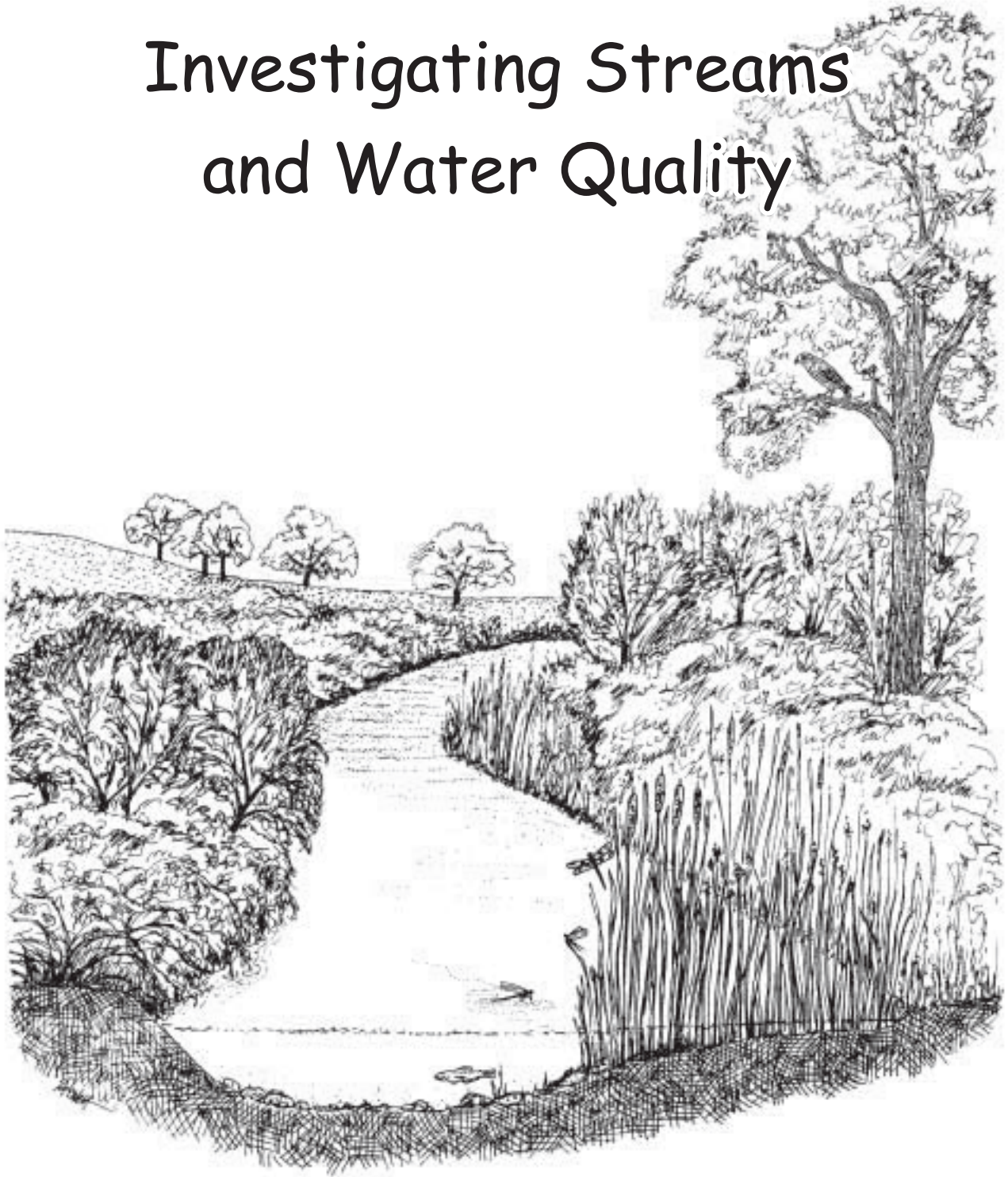


Life in Our Watershed

Investigating Streams and Water Quality



Student Workbook

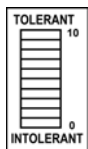
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Stream Bioassessment

Stream bioassessment measures the health of a stream by identifying the benthic macroinvertebrates (BMIs) living in the benthos (bottom). In this exercise, a sample of BMIs collected from a stream will be identified to the Family level. Stream biologists know that pollution-intolerant BMIs live only in clean water and pristine habitat. They are rarely found in a stream with impaired water quality or habitat. As a stream becomes increasingly impaired, only the most pollution-tolerant BMIs can survive.



Many bioassessment calculations called “metrics” are used to assess the condition of a stream. The Tolerance Value metric assigns a pollution Tolerance Value (from 0 to 10) to every Order or Family of BMIs. Those that are intolerant of pollution are assigned low Tolerance Values (nearer to zero). (See inset scale.) BMIs that tolerate more pollution are assigned higher Tolerance Values.

The Tolerance Value metric for a stream is the average pollution tolerance of all the BMIs living in it. When conditions are no longer suitable for the BMIs that require clean water, the stream Tolerance Value increases. The pollution-tolerant BMIs that survive have higher Tolerance Values, which push the stream Tolerance Value upward. Biologists suspect impaired conditions in a stream when the Tolerance Value increases over time or when it is higher than a comparable, clean, “reference” stream.

Identifying Trends in Water Quality

Envision two local streams – Stream X and Stream Y. Stream X flows through the city and many new neighborhoods are being built within its watershed. Stream Y meanders through several cattle ranches and its watershed remains largely undeveloped. Residents living along Stream X notice that the stream has become muddy and its banks are eroding at a faster rate. They report their concerns to city officials who suggest a study to verify the residents' observations and to investigate possible causes.

The residents team up with students from a local high school to conduct a long-term stream bioassessment. A biologist is hired to help this “Stream Team” learn to collect and identify BMIs and look for evidence of trends in water quality. For six years the Stream Team uses the BMI Tolerance Value metric, in combination with many other metrics, to see if conditions in Stream X are becoming better or worse, or remaining stable over time.

Today your class will use the Tolerance Value metric in a simplified, mock bioassessment using a sample of real BMIs from Stream X. Refer to the information presented above to complete the following class exercise.

In your lab group:

- Identify your BMI specimen from Stream X and its pollution Tolerance Value.
- Add your data to other data generated by your classmates in Table 1.
- Use the data in Table 1 to calculate an average Tolerance Value for Stream X.
- Enter the Stream X Tolerance Value in Table 2.

As a class:

- Compare the Tolerance Value for Stream X to data collected from Stream X in previous years.
- Compare the Stream X Tolerance Value to data from a nearby healthy stream (Stream Y).
- Review the data to determine if conditions in Stream X are getting better, worse, or staying the same.

Table 1. Bioassessment Calculations for Stream X

Station #	BMI Name	Tolerance Value
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Tolerance Value for Stream X

$\frac{\text{total number of BMIs identified}}{\text{sum of all their Tolerance Values}} = \underline{\hspace{2cm}}$

Directions: Add the calculated Tolerance Value for Stream X to Table 2 and answer the questions below. Circle your answer and explain your reasoning in the space provided.

Table 2. Stream X and Stream Y Tolerance Value Data

	5 years ago	4 years ago	3 years ago	2 years ago	1 year ago	this year
Stream X Tolerance Values	4.3	4.8	5.2	4.8	5.0	
Stream Y Tolerance Values	4.2	3.8	4.0	3.7	3.5	3.5

- Based on the data in Table 2, would you say that conditions in Stream X have been getting better, worse, or remaining fairly constant over the last six years? BETTER WORSE SAME
How do you know?
- Based on the data in Table 2, would you say that conditions in Stream Y have been getting better, worse, or remaining fairly constant over the last six years? BETTER WORSE SAME
How do you know?
- Based on all the data from Table 2, which stream appears to have better stream conditions?
 STREAM X STREAM Y
How do you know?
- Would you have reached the same conclusions after only one year of stream monitoring? YES NO
Why or why not?
- Considering the status of their watersheds, list possible reasons for differences in the Tolerance Values of Stream X and Stream Y.

EXTRA CREDIT: On a separate piece of paper, graph the data presented in Table 2.

Vocabulary I

Define the following words and phrases.

aquatic macroinvertebrate

tributary

food web

watershed

runoff

Your Score _____

Activity II-A

Designing an Experiment

To measure the effects of two urban runoff pollutants on an aquatic macroinvertebrate, imagine putting live *Daphnia magna* into vials containing three types of water:

1. Water with Pollutant #1
2. Water with Pollutant #2
3. Clean, non-toxic water

How would you set up this experiment? Imagine that you have the three types of water listed above and an unlimited supply of *Daphnia* and vials. Describe what your experiment would look like. Consider the following questions to get started.

How many vials will you use and why?

What kind of water will you put into each vial?

How many *Daphnia* will you put into each vial and why?

Creating Instructions

1. Get into groups of three or four.
2. Set up a mock experiment using the three types of water and the vials provided by your teacher.
3. Write out step-by-step instructions on how to set up your experiment. Number each step. Write these instructions so clearly that any student could understand them and be able to repeat your experiment.
4. Draw your experimental design in the space provided. Draw the vials and what is inside each of them (polluted or clean water and each imaginary *Daphnia*).
5. Select one person from your group to draw your design and write your hypothesis on the front board.
6. Clean up your lab station. Leave it the way you found it – ready for the next class.
7. Sit back at your desk.

Instructions (Number your steps.)

Draw your experimental design

Your Score _____

Notes from Class Discussion

Review your experimental design with the class and answer the following:

- A. If the purpose of this experiment is to determine what Polluted Water #1 and #2 will do to the *Daphnia*, why do we need to include *Daphnia* in the Clean Water as well?
- B. What are the *variables* and what is the *control* in our experiment?

Your Score _____

Vocabulary II-A

Define the following words and phrases.

bacteria

first flush

effluent

heavy metals

storm drain

protozoa

sewage

sanitary sewer

wastewater

wastewater treatment plant

Your Score _____

Activity II-B

Storm Water Pollution Bioassay Lab Report

I. Purpose

II. Hypothesis

III. Materials

Storm Water Pollution Bioassay Lab Report

IV. Methods

V. Diagram of Experimental Design

Your Score _____

Storm Water Pollution Bioassay Lab Report

VI. Results

Record your results in Data Table 1 below.

Data Table 1

	Control			Variable #1			Variable #2		
	Day 0	Day 1	Day 2	Day 0	Day 1	Day 2	Day 0	Day 1	Day 2
Vial 1									
Vial 2									
Vial 3									
Total									
% Survival									

Calculations

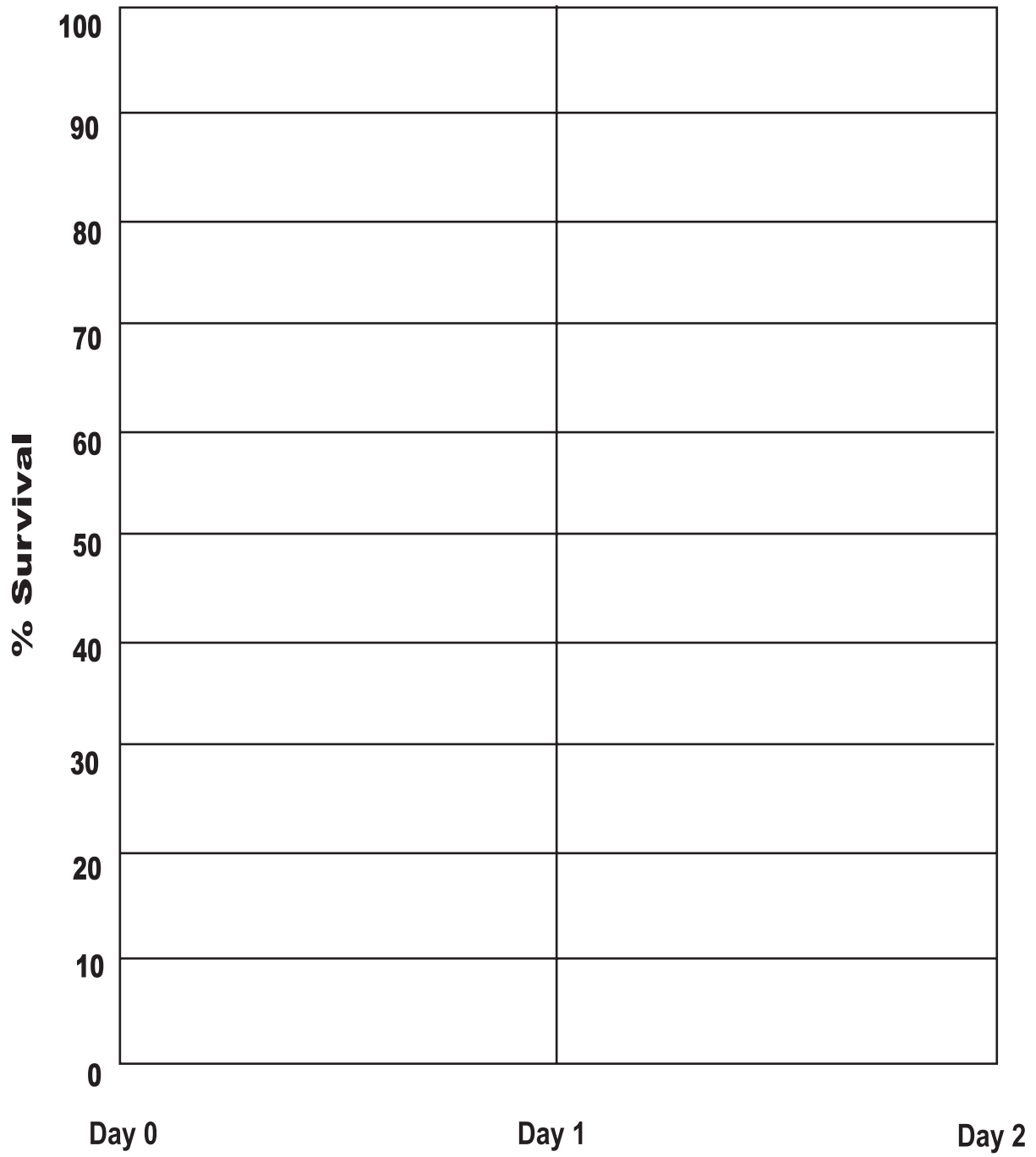
- The total of the **Day 0** values is equal to 100% survival.
- Calculate the **Day 1** and **Day 2** values for percent survival as follows:

$$\frac{(\text{Day 1 Total})}{(\text{Day 0 Total})} \times 100 = \text{Day 1 Percent (\%) Survival}$$

$$\frac{(\text{Day 2 Total})}{(\text{Day 0 Total})} \times 100 = \text{Day 2 Percent (\%) Survival}$$

Storm Water Pollution Bioassay Lab Report

Plot your results from Data Table 1 on the graph below.



Storm Water Pollution Bioassay Lab Report

Description of Your Results

Describe your results in your own words. Include a description of your graph.

VII. Conclusions

Your Score _____

Vocabulary II-B

Define the following words and phrases.

bioaccumulate

bioassay

control

pollutant

variable

Your Score _____

Activity III

During this activity you will design a new neighborhood that can decrease the amount of urban runoff pollutants in your community.

Step 1

Obtain a grid sheet from your instructor. The grid represents the area of town that you will develop. It is 1.5 square miles of grassland covered hills and oak trees. Each square on your piece of paper equals about 1.5 football fields on a side, or approximately 5 acres. Using this sheet your group must design a new part of town using the guidelines and challenges below.

Step 2

Guidelines

1. In your groups, design a new section of town that includes the following features:

Feature	Number of squares	color
Stream	Draw this first! Your stream must cross through at least 30 squares. Of these 30 squares only 2 may be on the outer perimeter of the grid sheet, and you must include at least one of the four dotted-line squares in the center. The width of the stream may vary, but bear in mind that each square is 1.5 football fields wide!	Blue
Shopping mall parking lot	22	Red
Shopping mall buildings	8	Pink
Housing	36	Green
Freeway	Your freeway must cross through 12 squares and take up 25% of each square through which it passes.	Black

2. Start by drawing your stream (follow the instructions in the table above). After drawing your stream, plan how you will add your shopping mall, homes, and freeway to your grid.

Challenges

1. See if your neighborhood design can keep at least one square between the stream and any freeway, homes, or shopping mall features. (See #9 in the table “Ways to Decrease Urban Runoff Pollution” on page 16 of the Student Handbook.)
2. Shopping malls, parking lots, homes, and freeways add impervious surfaces to the watershed that rain cannot penetrate. Refer to the table of “Design Elements for Community Planning” provided by your teacher and the table on page 16 of the Student Handbook to include features in your grid that will slow down and filter the runoff from all impervious surfaces before the runoff reaches your stream. On a separate piece of paper, write down which Community Design Elements your group has included in your design. Attach a symbol key for these elements so others can locate and identify them on your grid sheet.

Your Score _____

Step 4

Now that you are more aware of ways to reduce urban runoff pollution, look around your neighborhood to see if you can identify areas with and without impervious surfaces. The next time you travel around town, look for large detention basins in newer developments, vegetated swales, or other runoff-reducing measures.

Vocabulary III

Define the following words and phrases.

impervious surface

non-point source

point source

pathogen

Clean Water Act

Your Score _____

Glossary

anaerobic bacteria – bacteria that can live without oxygen

aquatic macroinvertebrate – one of a diverse group of animals that live in water, are big enough to see without a microscope, and have no backbone

bacteria – single-celled organisms without a nucleus (prokaryotes)

bioaccumulate – to build up or concentrate within living tissue

bioassay – a method for determining the toxicity of a substance by measuring its effects on a test organism when compared against the effects of a control

biosolids – the solid byproducts of secondary wastewater treatment that can be used as fertilizer for some plants

cholera – a type of intestinal disease

control – in a scientific experiment, the “non-treatment” against which the effect of other treatments can be measured

detention basin – an large, manmade hole in the ground for temporary storage of stormwater runoff

dysentery – a type of intestinal disease that causes severe diarrhea

digesters – enclosed structures without oxygen in which anaerobic bacteria break down solid waste material, producing methane gas and biosolids as byproducts

effluent – water that is discharged into a stream

first flush – the first heavy rainstorm of autumn that washes accumulated pollutants from surfaces in the watershed into runoff

food web – the interconnected feeding relationships within an ecosystem

heavy metal – naturally occurring elements with high molecular weights (e.g., arsenic, mercury, selenium, cobalt, chromium, copper, zinc, cadmium) that are transformed by microorganisms into toxic compounds which can then enter biologic cycles

impervious surface – hard ground cover that prevents or retards the entry of water into the soil and increases runoff, such as asphalt, concrete, rooftops

landfill – a site where waste materials (trash) are buried under a thin layer of soil

lime – a white powder, calcium oxide (CaO), that can be used to reduce odors

non-point source – a source of pollutants which is either so common or so widespread that its origins are difficult to pinpoint

outfall – the place where water from a treatment plant, factory or storage facility flows into a stream

oxygen reactor – large open tanks at a wastewater treatment plant into which air is bubbled to provide oxygen for the rapid breakdown of wastes by bacteria and protozoa

pathogen – a microscopic disease-causing organism

point source – a single source of pollutants which is detectable and identifiable, such as the end-of-point discharge from a factory

pollutant – something that contaminates something else or deteriorates its condition, especially a harmful chemical or other waste material discharged into the water or atmosphere

protozoa – single-celled organisms with a nucleus (eukaryotes); wastewater treatment operators use protozoa to control levels of bacteria in an oxygen reactor

runoff – water that flows off artificial and natural surfaces and into streams

sanitary sewer – a system of pipes that carries wastewater to a wastewater treatment plant

sediment – soil deposited in stream bottoms

sewage – the combination of organic waste and wastewater generated by residential and commercial establishments

storm drain – covered pipe openings along street gutters that carry runoff directly into streams

tributary – a stream that feeds into a larger stream

variable – the condition in an experiment that changes due to the effects of the treatment(s) under investigation

wastewater – water that is flushed or washed from the inside of homes and businesses from sinks, toilets, showers, baths, washers, etc.

wastewater treatment plant – a facility where wastes are removed from water by biological, chemical, and physical processes

watershed – an area of land that sheds rain water into an interconnected network of streams

Student Scoresheet

Lesson	Activity	Your score
I	Draw a macroinvertebrate	
	Write a story	
	Vocabulary I	
	Test I	
II-A	Experimental Design	
	Vocabulary II-A	
	Test II-A	
II-B	Lab Report sections I-V	
	Lab Report sections VI-VII	
	Vocabulary II-B	
	Test II-B	
III	Neighborhood Design	
	Comparing Designs - questions	
	Vocabulary III	
	Test III	
Total score		

Instructor's comments:



Sacramento
Regional
County
Sanitation
District

