How Green Is It? Instructions

In this activity you will answer an environmental science question using data that reflect *real patterns* discovered on the eastern shore of Virginia. Results may surprise you!

1. Discuss the following in your group. Have one member of your group write down the group's answers.

a) Do you think *Gracilaria* will negatively impact microalgae?

b) What color and wavelength do you expect to see reflected where *Gracilaria* is present (hint *Gracilaria* is a red macroalga)?

c) What colors do you think are NOT absorbed when microalgae is present?

3. Look at your Reflectance and Absorbance Data Sheet. On the top part of the table you have reflectance data collected from Oyster Harbor and Willis Wharf mudflats. Mudflats were divided into four sampling areas. The bottom part of the table contains microalgae absorbance data collected from the sediment at both mudflats.

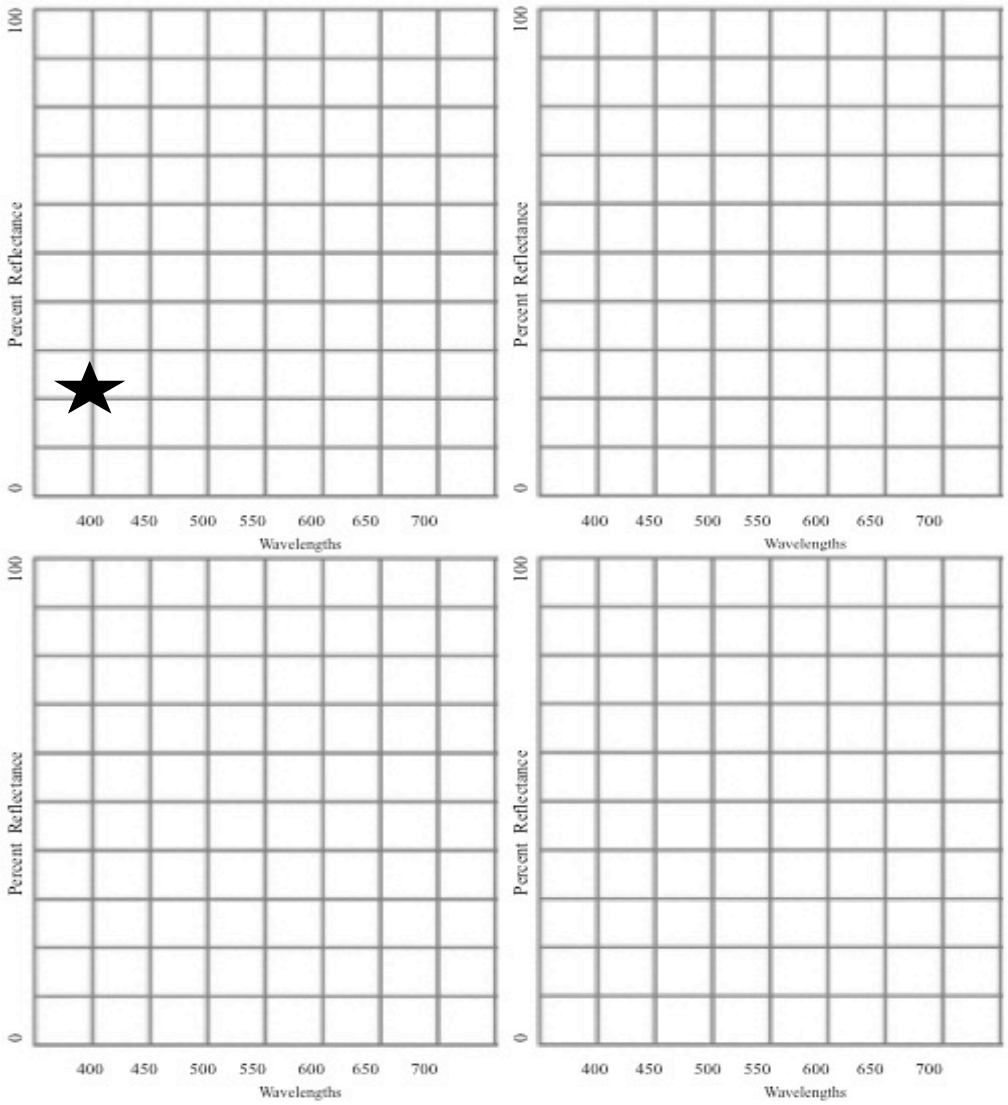
4. Begin plotting the reflectance data onto the coordinate planes below on pages 2 and 3. There are four coordinate grids, one for each sampling area of the mudflat. Label each coordinate plane with the appropriate sampling area number as you fill in the data. The first point has been plotted for you. Plot all of the points, and then connect them with a smooth line to create a reflectance spectrum.

5. Next color in the Oyster Harbor Colored Mudflat Figure 1 and Willis Wharf Colored Mudflat Figure 1. Look at the reflectance spectra you have drawn. You can identify if *Gracilaria* is present if **RED** wavelengths are **reflected**. In the real world it is not as simple as identifying a threshold reflectance- **but for this exercise if colors in the red and near-red wavelengths are reflected at ≥ 50% then consider *Gracilaria* to be present and color the sampling area in red**.

6. Now move on to plotting the microalgae absorbance data. Once again use the data from the data sheet, label your coordinate planes with the appropriate sampling area number, plots all of the points then connect them with a smooth line to create an absorbance spectrum.

7. Remember absorbance is a proxy for how much chlorophyll is present in the sediment. If microalgae has died, there will be less chlorophyll. Chlorophyll **reflects GREEN** light and **absorbs RED AND BLUE-VIOLET light**. Color in the Colored Mudflat Figure 2 for both sites on pages 4 and 5. **A sampling area should be colored in GREEN to represent the presence of microalgae if absorbance is ≥ 50% for light 400 nm and 650 nm.**

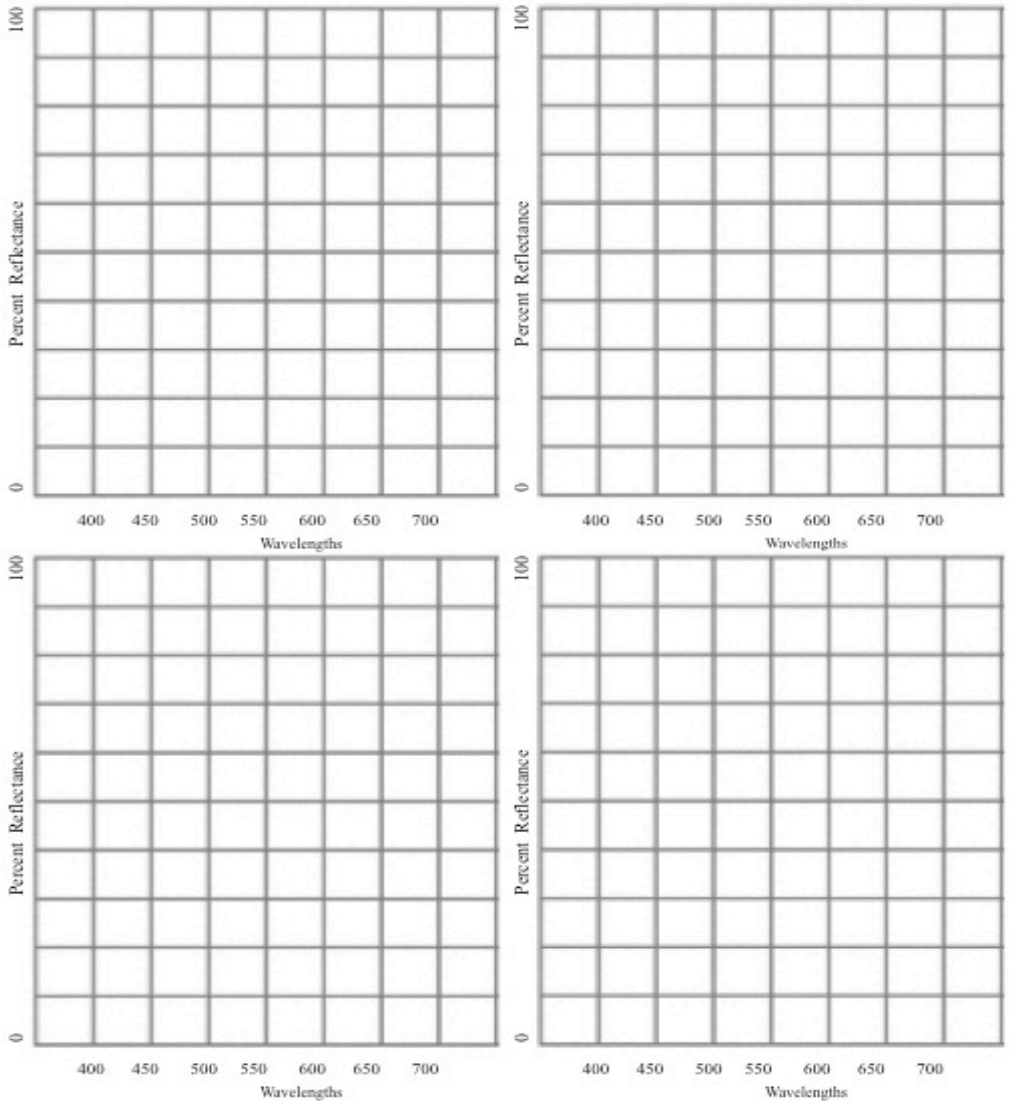
Oyster Harbor Mudflat Reflectance Plots



Oyster Harbor Colored Mudflat Figure 1

Sample Area 1	Sample Area 2
Sample Area 3	Sample Area 4

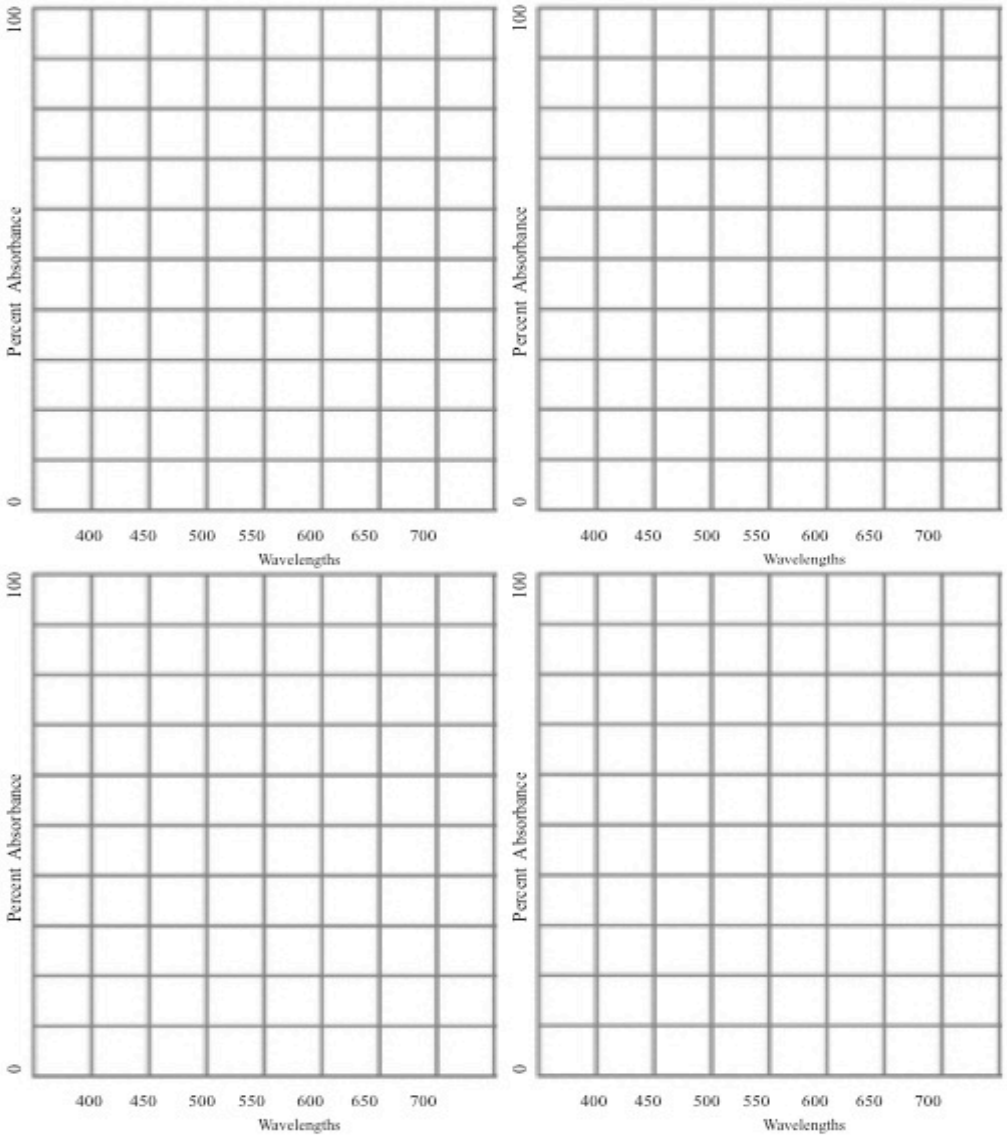
Willis Wharf Reflectance Plots



Willis Wharf Colored Mudflat Figure 1

Sample Area 1	Sample Area 2
Sample Area 3	Sample Area 4

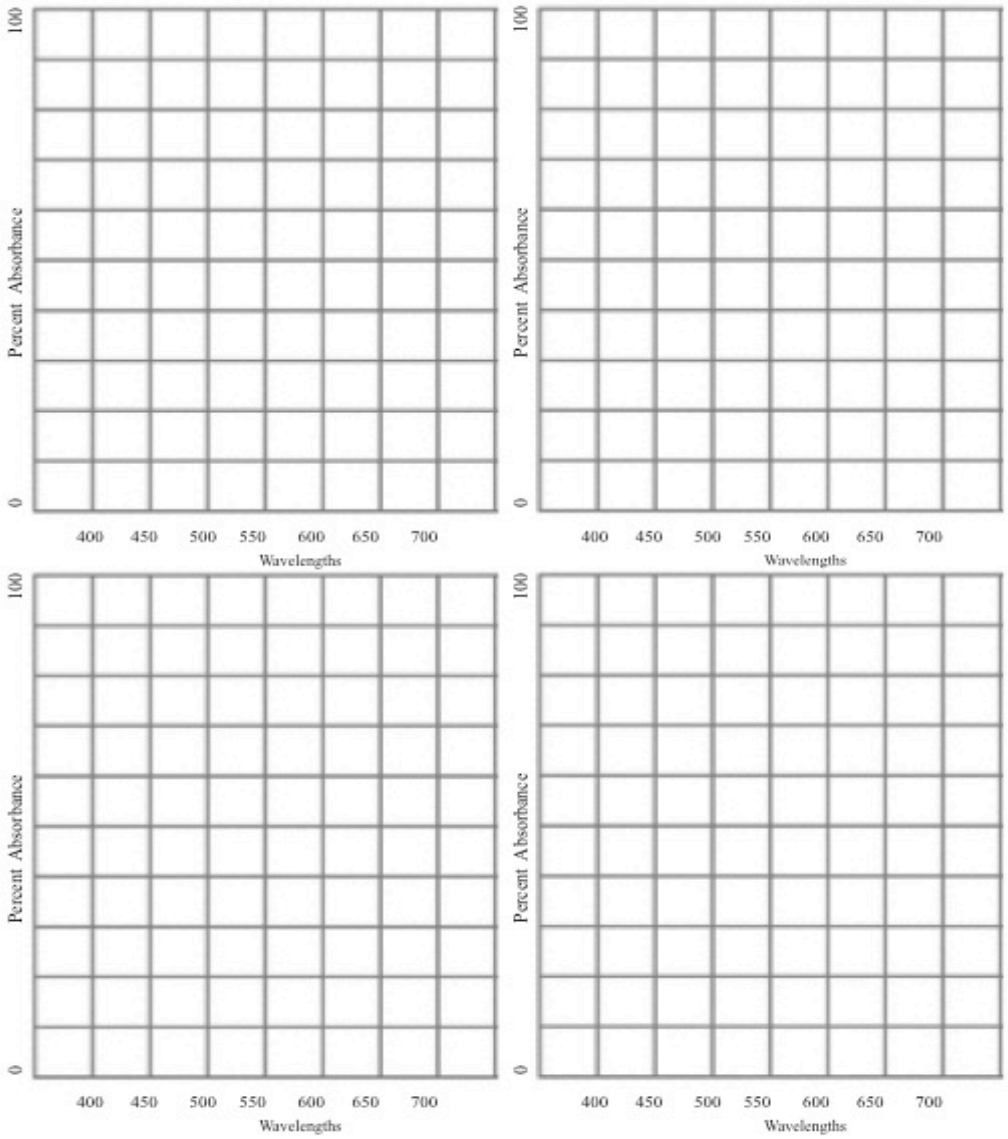
Oyster Harbor Absorbance Plots



Oyster Harbor Colored Mudflat Figure 2

Sample Area 1	Sample Area 2
Sample Area 3	Sample Area 4

Willis Wharf Absorbance Plot



Willis Wharf Colored Mudflat Figure 2

Sample Area 1	Sample Area 2
Sample Area 3	Sample Area 4

Analysis and Discussion- Entire Group

1. *Did Oyster Harbor or Willis Wharf have* Gracilaria *growing? What about microalgae? Fill in the table below with a "Present" or "Absent" using your colored mudflat figures.*

		Gracilaria	Microalgae
Oyster Harbor			
	Sampling Area 1		
	Sampling Area 2		
	Sampling Area 3		
	Sampling Area 4		
Willis Wharf			
	Sampling Area 1		
	Sampling Area 2		
	Sampling Area 3		
	Sampling Area 4		

2. *If you have a "Present" for Gracilaria and "Absent" for Microalgae what would you conclude? What if you have both present?*

3. From these results do you think *Gracilaria* is negatively affecting native microalgae?

4. Should managers spend time trying to control *Gracilaria* based on this research?

		Macroalgae (Seaweed) Reflectance Data						
		Wavelengths						
		400nm	450nm	500nm	550nm	600nm	650nm	700nm
Oyster Harbor	**Sample Area**							
	1	20%	20%	20%	20%	20%	20%	20%
	2	5%	5%	5%	30%	80%	80%	80%
	3	20%	20%	20%	20%	20%	20%	20%
	4	5%	5%	5%	30%	80%	80%	80%
Willis Wharf	**Sample Area**							
	1	20%	20%	20%	20%	20%	20%	20%
	2	20%	20%	20%	20%	20%	20%	20%
	3	20%	20%	20%	20%	20%	20%	20%
	4	20%	20%	20%	20%	20%	20%	20%

		Microalgae Absorbance Data					
		Wavelengths					
		400nm	450nm	500nm	550nm	600nm	650nm
Oyster Harbor	**Sample Area**						
	1	80%	0%	0%	0%	20%	80%
	2	70%	0%	0%	0%	0%	60%
	3	70%	0%	0%	0%	10%	70%
	4	50%	0%	0%	0%	0%	90%
Willis Wharf	**Sample Area**						
	1	80%	0%	0%	0%	10%	80%
	2	60%	0%	0%	0%	5%	60%
	3	70%	0%	0%	0%	7%	70%
	4	90%	0%	0%	0%	15%	90%

The Problem

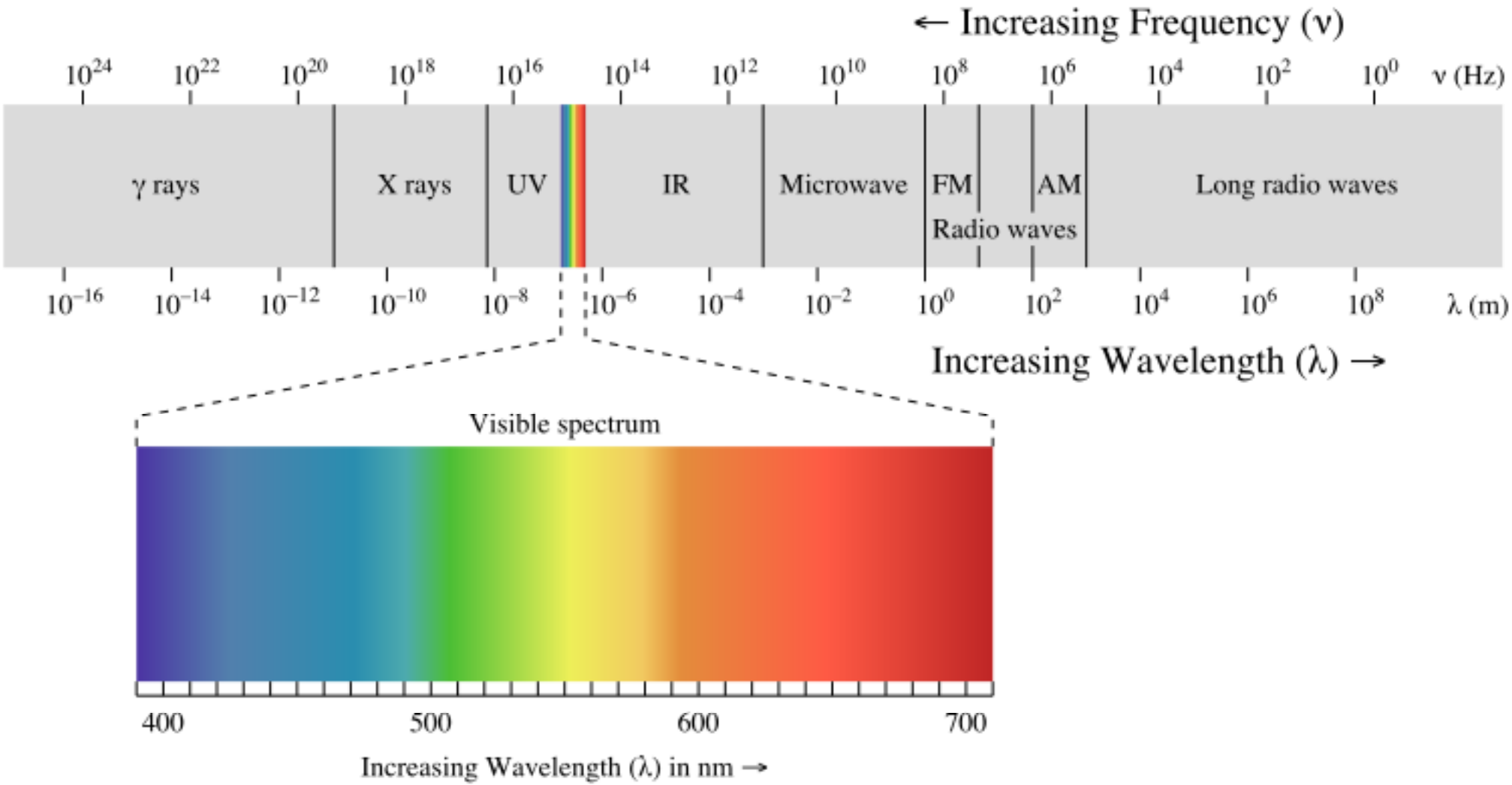
"An invasive red macroalga (or "seaweed") from Asia can be found along many of the coastlines in the United States. An invasive organism is one that has been moved by humans to a place where it is not originally from. Often invasive plants and animals can grow without any limitation similar to a weed in your garden. The coastline of Virginia is very important for many fish, birds, crabs, and other animals. Larger animals eat smaller animals like insects and worms, and those small animals consume microalgae. Microalgae grows on the surface of muddy intertidal areas called mudflats. Microalgae grow in a slimy mat on the mud surface; they are photosynthetic and contain chlorophyll.

When the invasive alga *Gracilaria* grows over these mudflats microalgae become shaded. Since microalgae require light to photosynthesize, there may be less microalgae, which means less food for insects and worms, and then less food for animals like birds and fish! Your job is to figure out where the invasive macroalga *Gracilaria* is and determine whether it is killing the microalgae.

To do this, you will apply your knowledge of the electromagnetic spectrum and visible light! Satellites can collect information on the surface of earth in a process called remote sensing (remote means far away). This information includes what color is being reflected by surfaces. Using this information we will figure out whether two of the mudflats in Virginia, one in Willis Wharf and one in Oyster Harbor have *Gracilaria* growing on them.

Then, we need to determine if *Gracilaria* is killing the important microalgae. To do this we are going to collect samples of the mud and look for the pigment called chlorophyll in the sample using a machine called a spectrophotometer. This will give us an *approximate* idea of how much microalgae is present (more chlorophyll = more microalgae). As you should remember, chlorophyll is the pigment in plant cells that absorbs energy the plant uses to make sugar. A spectrophotometer measures how much light is absorbed in different wavelength ranges.

We know which wavelengths chlorophyll absorbs (blue-violet and red). By measuring how much light is absorbed at those wavelengths we can figure out how much chlorophyll is in the sediment, and therefore figure out it microalgae is present. In this case, we will look at how much microalgae is present on the mudflat at Willis Wharf and at Oyster Harbor to figure out if *Gracilaria* has a negative impact on microalgae."


← Increasing Frequency (ν)
10^{24} 10^{22} 10^{20} 10^{18} 10^{16} 10^{14} 10^{12} 10^{10} 10^{8} 10^{6} 10^{4} 10^{2} 10^{0} ν (Hz)
γ rays
X rays
UV
IR
Microwave
FM
AM
Radio waves
Long radio waves
10^{-16} 10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^{0} 10^{2} 10^{4} 10^{6} 10^{8} λ (m)
Increasing Wavelength (λ) →
Visible spectrum
400
500
600
700
Increasing Wavelength (λ) in nm →