Student Data Sheet 1

Name _____

Date _____

Latitude (e.g. 75° N)_____ Longitude (e.g.18°W) _____

Recent weather conditions:

Current weather (circle one) Clear Partly Cloudy Fog Overcast Rain Snow

Air Temperature _____°C or °F

Wind Speed _____mph_

Water Sample: (circle one from each category)

Type of water: Freshwater ------Brackish------Seawater

Clarity of water: Clear------Cloudy------Muddy

Odor of Water: Fishy ------Rotten Egg------Gas------No Smell

Surface conditions: Calm------Light chop------Heavy chop with white caps-----Ice

Condition of the water (check one box for each category)

	Many	Few	None
Suspended particles/debris in the water?			
Plants or algae in the water?			
Any visible living species?			

WATER INDICATOR	Local Site	Local CBIBS	Compare/Contrast
Dissolved Oxygen (ppm)			
Salinity (ppt)			
Water Temperature °C/°F			
Turbidity (cm/m)			
pH			
Water Depth (cm/m)	NA		

Surrounding Area

Landmarks and description of the site:

Which of these are nearby? Land use descriptions and wildlife observation (check all that apply):

_____FARMS	_____LIVESTOCK FARMING	_____POULTRY
_____HOUSES	_____FACTORIES	_____STORES
_____PARKING LOT	_____WALKWAYS	_____EMPTY LOT
_____CARS	_____TRUCKS	_____BOATS
_____ QUARRY	_____LOGGING	_____CONSTRUCTION

_____ WOODS _____TREES _____PLANTS
_____LIVESTOCK _____DOGS/Pets
Others (Please specify):
_____

Describe the soil in detail, sketch and /or take some photographs of the surrounding area. This will enable you to note any changes in the area later, such as erosion caused by a major storm or new development on the shoreline.

Can you say that the area is covered with porous (water moves through easily) or impervious (water cannot move through easily) material? (Circle one)

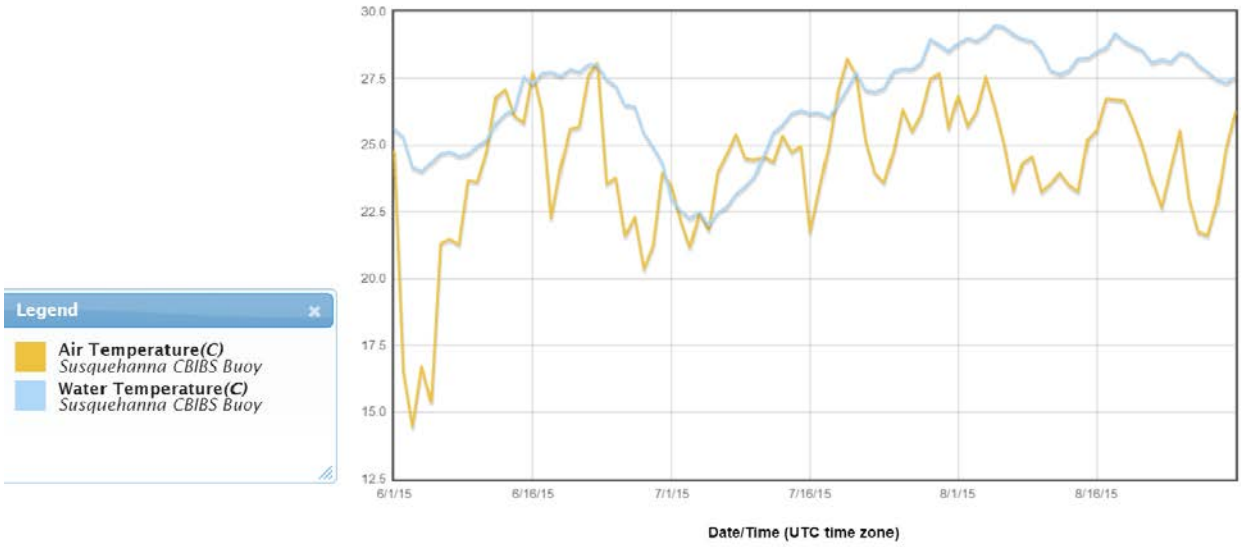
MOSTLY POROUS IN THE MIDDLE MOSTLY IMPERVIOUS

Is there any evidence of water runoff and/or erosion? (Circle one) YES NO

If yes, what do you think is/are the possible cause(s)?

Student Data Sheet 2

Scientists measure Bay water temperatures, turbidity (clearness of the water) and other indicators to monitor the health of the Chesapeake Bay. We will take a look at some archived data from the Chesapeake Bay Buoy system data to help answer some questions about the relationships between water quality indicators.



The air and water temperature graph below is from the Susquehanna Buoy between June 1 and August 30, 2015. (Temperatures are degrees Celsius)

1. What is the air highest temperature?

2. What do you notice in the changes in air temperature compared to the water temperatures?

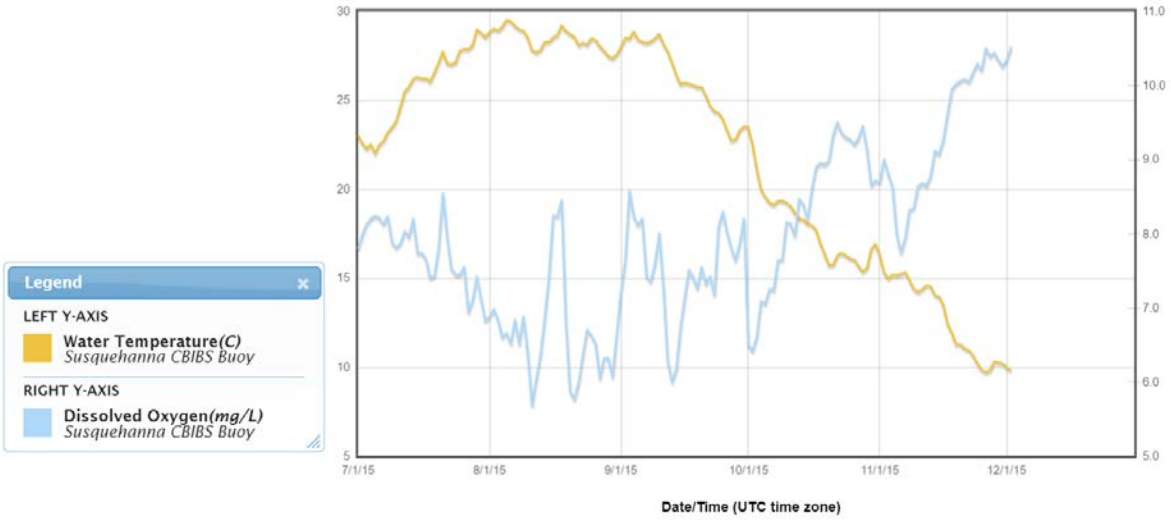
3. Why do you think that the water temperatures have a smoother plot than the air temperatures?

4. What weather events might cause the dramatic changes in the air temperatures?

Dissolved oxygen levels are influenced by temperature and salinity. The solubility of oxygen, or its ability to dissolve in water, decreases as the water's temperature and salinity increase.

To survive, fish, crabs, oysters and other aquatic animals must have sufficient levels of dissolved oxygen (DO) in the water. The amount of dissolved oxygen in the Bay's water is the major factor that determines the type and abundance of organisms that can live there. Oxygen enters the water through two natural processes: (1) diffusion from the atmosphere and (2) photosynthesis by aquatic plants. The mixing of surface waters by wind and waves also increases the rate at which oxygen from the air can be dissolved or absorbed into the water.

The graph below compares water temperature and the amount of dissolved oxygen from July 1 to December 31, 2015. (Note that mg/L is used here instead of ppm for dissolved oxygen)

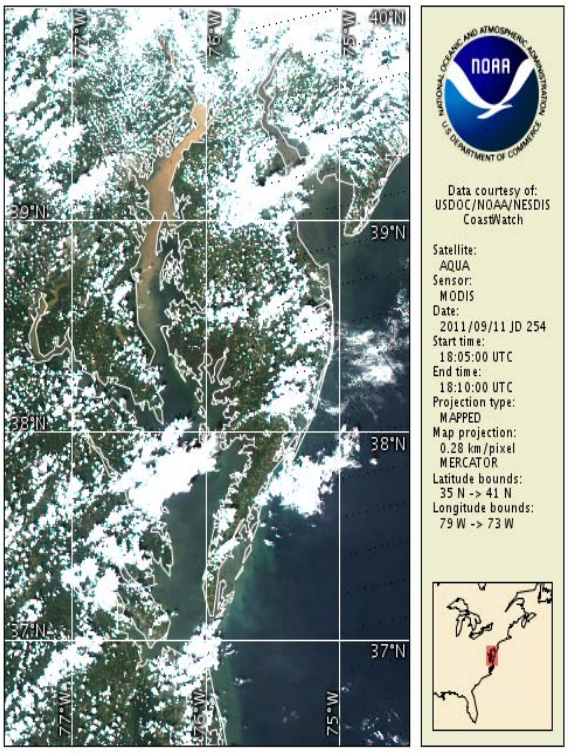


5. What do you notice about the pattern of water temperature over the 6 months compared to the dissolved oxygen?

6. What kind of relationship would we say exists between temperature and dissolved oxygen?

   Proportional - when one goes up, the other goes up
   Inverse proportional – when one goes up, the other goes down.

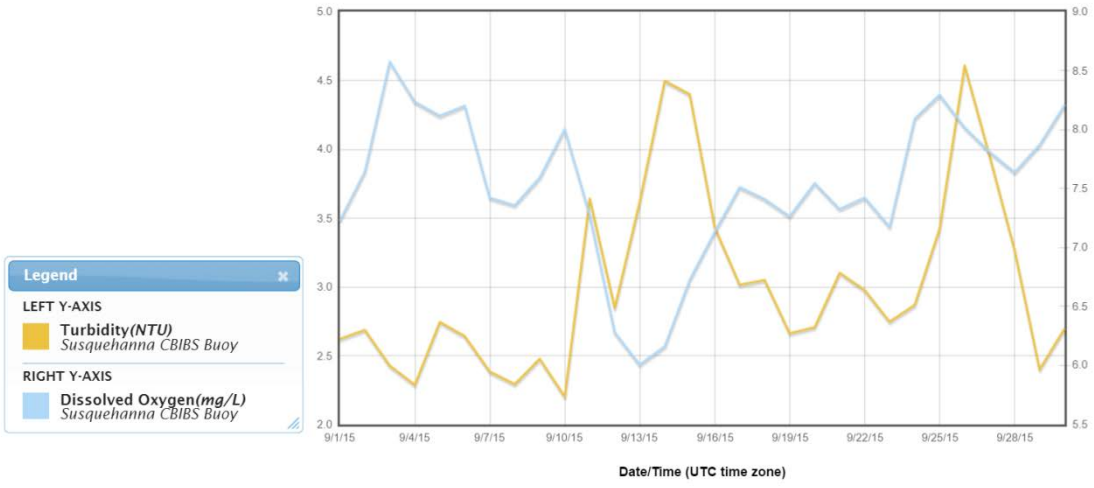
7. Less oxygen dissolved in the water is often referred to as a "dead zone" because most marine life either dies, or, if they are mobile, such as fish, leave the area. Habitats that would normally be teeming with life become, essentially, biological deserts. Go to this site. http://oceanservice.noaa.gov/facts/deadzone.html. What is the primary cause of these zones?



Turbidity in water is caused by suspended matter, such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water. Turbidity also includes plankton and other organisms, and the cloudier the water, the greater the turbidity. The effects of large amounts of rainfall around the Bay's watershed make the turbidity change. Turbidity of natural waters tends to increase during runoff events because of increased overland flow, stream flow, and erosion.

In this image, a "plume" of water carrying sediment and debris is entering the Bay from the Susquehanna River (on the top of the image) can even be seen by satellites.

The turbidity of the Bay's water affects life above and below the surface. Water clarity is influenced by weather events such as droughts and rain storms. When rains fall in the watershed, it carries sediments that eventually lead to the Bay. This combines with decaying plant and animal matter, sewage, and industrial wastes to form suspended particles in the water, causing it to be more turbid because the particles scatter light. Clear waters are healthier waters. Turbidity affects organisms that are directly dependent on light, like aquatic plants, because it limits their ability to carry out photosynthesis. This, in turn, affects other organisms that depend on these plants for food and oxygen. The graph below compares turbidity and dissolved oxygen from September 1 to September 30, 2015. (Note that mg/L is used here instead of ppm for dissolved oxygen)



8. What kind of relationship would we say exists between turbidity and dissolved oxygen? (Circle one)

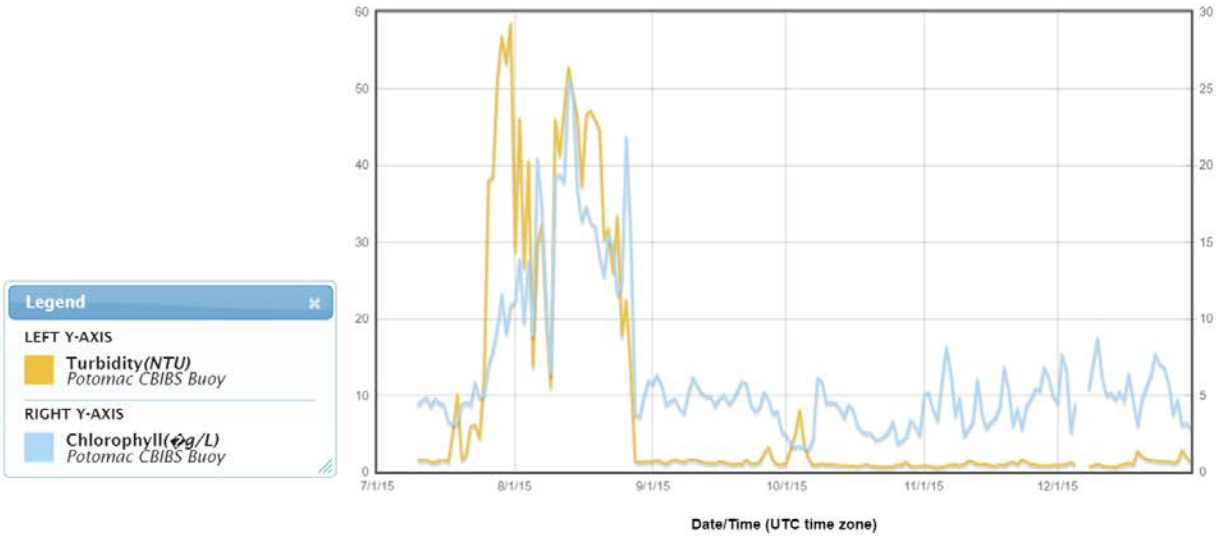
   Proportional - when one goes up, the other goes up
   Inverse proportional – when one goes up, the other goes down.

9. In mid-September, there is a spike in turbidity and a drop in dissolved oxygen. What weather event might have caused this?

10. Animals are dependent on the amount of dissolved oxygen that is available in the water for respiration. Compare the graph with the fish listed below and determine if any of these fish species were at risk during September. (Numbers are the Lowest DO at which fish survived for 24 hours in summer)

    - Black Bass - 5.5 ppm
    - Common Sunfish - 4.2 ppm
    - Yellow Perch - 4.2 ppm
    - Black Bullhead - 3.3 ppm

Plants only produce oxygen when light is available for photosynthesis, and turbidity reduces the amount of light in the water. The chart below is from data at the Potomac CBIBS buoy from July 1 to December 31, 2015 comparing turbidity and chlorophyll produced from phytoplankton.



11. The turbidity and chlorophyll patterns are very similar. Why do these seem to be connected?

12. There is a delay between the rises and drops of turbidity and corresponding chlorophyll levels. Why?

13. On October 5, a spike of turbidity resulted in a quick drop in Chlorophyll. What weather event might have caused this disturbance?

14. The oyster population in the Bay is less than 1% of what it once was. It has been estimated that oysters were once able to filter all the water in the Bay in about a week. The sharp decrease in the number of oysters means that it now takes the current oyster population about a year to filter the same amount of water. Degrading water quality is both a cause and an effect of the oyster decline, because fewer oysters mean less filtration capacity. But oysters, as hardy as they are, can be killed by prolonged periods of low dissolved oxygen at the Bay's bottom. From your investigation into water quality, what water parameters do you think are most important to the Bay's health?

    In what ways can repopulating the Bay with oysters contribute to the overall quality of the Bay's water?

Student Data Sheet 3
Water Quality Parameters and Effect on aquatic organisms

Let's look at several water quality parameters and their influence on oyster populations.

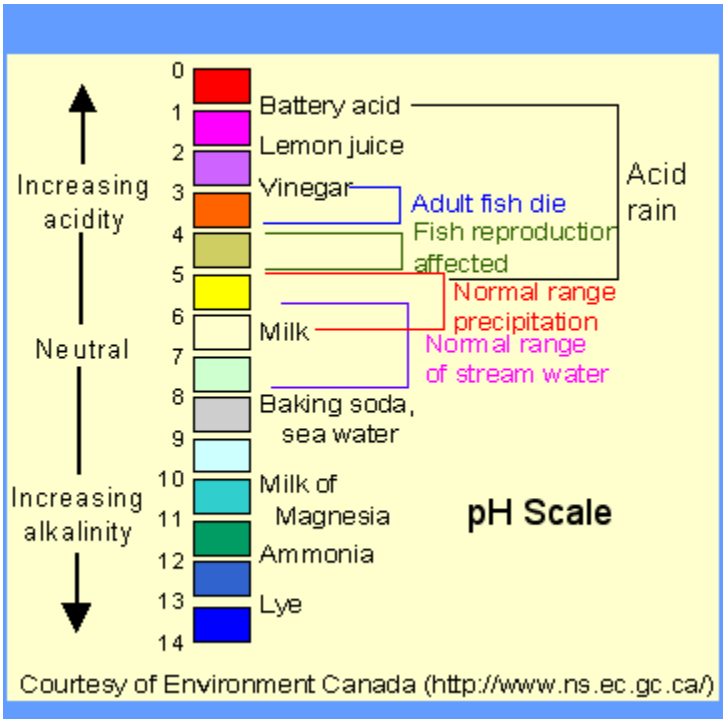
Dissolved oxygen plays a role in oyster survival and growth. Low dissolved oxygen can result in oyster mortality. In shallow waters where nutrient pollution runs high, oxygen levels can plummet to nearly zero at night. Oysters living in these zones are far more likely to pick up the lethal Dermo disease. Researchers at the Smithsonian Environmental Research Center exposed oysters to low-oxygen cycles similar to those in the Bay. Some had constant levels of normal dissolved oxygen concentrations (about 7 milligrams dissolved oxygen/liter), some dropped to 1.5 mg/L for a few hours each day, and some dropped to 0.5 mg/L.

1. What was the dissolved oxygen at your test site?

2. What time of day was the test done?

3. Is your reading in the normal range?

pH is measured on a scale of 1 – 14 with 7 being neutral. The lower the number the more acidic a solution is; the higher the number the more basic it is. Acidity is increasing in some regions of the Chesapeake Bay even faster than is occurring in the open ocean. These more acidic conditions in key parts of Chesapeake Bay reduce rates of juvenile oyster shell formation and growth. Inputs of nutrients from sewage systems and agriculture promote increased phytoplankton populations in the upper Bay. As these plants grow, they absorb large amounts of carbon dioxide from the water column, thereby making waters in that region less acidic. When the algae decompose, the pH becomes more acidic because the algae respiration and decomposition. This results in the release of carbon dioxide making it significantly more acidic.

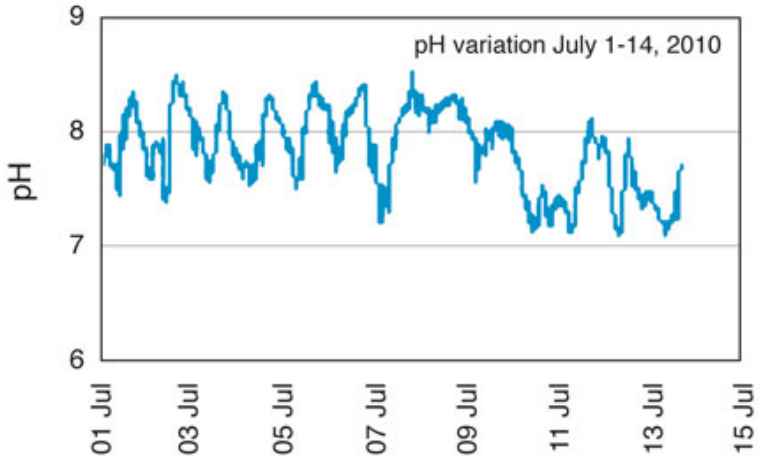


The eastern oyster can spawn in water with pH between 7.8 and 8.2, and has difficulties in pH that is lower than 6 or higher than 10. Larvae mortality rates increase rapidly when the pH is in the 9.00 to 9.50 range. The pH also affects the respiration rate, and the pumping rate of water over the gills.

4. Would oysters be able to live and reproduce with the pH of your local stream?

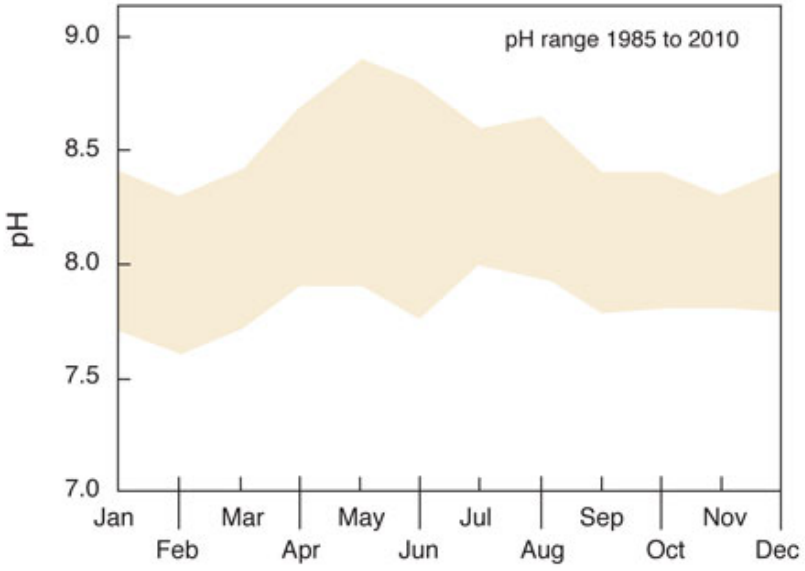
Measuring pH in the Bay is a challenge. Levels can vary widely over time and at different locations.

The graph on the right shows the variation of pH over 14 days in July 2010 at Fort Howard.
Source: Maryland Department of Natural Resources, *Eyes on the Bay.*



5. What might have caused the decrease in pH between July 10 and 11?

6. Would oysters be able to spawn in this area?



The graph on the left shows the ranges of monthly pH at one station in the Bay, Cedar Point, from 1985 to 2010. The wide plot shows many years of data.
Source: Maryland Department of Natural Resources, *Eyes on the Bay.*

7. In general, at what time of year is the pH the highest?

8. What might account for this increase of pH (less acidic)?

Salinity
Oyster reefs can be found in a wide salinity range (12 ppt to 28 ppt). Extreme salinity fluctuations affect the survival, growth, and distribution of oysters that form reefs. During severe storms, salinity changes occur in estuaries which may promote oyster diseases. The ideal salinity range for growth and development is 10 to 22 ppt. Salinity below 10 ppt inhibits spat set. Seed oyster production does well within a salinity range from 10 to 15 ppt.

9. What was the salinity at your site?

    Is it within the salinity range for oyster grown and development?

    Is it within the salinity range for oyster reproduction?

Nitrates are essential nutrients used by plants and animals for maintenance and growth (building protein), but too much can be toxic. Oysters are tolerant of high nitrates compared to other marine species and can remove excess nitrogen from the water. Some of it is absorbed in the shell and flesh where it is stored. It is thought that the oyster also takes nitrogen (N) from the water and converts it into harmless nitrogen gas. Oysters are powerful filters. (We will learn more about this in the next activity). The U.S. Public Health Service has established 10 mg/L of nitrate-nitrogen as the maximum contamination level allowed in public drinking water.

10. Compare the nitrate-nitrogen level of your site to the maximum allowed in drinking water.

Turbidity
Although oysters filter water and improve its quality, a big increase in turbidity can influence oyster reef growth and survival. Too much from storms or tides can smother oyster larvae, and disturb the filter feeding process of oysters, affecting their growth and development. High levels of sediment can cause permanent changes in the oyster reef community. Oysters can be overwhelmed and buried by heavy sedimentation. Waters with low concentrations of total suspended solids (TSS) are clearer and less turbid than those with high TSS concentrations.

11. What was the Secchi or turbidity reading at your site?

Was there a recent weather event that might have affected the level of turbidity at your site?

Temperature
Oysters spawn at temperatures greater than $60.^0$F. Adult oysters grow well at 50^0 to 80^0F or higher, but the most favorable temperatures are 77^0 to 79^0F.

12. Were the water temperatures at your site within the range for adult oysters?

    Were the water temperatures high enough for oysters to spawn?