Water Quality Test for Whitaker Ponds Using Macroinvertebrates as Bioindicators

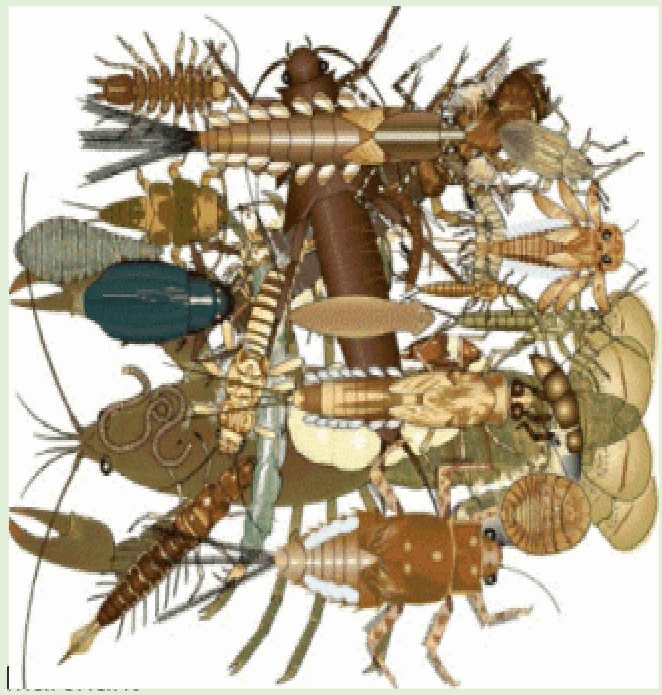
Introduction: The VFE for Whitaker Ponds is a virtual water quality program where students will conduct real scientific work. Students can be guided through the virtual field or be used as a supplement for in person field activity. Students will learn how to monitor water quality by sampling and identifying macroinvertebrates. The goal of the exercise is to gain knowledge of the Columbia Slough watershed, biology and ecology. The skills they will gain include data collection, analysis and taxonomic identification.

Next Generation Science Standards:

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

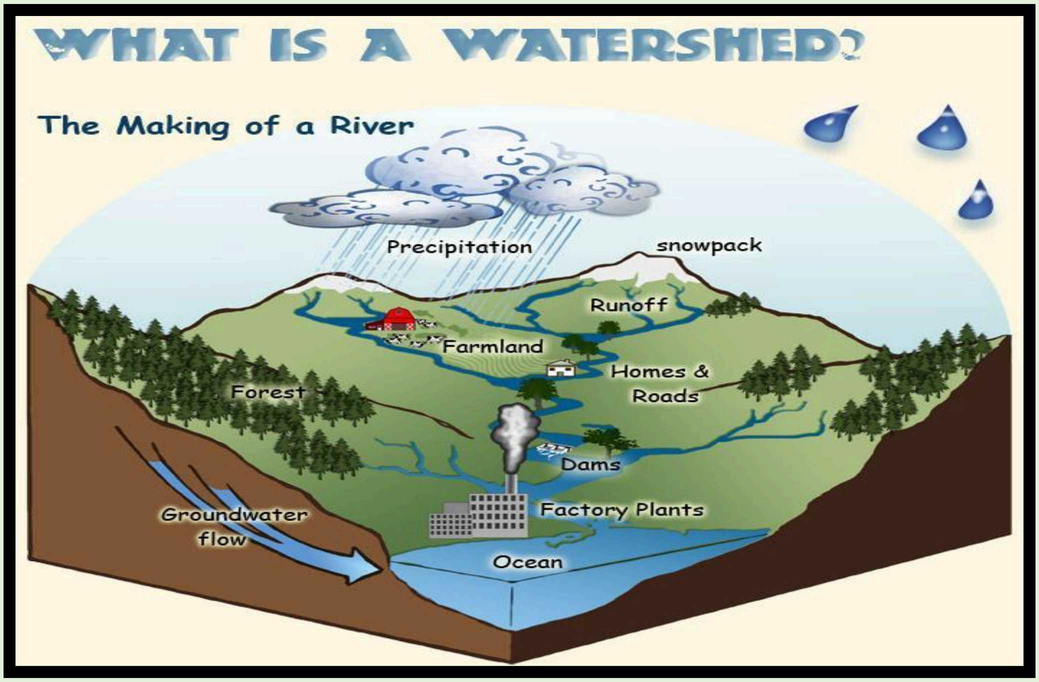


Provide students with background information before VFE viewing or field site collection.

1. Discuss with students what aquatic macroinvertebrates are: “aquatic” means water and “macro” means big, big enough to be seen without a microscope and “invertebrates” means an animal without a backbone. Macroinvertebrates include arthropods (insects, mites, scuds and crayfish), mollusks (snails, limpets, mussels and clams), annelids (segmented worms), nematodes (roundworms) and Platyhelminthes (flatworms).

    - Ask students to give examples of macroinvertebrates

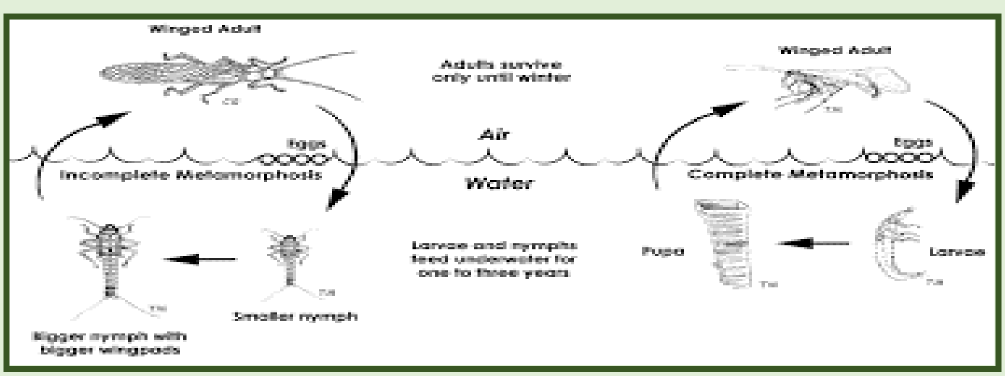
2. Discuss what is a watershed: a watershed is a drainage basin where rain/precipitation is collected and drained off into a common outlet such as a river or stream. The Columbia Slough, which Whitaker Ponds is a part of, is one of our local watersheds. Many organisms depend on watersheds for their survival.



What is a Watershed? Credit [US Forest Service Department of Agriculture][2]

- Ask students to provide examples of how water gets polluted
- What do they think would happen if the water becomes polluted?
- Which are some ways we can prevent pollution?

3. Discuss the macroinvertebrate life cycle: Many macroinvertebrates live their entire life in the water and others live in the water during their juvenile (Larva and nymph/pupae) stage and their very short adult stage on land. Many of the macroinvertebrates we will be examining, will be organisms in the nymph stage. Aquatic invertebrates go through a process of metamorphosis. There are 2 types of metamorphosis; *Complete Metamorphosis*: egg, larvae, pupae, adult and *Incomplete Metamorphosis*: egg, nymph, adult egg, nymph, adult.

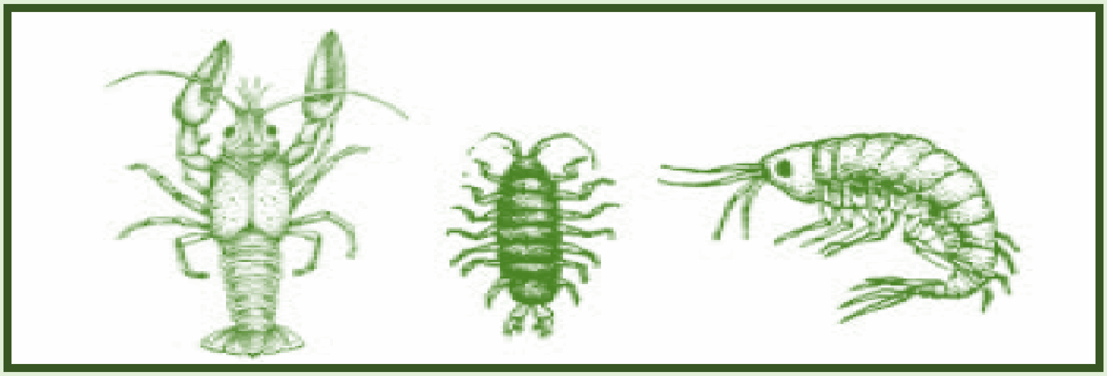


4. Why do we use macroinvertebrates to test water quality: We can use macroinvertebrates to test water pollution, some macroinvertebrates are highly sensitive, while others tolerate it, therefore we can determine if Whitaker Ponds is polluted by seeing what types of

macroinvertebrates are living in Whitaker Ponds. Macroinvertebrates are either sensitive, somewhat sensitive or tolerant to pollution.

5. Take the Freshwater macroinvertebrate for streams in Western Washington and Oregon handout (or any other samples of macroinvertebrates) and have students make observations

- How many legs do they have?
- What is unique about them?
- How do you think they move?
- Are there any special adaptations that might help them survive?



Magnificent Macroinvertebrates. Credit Oregon State University[4]

About Whitaker Ponds Natural Area[5] (Taken from the City of Portland)

This nature park is home to two ponds, a ½ mile loop trail, an ecoroof-covered gazebo, and a canoe launch into Whitaker Slough. The two ponds are surrounded by a black cottonwood forest which has been enhanced over the past 15 years with thousands of native plants. Native shrubs and wildflowers support local pollinators in the summertime, and the path around the West pond park highlights plant communities from the Northwest.

A sloping ramp leads down to an observation dock on the west pond, from which visitors can see fish, frogs, and water bugs. A second dock into Whitaker Slough is located on the north side of the park, and offers excellent access for canoes and kayaks. Paddlers can launch from the park and travel west on Whitaker Slough to connect to the main stem of the 19-mile Columbia Slough. Note that no fishing or paddling is allowed in either of the ponds.

The park is frequented by many animals, including downy woodpeckers, rabbits, beavers, garter snakes, osprey, dragonflies, otters, and wood ducks. In February, park visitors may spot fuzzy grey owlets from the great horned owl's nest in a bare cottonwood tree. And in May, bird enthusiasts can enjoy the feisty territorial spats between individual rufous hummingbirds as they establish who has rights to which red-flowering currant bush.

PP&R Environmental Education, the Bureau of Environmental Services, and the Columbia Slough Watershed Council provide youth and adult education programs. The nature park is maintained by PP&R staff with the help of volunteers from the Columbia Slough Watershed Council.

Whitaker Ponds Natural Area. Credit City of Portland

Now it is time to do some field work.

1. Provide each student or group of students with Macroinvertebrate Sampling Data form
2. Using the VFE have students identify and keep count on the sampling Data form of each of the macroinvertebrates they identify
3. Now have students tally each of the 3 columns, Sensitive, Somewhat Sensitive and Tolerant and multiple the total x3 for sensitive group, x2 for somewhat sensitive and x1 for tolerant
4. Add all the totals together to get the water quality rating
5. Have the student use the water quality rating on the bottom of the sheet to determine if the water quality is excellent, good, fair or poor

Follow up field work and other ways we can test the water quality of Whitaker Ponds.

Turbidity

Turbid water is what scientists call water that is muddy or cloudy. Turbidity is the measurement of water clarity or the degree to which light penetration is blocked by suspended particles. Waters with low concentrations of total suspended solids (TSS) are clearer and less turbid than those with high TSS concentrations. Turbidity can be temporary; it is normal for a pond to have a period where it is muddy after a heavy rainstorm. If the pond is continuously turbid and you can not see the bottom at about two feet, the pond is not a good environment for the organisms that live in it. Turbid water reduces sunlight penetration which inhibits plant growth, decreases oxygen production and limits primary food production. Turbid water reduces visibility and affects how animals see their environment. The extra silt (mud particles) can irritate fish gills and suffocate benthic (bottom dwelling) aquatic macroinvertebrates.

What causes water to become turbid? There are several ways a pond can become turbid. One way is from clay particles from soils becoming suspended in the water. The small clay particles carry the same electrical charge, and they repel each other and when they enter a water source such as Whitaker Ponds, they do not settle out. Another way water can become turbid is from mechanical activity from the organisms that live in the pond. The feeding activity of some of the organisms living in the pond, such as fish, can stir up sediment from the bottom of the pond which gets suspended in the water. The sediment at the bottom of the pond can also be disturbed by the benthic (bottom dwelling) organisms that live on it, such as crayfish and burrowing aquatic insects. Erosion caused by wind, wave action and human activity can also cause particles to be suspended in the water. Big storms events that cause water runoff from agriculture, logging and construction sites that flood into Whitaker Ponds can quickly cause the water column to become turbid

- Ask the students to discuss how turbidity can negatively impact the organisms living in Whitaker Ponds
- Ask the students to discuss ways Whitaker Ponds can become turbid

Testing for Turbidity

There are several ways to test for turbidity. Here, we will use two different methods, a simple method and a Secchi Disk.

Materials needed for simple method:

- Clear quart sized jar
- 6 samples of water obtained from 3 sources, 3 samples from different areas of Whitaker Ponds and a sample from 2 different sources, this can be tap water or water from another pond and filtered water used for a control.

Materials needed for making a Secchi Disk (Secchi Disks can be purchased by science equipment suppliers)

- 20cm- diameter, 6mm- thick plexiglass disk with a hole in the middle
- Metal disk with a hole in the middle (for weight)
- An eyebolt with nuts and washers to fit in
- Rope or cord (not made of cotton)
- Waterproof black and white paint or markers

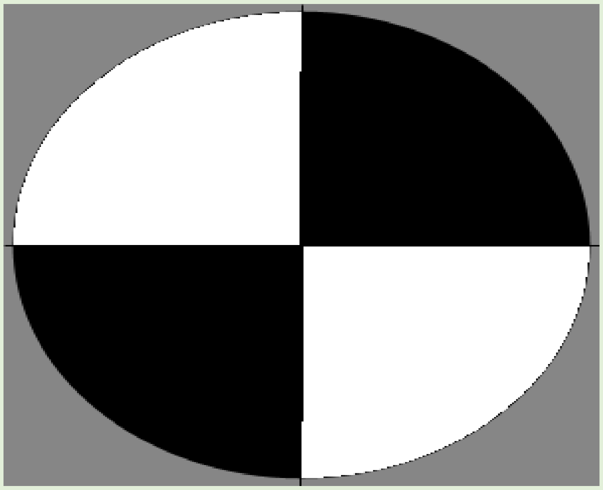
Simple test procedure:

Collect water samples in a clear quart sized jar, make sure to label each jar with the correct source. Leave the jars in a place where they will be undisturbed. Watch how fast the particles settle to the bottom. If the water clears in a week or less, any muddiness seen beforehand was caused by mechanical disturbances and is not a cause for alarm. If the particles do not settle after a couple of weeks, Whitaker Ponds has a clay turbidity issue.

Secchi Disk procedures 6:

Have students assemble the Secchi Disks or have the disks prepared beforehand

1. Divide the Plexiglas disk into four equal quadrants and paint the quadrants alternating black and white. Let the paint dry fully.
2. Attach the metal disk to the unpainted side of the Plexiglass disk using the eyebolt, nuts, and washers.
3. Tie the cord securely to the eyebolt. You may want to mark the cord with a permanent marker in 0.5 or 1 m increments to make measurements easier to read.



Using the Secchi Disk at Whitaker Ponds

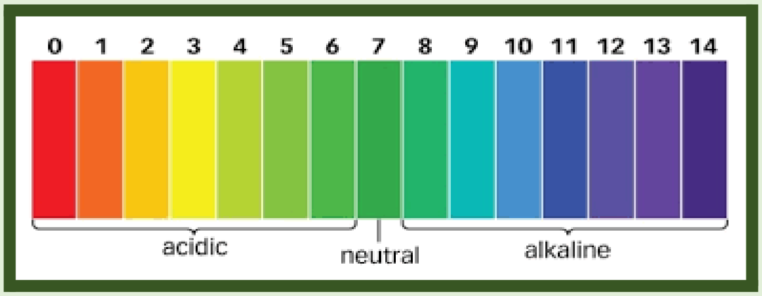
1. Slowly lower the Secchi disk into the water until it is no longer visible. Record this depth.
2. Slowly raise the disk until it just becomes visible once again. Record this depth.
3. Average the depths from steps 1 and 2 to get the Secchi depth.
4. This may be repeated for a measurement of precision.

Note: When taking measurements with a Secchi Disk we need to consider that the depth can vary because of the difference in the student's visual abilities. The Secchi Disk is also dependent on external variables in sunlight intensity and wave action. Take repeated measurements, during the same time of day, to aid in resolving the variables.

Analyzing the Secchi Disk Date

Turbidity measurements can vary between different environments and different times, it is useful to compare the Whitaker Ponds data from samples taken at different days or to compare Secchi depths from other sources. You can find examples of Secchi depths at [The Great North American Secchi Dip-In Records Website]

pH and Water Quality



Discuss with the students the pH scale and that pH is the measurement of whether water is neutral, acidic or alkaline (basic). Plants, animals and microorganisms must live in an environment which supports an optimum range of pH, in general the environment is healthy when it is nearly neutral, or close to the pH of 7.0. For example, the average blood of pond fish is 7.4 pH[9], therefore the optimal pH of Whitaker Ponds would be close to 7.4. The acceptable range would be from 6.5 to 9.0. Fish become stressed in acidic ranges of 4.0 to 6.5 pH and alkaline ranges of 9.0 to 11.0 pH. Fish growth is diminished in water that has less than a 6.5 pH, and reproduction ceases and fish fry (offspring) die at 5.0 pH. If Whitaker Ponds become in the range of 4.0 or less or greater than 11.0, the fish will die. In general, if the pH is less than 5 or greater than 9, Whitaker Ponds will support little aquatic life.

Testing for the pH of Whitaker Ponds

Materials needed:

- Litmus pH strips
- 6 jars
- Tap water
- Filtered water
- Salt
- Baking Soda (alkaline control)
- Vinegar (acidic control)
- Whitaker Ponds water sample

1. Fill each jar with the different type of water making sure to label each one with the sample it contains: tap water, filtered water, salt water, baking soda water, vinegar, and Whitaker Ponds water sample
2. Ask students to make predictions on whether each water sample would be acidic or alkaline
3. Have students use Litmus paper to test each of the samples, starting with the two controls
4. As the Litmus paper is drying review the different colors on the pH scale and what they mean
5. Have student record the results

Analyzing the data

- Ask the student how their predictions compared to their results
- How did Whitaker Ponds water sample compare to the other samples? Was it acidic? Was it alkaline? Was it in a healthy pH range of 6.5 to 9.0 pH?

- Have the students discuss if Whitaker Ponds is a healthy environment for aquatic life

Resources

(1) Marchant, R., & Yule, C. M. (2018). Aquatic Macroinvertebrates. *Freshwater Ecology and Conservation,* 240-254. doi:10.1093/oso/9780198766384.003.0011

(21) Parkes, S. (n.d.). Retrieved December 01, 2020, from https://www.fs.fed.us/rm/boise/research/techtrans/projects/scienceforkids/watersheds.shtml

(3) (n.d.). Retrieved December 02, 2020, from https://www.riverwatch.ab.ca/science/how-to-monitor

(4) Magnificent Macroinvertebrates. (2018, July 24). Retrieved December 02, 2020, from https://smile.oregonstate.edu/lesson/magnificent-macroinvertebrates

(5) Whitaker Ponds Natural Area. (n.d.). Retrieved December 04, 2020, from https://www.portland.gov/parks/whitaker-ponds-natural-area

(6) Measuring Lake Turbidity Using A Secchi Disk. (2020, November 03). Retrieved December 04, 2020, from https://serc.carleton.edu/microbelife/research_methods/environ_sampling/turbidity.html

(7) Figure 2f from: Irimia R, Gottschling M (2016) Taxonomic revision of Rochefortia Sw. (Ehretiaceae, Boraginales). Biodiversity Data Journal 4: E7720. https://doi.org/10.3897/BDJ.4.e7720. (n.d.). doi:10.3897/bdj.4.e7720.figure2f

(8) PH Scale Defined - What is pH? (n.d.). Retrieved December 04, 2020, from https://www.jansanconsulting.com/ph-scale.html

(9) Stevens, R. (n.d.). Fish Pond Water Quality: As Simple as Chemistry 101. Retrieved December 04, 2020, from https://www.noble.org/news/publications/ag-news-and-views/2009/july/fish-pond-water-quality-as-simple-as-chemistry-101/