Title: **Lake Waterford Fish Kill**		
Overview:	At the conclusion of this lesson students will be able to • Make use of authentic water quality data tables from the Eyes on the Bay website. • Explain the importance of water quality monitoring stations in helping scientists determine the causes for changes in fish populations.	
Grade:	Upper Elementary Middle School	
Standards	NGSS	• 3-LS4-3 – Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well and some cannot survive at all. • 3-LS4-4 – Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change • 5-ESS3-1 – Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. • 3-5- ETS1-2 – Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • MS-ESS3-3 – Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
	Core Idea	Ecosystems: Interactions, Energy, and Dynamics
	Practices	• Asking questions and defining problems • Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations • Obtaining, evaluating, and communicating information
	Cross-Cutting Concepts	• Cause and effect • Stability and change
	Reading, Writing and Social Studies	• CCSS.ELA/Lit.SL.4-5.1 - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics and texts, building on others' ideas and expressing their own clearly. • CCSS.ELA/Lit.SL.6-8.1 - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly. • CCSS.ELA/Lit.RST.6-8.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
	Environmental Literacy	• 1.A.1 – Identify an environmental issue • 4.B.1 – Analyze the growth or decline of populations and identify a variety of responsible factors

		• 5.A.2 – Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes. • 7.A.1 – Investigate factors that influence environmental quality

	Description	Resources
Engage	• Ask students whether any of them watch crime shows on TV, like CSI. How do the detectives or forensic experts solve a case? What sorts of things do they look for? *Answers may include physical clues like fingerprint or blood stains, autopsy results, toxicology studies, etc.* • Suppose the "victims" were fish; why might scientists be concerned about a large number of dead fish? *Because whatever was causing the fish to die might cause serious damage to the environment, affect the commercial and recreational fisheries, or be dangerous to humans.* • In the case of a fish kill, what sorts of things might scientists do to determine the cause? *Look at water quality, do necropsies and toxicology studies on the fish, test the water for the presence of toxic chemicals, etc.*	
Explore	Tell the students that there has been a fish kill in Lake Waterford in Anne Arundel County. This fish kill is an actual event that occurred in March 2010. Since they can't necropsy the fish, they are going to have to use water quality data to try to determine the cause. • Give the students a copy of the Student Worksheet. Tell them that the information they need will be found on the worksheet. • Explain that they are to try to determine not only the direct cause, but also the indirect cause or causes.	Student Worksheet
Explain	• Once the students think they have figured out the "mystery", have them read http://mddnr.chesapeakebay.net/eyesonthebay/documents/Magothy_monitoring_story2010.pdf • What caused the fish kill? *Low dissolved oxygen.* • What often causes a sudden severe drop in dissolved oxygen? *An algal bloom probably occurred. When the algae died, the process of decomposition used up the oxygen.* • What usually triggers an algae bloom? *Excess nutrients.* Where might these nutrients have come from in Lake Waterford? *The area around the lake is very developed with a lot of impervious surface. There had been heavy rains earlier in the month which would have washed pet waste, excess lawn fertilizer, etc. off the roads and into the lake.*	Computer with Internet access
Extend	Have students design posters, brochures, etc. to inform the community about the possible effects of lawn fertilizer or pet waste on the local waterway.	

Teacher Background:

This activity is based on an event that occurred in Lake Waterford in Anne Arundel County. Lake Waterford is a 12 acre, man-made lake, created by a dam near the headwaters of the Magothy River. The area around the lake is surrounded by development, mostly suburban homes, with a lot of impervious surfaces. On March 23, 2010, a day after DNR stocked the lake with 700

rainbow trout, approximately 500 dead fish, many of them trout, were found floating in the lake.

Scientists from the Maryland Department of the Environment were called in to investigate. They discovered that the dissolved oxygen levels in the lake were less than 1 mg/L. Most fish, but especially trout which require high dissolved oxygen levels, cannot survive levels this low for more than a few hours. On March 25, water quality data from DNR's Monthly Monitoring Station downstream in the Magothy river showed that the dissolved oxygen level in the river was still very low (0.80 mg/L).

The scientists concluded that the immediate cause of death was low dissolved oxygen in the lake, which may have lasted for several days. The low oxygen level was probably triggered by an algae bloom fueled by nutrients washed off the land by the earlier heavy rains (over 3 inches of rain across much of Maryland). When the algae ran out of nutrients, they died and the process of decomposition used up the oxygen.

Lake Waterford Fish Kill – Student Worksheet

You work for the Maryland Department of the Environment and one of your duties is to investigate fish kills.

On March 22, 2010, the Maryland Department of Natural Resources stocked 700 rainbow trout in Lake Waterford in Anne Arundel County. The following day, 500 dead fish were found floating on the surface of the water. Lake Waterford is formed by a dam near the headwaters of the Magothy River and is a popular fishing lake. Your job is to try and figure out what caused the fish to die, since you obviously do not want people fishing there if there is a problem.

You know that the area around the lake is surrounded by development, mostly suburban homes, with a lot of impervious surfaces (roads, driveways, rooftops, and parking lots). You also read the following article:

> *The heavy rainstorms of mid-March 2010 resulted in over 3 inches of rain across much of Maryland. In addition to the heavy rains, rapidly melting snow cover in western Maryland and Pennsylvania, and saturated soils caused the rain and snowmelt to run off streets, parking lots, buildings, residential yards and farm fields, filling neighborhood stormwater facilities and downstream culverts, small creeks and wetlands. This surge of water carrying excessive nutrients, sediments and other pollutants continued downstream to rivers, and then eventually down to the Chesapeake Bay. Continued wet spring weather could extend these high freshwater flows that might result in less underwater grasses, an increase in algal blooms and an early onset of Bay "dead-zones."*
>
> http://mddnr.chesapeakebay.net/eyesonthebay/documents/March2010RunoffEvent.pdf

The water in the lake has already been tested for toxic chemicals and the results came back negative, so you know that's not the answer. There are no water quality monitors in Lake Waterford, but there is a monthly monitoring station downstream in the Magothy River. Maybe the information from the downstream station will give you a clue, so you pull up the data on dissolved oxygen, water temperature, and turbidity.

You know that rainbow trout require the following water quality parameters:

- Dissolved oxygen – greater than 5.0 mg/L
- Water temperature – ideal temperature range is between 50° and 60° F but rainbow trout can survive warmer water than other species of trout
- pH – 6.5-8.5

The data tables include the “Mean” or average data for each month. You want to compare the March 2010 data with the Mean data for March.

Magothy River - Dissolved Oxygen (mg/L)				
Month	**Minimum**	**Mean**	**Maximum**	**2010**
January	4.10	8.91	14.00	8.10
February	1.70	9.34	13.60	7.20
March	4.90	10.06	13.00	0.80
April	2.30	7.48	10.80	
May	0.08	5.14	11.00	
June	0.00	1.97	6.70	
July	0.00	0.92	3.50	
August	0.00	1.54	6.10	
September	0.00	3.11	8.70	
October	0.70	5.96	11.60	
November	0.02	7.40	12.20	
December	1.60	8.49	13.30	

Magothy River - Water Temperature				
Month	**Minimum**	**Mean**	**Maximum**	**2010**
January	32.90	37.58	45.50	36.86
February	33.98	38.65	41.90	37.40
March	38.84	45.01	52.52	54.68
April	45.32	54.61	64.94	
May	60.62	66.33	76.64	
June	71.24	77.01	83.48	
July	77.72	81.21	86.72	
August	76.28	81.10	86.72	
September	67.64	75.03	80.42	
October	57.20	63.80	70.16	
November	43.16	51.51	60.80	
December	35.24	42.60	50.36	

Magothy River - Surface Water pH				
Month	**Minimum**	**Mean**	**Maximum**	**2010**
January	7.60	8.26	8.70	8.00
February	7.40	8.03	8.60	8.10
March	7.20	8.03	8.90	8.30
April	7.40	8.13	9.00	
May	7.90	8.71	9.60	

June	7.60	8.21	9.20	
July	7.20	8.05	8.90	
August	7.20	8.13	8.90	
September	7.40	8.08	9.50	
October	7.40	8.02	9.00	
November	7.50	8.41	10.00	
December	7.60	8.35	9.20	

Do you see something in the data that might explain why the fish died?

What might have caused this to happen?