

Watershed Testing with Vernier Probes

Grade Level: 9-12

Time: 45 minutes

Adapted From: “Biology with Computers” Experiment #20

Objectives:

- Students will be able to define a watershed, conductivity, pH, and dissolved oxygen.
- Students will be able to identify, correlate, and predict trends and factors shaping a watershed.
- Students will be able to analyze the data from the probes and graphs to determine water quality from selected water samples.
- Students will be able to use probes connected to computer software to collect and analyze data collected from watersheds.
- Students will be able to create their own hypothetical watershed given options from categories and explain why and how their choices will affect the watershed and environment surrounding it.
- Students will recognize the significance and importance of testing water.

Idaho Achievement Standards:

- 648.02a Know that observations and data are evidence on which to base scientific explanations.
- 648.02c Develop scientific explanations based on scientific knowledge, logic and analysis.
- 649.01c Use technology and mathematics to improve investigations and communication.
- 652.02e Know that human beings live within the world’s ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption.
- 656.01a Identify environmental quality issues, both natural and human induced, related to water quality.
- 656.03c Understand the role and effect of management of natural resources.

Materials:

Vernier Probes (conductivity, pH, dissolved oxygen)
Vernier software connected to computers (3)
Elmo/Overhead Projector
Several (8) watershed samples in glass jars
Distilled water
Waste water containers
Tables to compare values
Map of Idaho to show locations of water samples

Introduction—Engage the students with an activity to get them thinking about the importance of water quality. I drank lemon water in front of the students, wanting them to get thirsty and ask for a drink. When they did, I poured them a glass of dairy water to drink. Then, I asked the students how they know that Pocatello water is drinkable but dairy water is not. Start with a discussion of water quality in general. Then, go over the tests that can be performed to test water and the tests that they will actually be performing in lab.

Discuss the different tests (pH, conductivity, temperature, and dissolved oxygen) and what each test means. Introduce the class to the probes, then talk about how each probe actually works. Tell them how the conductivity probe measures the number of cations and anions and how the pH probe measures the level of hydrogen and hydroxide ions. Teach the class about weighting the tests and why this is significant in testing water quality. Show graphs and charts as you teach so students get a general idea of which values are acceptable and which are not. List the different areas from which the water samples were obtained. Show a map of these areas so that students can visualize from where the water they're working with actually came. Talk about the total water quality and how each test significantly contributes to the water quality as a whole. After these discussions, hand-out the charts and tables that the students will be working with. Have the class make predictions on which water sample they think will have the highest water quality and the sample that will have the lowest. Write these predictions down so they can be compared with later. Divide the students into groups and prepare them to work with the water samples.

Lab Activity—Assign each group a specific test and probe to work with. Put them in charge of collecting data for this probe and recording it in the form of a chart. Each group will test each water sample, but with only one probe. Teach the students how to figure the calculations and obtain the q-values. Have a chart on the board where the students can put their data. Have each group explain their data and any hypotheses that they have on why these results were obtained.

Closure—Add up all the q-values to get a total water quality for each stream. Then, discuss with the class which water sample had the highest water quality reading and which had the lowest. Were their predictions wrong or right? Ask questions to get the students to think critically—why did our results turn out the way that they did? What does this tell us? Show the map of the water samples again and talk about possible reasons why some water has a higher quality than others.

Procedures:

Directions for Probes:

1. Remove the probes from their storage bottles (D.I. water)
2. Place the probe into the water sample bottle
3. Gently and continuously swirl the bottle and water around the probe's tip for about 20 seconds.
4. Hit the Collect Button (Data will be collected on computer screen graph)
5. Hit the Stat button to find mean of results
6. Rinse the probe with deionized water and repeat for all watersheds

Put means in Table:

	Dissolved Oxygen mg/l (D.O.)	pH	Conductivity (TDS)	Temperature	Saturated Dissolved Oxygen Level
Salmon River				4 Degrees C	11.40
Big Lost River				5 Degrees C	11.12
Bear River #1				10 Degrees C	9.86
Bear River #2				6 Degrees C	10.85
Snake River (TF)				10 Degrees C	9.86
Snake River (Burley)				8 Degrees C	10.33
Poky drinking				10 Degrees C	9.86
Dairy				20 Degrees C	7.96

To find % saturation for dissolved oxygen use:

$$\% \text{ saturation} = \frac{\text{measured D.O. level}}{\text{Saturated D.O. level}} \times 100$$

Test Results (Dissolved Oxygen, pH, Conductivity, and Q Values)

DO (% saturation)	Q value
0	0
10	5
20	12
30	20
40	30
50	45
60	57
70	75
80	85
90	95
100	100
110	95
120	90
130	85
140	80
150	75

PH	Q Value
2.0	0
2.5	1
3.0	3
3.5	5
4.0	8
4.5	15
5.0	25
5.5	40
6.0	54
6.5	75
7.0	88
7.5	95
8.0	85
8.5	65
9.0	48
9.5	30
10.0	20
10.5	12
11.0	8
11.5	4
12.0	2

Conductivity (TDS) Test Results
Temperature Results

TDS (mg/L)	Q Value
0	80
50	90
100	85
150	78
200	72
250	65
300	60
350	52
400	46
450	40
500	30

Temp (C)	Q Value
0	95
5	75
10	45
15	30
20	20
25	15
30	10

Watershed Testing

(Times Q-Values by their weights, add up total Q-Values for overall quality)

Salmon River

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Big Lost River

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Bear River #1

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Bear River #2

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Snake River (Twin Falls)

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Snake River (Burley)

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____**Poky Drinking**

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____**Dairy**

Test	Q-Value	Weight	Total Q-Value
DO		0.38	
PH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality: _____

Evaluation (Take Home)

Homework: Create A Watershed

Create a hypothetical watershed in the form of an essay. Choose any combination of the following options below with 1-2 choices per group plus any others you want to add. Be creative in your watershed and think critically about possible positive and negative effects on the overall quality of the watershed. What might be the effects of the choices? What are the correlations among the given groups? Give your watershed a name.

Geology: (1)

Basalt (ex. Snake River, Blackfoot River, Bear River, Teton River)

Granite (ex. Salmon Rivers, Selway River, Lochsa River)

Botany: (1-2)

- Ponderosa trees
- Cedar trees
- Douglas Fir
- Aspen
- Cottonwood
- Willows
- Algae/moss
- Cattails

Elevations and Pressures: (1)

Elevation (ft)	Pressure (mm Hg)
330	748
2600	700
5000	636
6000	612
7500	571

Biology:

Fish: (1-2)

- Salmon/Steelhead
- Trout
- Carp
- Chub
- Catfish

pH (1)

Q-Value

3.0	3
7.5	95
9.0	48
11.0	8

Aquatic Life: (1-2)

- Stoneflies
- Caddisflies
- Mayflies
- Mosquito
- Worms

Dissolved Oxygen (1) Q-Value

10	0
60	57
100	100
140	80

Average Annual Temperatures: (1)

- 40 Degrees F
- 50 Degrees F
- 60 Degrees F
- 70 Degrees F
- 80 Degrees F

Conductivity (TDS) (1) Q-Value

0	80
200	72
350	52
500	30

Average Gradient of Lake or Stream (1)

Flat, 10 ft/mile(riffles), 50 ft/mile(whitewater), 100 ft/mile(waterfalls)

Critical Thinking Questions:

1. If you were a trout which stream would you live in?
2. Which kinds of fish, insects might be found in what kind of stream?
3. If you had a stream with a pH of 7, a conductivity (TDS) of 50 mg/L, a temperature of 41 degrees F (5 degrees C), and a dissolved oxygen of 100% saturation what could you infer about the organisms, geology, biology, and botany surrounding the stream?
4. An abundance of trees and therefore shade on the river usually equals more trout and is a good spot to fish for them. Why?
5. What might the effects of overgrazing be on a stream?
6. Basalt is easily eroded and will therefore have a relatively high or low conductivity or total dissolved solids compared to granite which is not easily eroded?
7. The pH of a river generally rises during the day and decreases at night. In response to plant growth why might this be? (photosynthesis occurs during the day, respiration at night and the CO₂ reacts with water to create carbonic acid which would do what to the pH?)
8. What might be a practical application to knowing the conductivity or ionic strength of a watershed? (the ions driven by geology in the river create an electric current. If you were electroshocking fish in a river with low conductivity there would be more "juice" required for the appropriate amount to safely shock the fish because it would be harder to push through the current)
9. What are the effects of the diminishing salmon runs in central Idaho? (ecology interrupted as the spawned salmon provide nutrients for baby fish, insects, algae and zooplankton interrupted)
10. What might the differences be between surface water and underground, aquifer water in relationship to dissolved oxygen and pH? (underground water would not be impacted by barometric pressure forcing the oxygen into the water as is the case in surface water so the dissolved oxygen would be lower. The pH would not have the diurnal swings in aquifer water as is the case with surface water do to photosynthesis and respiration)
11. Which Bear River site, 1 or 2, do you think is the site above the Grace powerplant and below and why?

Terms

Watershed: a region or area bounded by a divide and draining ultimately to a particular water course or body of water. Water, both surface and aquifer (underground), runs downhill.

PH: a measure of acidity and alkalinity of a solution that is a number on a scale which a value of 7 represents neutrality and lower numbers indicate increasing acidity and higher numbers increasing alkalinity.

Dissolved Oxygen: The amount of oxygen dissolved in the water.

Conductivity(Total Dissolved Solids): the quality or power of conducting or transmitting

Rubric For Watershed

	Target Not Met	Target Partially Met	Target Met
Points	0	5	15
Watershed Categories	No items from categories	Half of items from categories used	All items from categories used
Proper analysis and questions answered	No analysis or questions answered	Some questions answered with some flaws in analysis	Proper analysis and questions answered
Creativity/Critical thinking	No creativity	Fair creativity with fair some examples of critical thinking skills	Excellent creativity with name of watershed and great evidence of critical thinking skills
Grammar/Writing	Not Done	Some incomplete sentences, grammatical errors, and spelling errors	Complete sentences, proper grammar, error free

Total Possible: 60 points

A: 54-60

B: 48-53

C: 42-47

D: 36-41

F: 0-36

Your score/grade: