants which play a large role in erosion prevention by anchoring the soil in place with their roots.

Waterfront landowners face the challenge of keeping their property from eroding away. The most common method is building up a retaining wall called a **bulkhead**, made from wood or synthetic materials. The Maryland Department of the Environment (MDE) banned the building of bulkheads in tidal areas, except for the replacement of pre-existing bulkheads. In areas of high wave action, **rock riprap revetments** are also used.

Wooden Bulkhead

Riprap Revetment

While bulkheads and riprap revetments do a fair job of keeping their landowner's property intact, they present some problems. Bulkheads and riprap revetments don't provide the grassy wetland habitat needed by various aquatic animals, such as small or baby fish, molting crabs, and other crustaceans. Bulkheads also suffer wear and tear and eventually need to be replaced, putting more expense on the landowner. Additionally, bulkheads and riprap don't diffuse wave energy; they simply pass it on to cause erosion on adjacent properties, as well as the churning up of the underwater soil, so that submerged aquatic vegetation (SAVs) cannot grow.

Living Shoreline

Living shorelines present an environmentally-friendly alternative. Using bio-logs made from coconut or other natural fiber, stakes, sand, and many native wetland plants, we can build a natural shoreline that serves the same purpose of preventing erosion and provides much needed habitat for aquatic life. The MDE now prefers the installation of living shorelines as the best erosion-prevention method in areas with low wave action. Even in areas with moderate wave action, living shorelines can be installed as long as they're protected by rock riprap.

Supplement C

Discussion Points and Questions

Motivation/Warm-up – Poster Discussion

Point	Discussion
Animals	Birds, turtles, and other wildlife depend on shorelines for food and habitat.

	Riprap and bulkheads limit their ability to find food and shelter.
Plants	Submerged aquatic vegetation (SAVs) - plants such as underwater grasses and are important sources of food and habitat for wildlife.
Bulkheads	Bulkheads are man-made wooden structures put in place to help prevent shoreline erosion. However, the water beats against the bulkhead instead of being slowed down. This action against the bulkhead prevents wildlife from being able to live there. Bulkheads are usually built with chemically treated wood to preserve the wood; these chemicals often leech into the water and are toxic to wildlife. They are now banned in tidal areas.
Riprap	Riprap is man-made rock structure to help prevent shoreline erosion. Due to the rough surface area, rock riprap slows the water on the way in and on the way out. However, because there is no plant life, they do not provide shelter or food for wildlife and don't make good habitats.
Living Shoreline	Living shorelines are plants put in place to prevent erosion. They slow water on the way in and on the way out. The plants provide shelter and a food source for wildlife. Submerged plants (SAVs) also provide dissolved oxygen in the water through the process of photosynthesis. They also filter out excess nutrients carried from the land and preventing them from entering the water.

Assessment

Question	**Answer**
What are the physical characteristics of the different types of shorelines?	Bulkheads are hard and flat, riprap is hard but has many gaps, the living shoreline has many grasses, etc.
Why do you think people build different types shorelines?	The living shoreline provides habitat and food for grass shrimp, small fish, larvae, molting crabs, and many other creatures. Bulkheads and riprap don't provide sheltered habitat for wildlife. They also don't diffuse wave energy; they simply pass it on to cause erosion on adjacent properties, as well as churning up of the underwater soil, so that submerged aquatic vegetation (SAVs) cannot grow. People might build riprap and bulkheads because they don't require the same amount of maintenance as living shorelines and are cheaper to implement.
Which is the best way to prevent shoreline erosion?	Building living shorelines with native grasses is the best way to prevent shoreline erosion. These decelerate waves from boats and storms which cause shoreline damage. Grasses also slow down and filter stormwater runoff from the land and provide habitat for aquatic animals. Rock riprap and wooden bulkheads help prevent erosion but they don't dampen the waves. They provide only limited habitat, and they don't filter or slow down runoff from the land. Often erosion will develop behind these structures over time. These

	structures also make it difficult for amphibians and terrestrial animals to get in and out of the water to preform activities such as building nests and laying eggs.
When you canoed into the cove toward the wetland, did you notice a difference between the plants on the left compared to the plants on the right?	There is less diversity on the left than on the right. The plants on the left are a nonnative, invasive species called phragmites. Phragmites grows so aggressively that it does not allow other plants to grow. Phragmites can also threaten rare and endangered plants. The right side of the cove is a natural wetland with many different kinds of native plants such as cord grass and cattails. These native plants provide food for animals (pollen, nectar, fruits, roots and seeds) and provide more habitat for birds, insects and other animals.

Supplement D: Poster