Name: _____ Date: _____ Period: _____

Ecology Disrupted
Winter Roads Case Study (Scientific Method)

In this case study, we are going to discuss scientific research that has been published in a peer-reviewed journal. The goals of the next several days are to:

- Learn about real scientists and their stories—what motivates them, how and why they ask questions, and what type of data or evidence they collect to address their questions.

- Connect your daily life activities to ecological function.

- Connect disruptions in ecological function to environmental issues.

Along the way, we will learn about some concepts that are relevant for understanding the case study. We will begin by looking at the work of Dr. Sujay Kaushal, a young scientist living in Maryland. Dr. Kaushal became interested in learning how snow and ice in the Baltimore area might affect the area's water supply.

Scientific Method Vocabulary:

Independent Variable: What is changed by the experimenter in the experimental group

The variable the experimenter is changing to see how it affects the dependent variable. Ex: How does the amount of sunlight affect plant growth. The amount of sunlight is the independent variable

Dependent Variable: What is measured in the experimental and control group

The variable that is measured by the investigator to see how it changes because of the change in the independent variable. DATA. Ex: How does the amount of sunlight affect plant growth...plant growth is the dependent variable.

Control Group: A group that is tested as a comparison to the experimental group.

Group where you DO NOT change the independent variable, but still measure the dependent variable. This allows you to compare results with the experimental group.
Ex: Does a medicine help decrease the # of asthma attacks in asthma patients. The control group is the group of patients who DO NOT receive the medicine. The data collected is the number of asthma attacks these patients have.

Experimental Group: Group that is tested to see the effect of the independent variable on the dependent variable

Group where you change the independent variable and measure the dependent variable.
Ex: Does a medicine help decrease the # of asthma attacks in asthma patients. Experimental group are the people who receive the medicine. The data collected is the number of asthma attacks they have while on the medicine.

Constant (Controlled Variable): the factors that stay the same between the control group and experimental groups

A well-designed experiment will have the following:
-Large Sample Size
Control Group
Experimental Group
Repeated Trials
Only 1 independent variable
Keep other variables (other than independent and dependent variables) constant: (Controls/Controlled Variables/Constants)
Repeatable Procedures

Part 1: Identifying the problem

View the **Science Bulletin** titled "Winter Roads Make Salty Streams" that is based on the scientific research of Dr. Kaushal. He was interested in answering the question "Does the salt we put on roads to melt snow and ice end up in our streams?"
1. Why is salt put on roads? _____
2. How does the salt get into streams? _____
3. What are the scientists doing to determine if salt is getting into the streams?

    _____
4. How does an increase in salt affect the ecosystem (think about animals and plants)?

    _____

Baltimore Winters - some facts
Take notes on the slides "Baltimore Winters, Snow and Salt" to understand the average conditions for the city and surrounding area in which Dr. Kaushal set his research.

1. How many people live in Baltimore?   _____
2. How many people live in the metropolitan area of Baltimore? _____
3. What is the average snow fall in Baltimore? _____
4. What does the city of Baltimore do to make roads passable? _____

Meet the Scientist (Watch the video and answer the questions)

1. Scientists ask questions. What question(s) did Dr. Kaushal ask?

2. What motivated him to do this type of research? Why is he interested in the water in the streams?

3. Identify one question that you have about storm water and runoff from this video.

Research Design
What is a simple experiment that could be done to answer this question: "Does the salt we put on roads to melt snow and ice end up in our streams?"


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Wrapping it all together

1. What is the research question for this case study?

2. Why do cities use road salt?

3. During snowy and icy months, which nearby streams do you think will have the highest levels of salt: urban, suburban, or forested? **Why**?

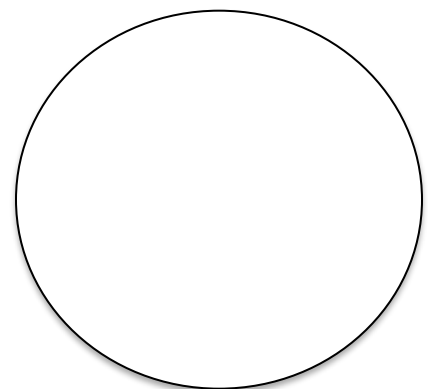**Part 2: Salt and Ecosystems:**   The effect of salt on plant cells:

Create a diagram or model of the demo your teacher did with the plant cells and salt:
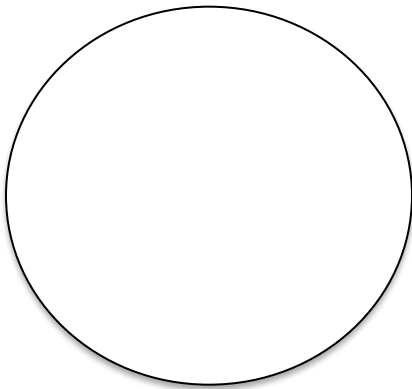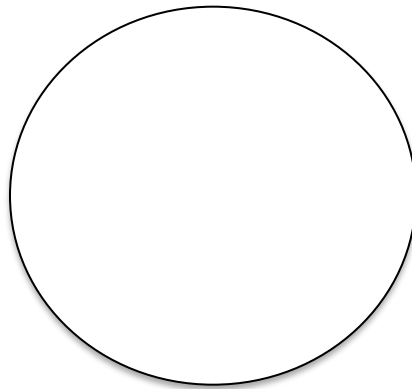
Eggplant in Water	Eggplant	Eggplant in Salt

Review:

Molecules are in constant motion, and tend to move from areas of higher concentrations to lesser concentrations. Diffusion is defined as the movement of molecules from an area of high concentration to an area of low concentration. The diffusion of **water molecules** through a selectively permeable membrane is known as Osmosis. Selectively permeable means that some molecules can move through the membrane while others cannot.

Movement through membranes is called transport.   The difference between high and low concentration is known as the concentration gradient. Diffusion and osmosis are passive forms of transport; this means that do not need energy to move areas of high concentration to areas of low concentration. Active transport requires energy to transport molecules from low concentration to high concentration.   Osmosis is the movement (transport) of water (small dots) through a selectively permeable membrane from an area of high concentration to an area of low concentration.

Selectively Permeable Membrane
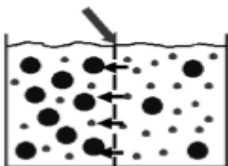
Use the information from the reading to draw arrows on the diagrams of the eggplant above to show the movement of the water.

3

Salt and Ecosystems Infographic summaries

Use the ecosystem infographics to complete the table below

	List at least two organisms that live in this ecosystem	How will increasing salt levels affect the organisms that live in this ecosystem?
Forest		
Fresh Water		
Swamp		
Marsh		
Estuary		
Ocean		

Reflect on what you have learned:

1. At what level does salt start to affect non-saltwater organisms in the forest? Is it a small or large amount and which organism is most affected?

2. At what level does salt start to affect non-saltwater organisms in a freshwater pond? Is it a small or large amount and which organism is most affected?

3. Pine trees are hurt by salt levels as low as 67.5 mg/L, but people are allowed to drink water with more salt than that level. What system/organs in humans help to regulate the salt levels in your body?

4. Why is it okay for people to drink water with some salt, but bad for people if they drink water that is too salty? (Relate this to osmosis…what will happen to your cells?)

4

5. Some of the organisms that are most affected by salt are the small pants and animals that are lowest on the <u>food chain</u>. How will their death affect other biotic factors in a freshwater ecosystem?

6. How is it possible for a freshwater swamp to turn into a salt marsh without trees? What happened to the trees? What human activity can lead to this?

Wrapping it all together
1. Support the statement that the salt level isn't the problem for ecosystems; the problem is <u>changing</u> the amount of salt in an ecosystem. Give a specific example.

2. List three ways that salt can negatively affect these organisms in a freshwater, forest or swamp ecosystem:

Effect on plants:
Effect on fish/aquatic animals:
Effect on land animals:

Part 3: Water in Our Daily Lives:

Water - coming in and going out.

Watch the two video clips about the source of water in Montgomery County. Take notes as you listen.

Video 1: **Where Does WSSC Water Come From?**	Video 2: **How Stormwater Destroys Our Streams**

Surface Water and Groundwater

Twenty one percent of the freshwater used in the United States comes from the ground. Some water seeps underground when it falls as rain, snow or sleet. The gravel or sand underground act like a sponge to absorb and hold the water, just like when you are digging at the beach and discover water when you dig down deep. In order to access stored underground water, people use well pumps to bring stored water to the surface. An area that holds a lot of water, which can be pumped up with a well, is called an aquifer. Wells pump groundwater from the aquifer and then pipes deliver the water to cities, houses in the country, or to crops.

Wrapping It All Together
1. What is the main way that salt enters our watershed (rivers and streams)?

2. How do storms contribute to water pollution?

3. How can we reduce the amount of pollutants that reach the waterways?

Part 4: Investigating and Graphing Salinity Data

"Water is the reflection of all the bad water quality things we do on land"
- Dr. Sujay Kaushal

Think-Pair-Share: Discuss this quote with the person next to you and write down what you think it means.

_____

_____

Predict & Plan: -

You will be analyzing sets of data from Dr. Kaushal's study. Where do you expect to find the saltiest water? Urban, Suburban or Forested? Why?

_____

After reviewing the data sets you will be graphing, identify which data will go on the x-axis and which will go on the y-axis. Complete the table below to plan your graphing strategy.

Data Set To Graph: Circle One: Urban, Suburban, Forested, Annual

Graph Style: You will be making a **line** graph.

Axis	Horizontal or Vertical axis?	Data description and Units	Scale (From _____ to ____)	Independent or Dependent variable?
X				
Y				

Part 5: Representing and Making Meaning from Salinity Data

Remembering the context

Why was it important to incorporate the benchmarks and population densities of the different areas onto the graphs?

Class discussion:

Making Sense of the Graphs

The guiding question for this study is: "How might snowy and icy roads affect Baltimore's water supply?"

Use your graphs to summarize and draw conclusions from the data collected in the study.

Data Set	What I See (Observation from graph)	What It Means (Reason for this observation)
Seasonal		
Annual		

Part 6: Finding Solutions

The problem of winter roads and how we management them so that we can get around in snow and ice has now been well defined and studied. We will now turn to possible solutions.

Summarizing the problem:

Questions	Winter Roads Case Study answers
1. What abiotic factor(s) have people changed?	
2. Why do people change the abiotic factor? Why does it help us?	
3. What are the consequences to the living (biotic) and non-living (abiotic) parts of the ecosystem of that abiotic change? Use the terms abiotic and biotic in your answer.	
4. How do you know these are the consequences? Describe the evidence or data that support the claim that changing this abiotic factor impacts the surroundings.	

Options for solving the problem:

Learn about strategies for solving this problem by listening to a video and analyzing a table of de-icers and their properties. Summarize the data here:

Video: Road Salt is Worse Than You Think	What are the benefits of road salt: Other than ecological damage, what are other drawbacks of using salt?
Table: **Properties of De-icing Agents** Explanations of the de-icers can be found here	Read through the table of alternatives. Identify what you think is the best alternative and provide reasoning and possible drawbacks (why aren't we using that already?).

What could this mean for Montgomery County?

Look at the Montgomery County Surface Water Supply Sources map. Could what is happening to Baltimore City's streams/rivers happen to us? Use evidence and reasoning to support your claim.

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