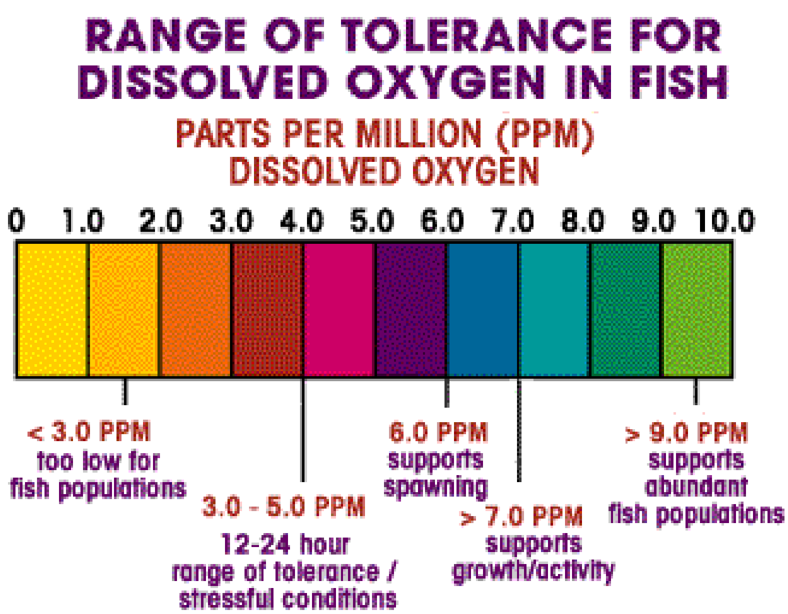
CORE LESSON: Water Ecology

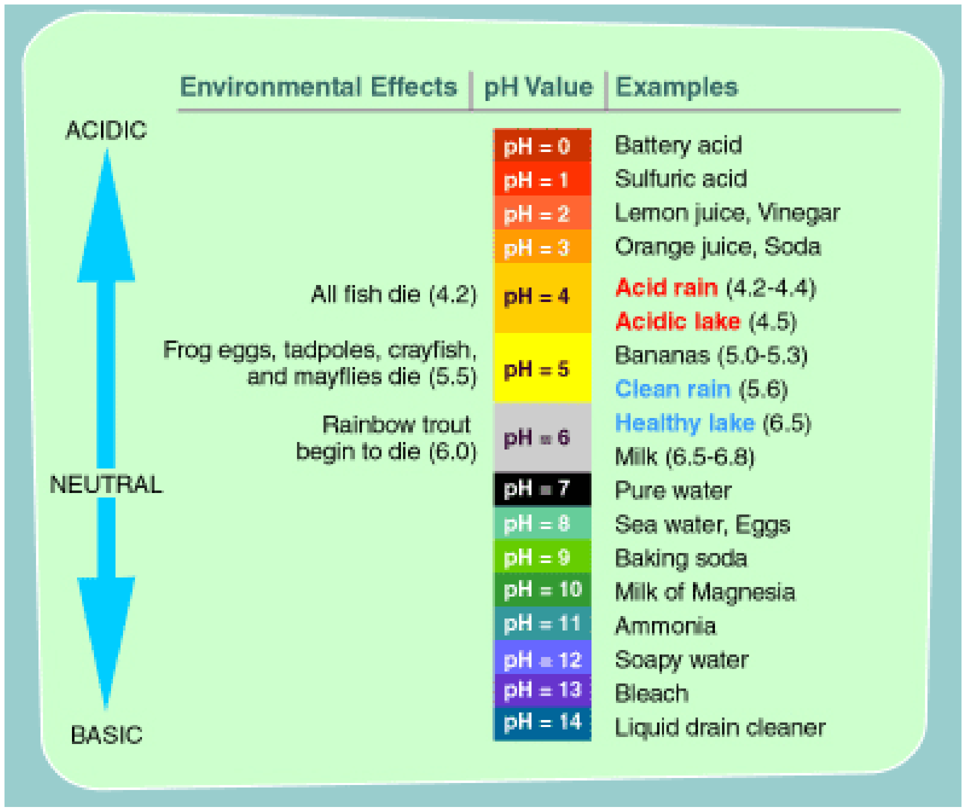
Objectives and Summary: Students will discuss and assess the ecological health of the South Fork of the Snoqualmie River using evidence gathered through testing water chemistry and by identifying the macroinvertebrates found there. Students use their journals to record data and observations. After the introduction, the class is divided into two groups (macroinvertebrate sampling and water chemistry). The groups will rotate after about 30min. ***Teachers can also expand and extend this activity by including additional elements like watercolors/oil pastels, River Sense, or the Long Haul. Discuss with Waskowitz staff in advance if you would like to plan for additions to the lesson as described here. For instance, if you wish to add a third rotation (River Sense, etc.) to the typical two station format (macros and chemistry), this will affect timing and material needs. Waskowitz staff needs to be involved in this planning. Ideally, you should indicate this option on your planning form.***

Background: The health of the river impacts plants, fish, insects, humans and all other organisms living in or near the river. Scientists use a variety of methods to gather quantitative and qualitative data to determine stream health. They include measuring:

- Dissolved O2, (DO) *and* Temperature: This number can tell us how much O2, in parts per million (ppm), is dissolved in the water. The amount of DO is a very important factor, as most aquatic life requires O2 just as terrestrial life does; aquatic animals often access this resource via specialized organs called *gills*. Without enough DO, fish and other aquatic organisms will suffocate and die or flee the area. DO is affected by water temperature (cold water can hold more DO than warm), turbulence (still, stagnant bodies of water have lower DO), and the presence, absence, and state of bacteria/algae. ***Temperature*** is an important factor in its own right as well. Water temperature influences many important factors in the aquatic world including how rapidly eggs hatch, and how easily diseases spread.



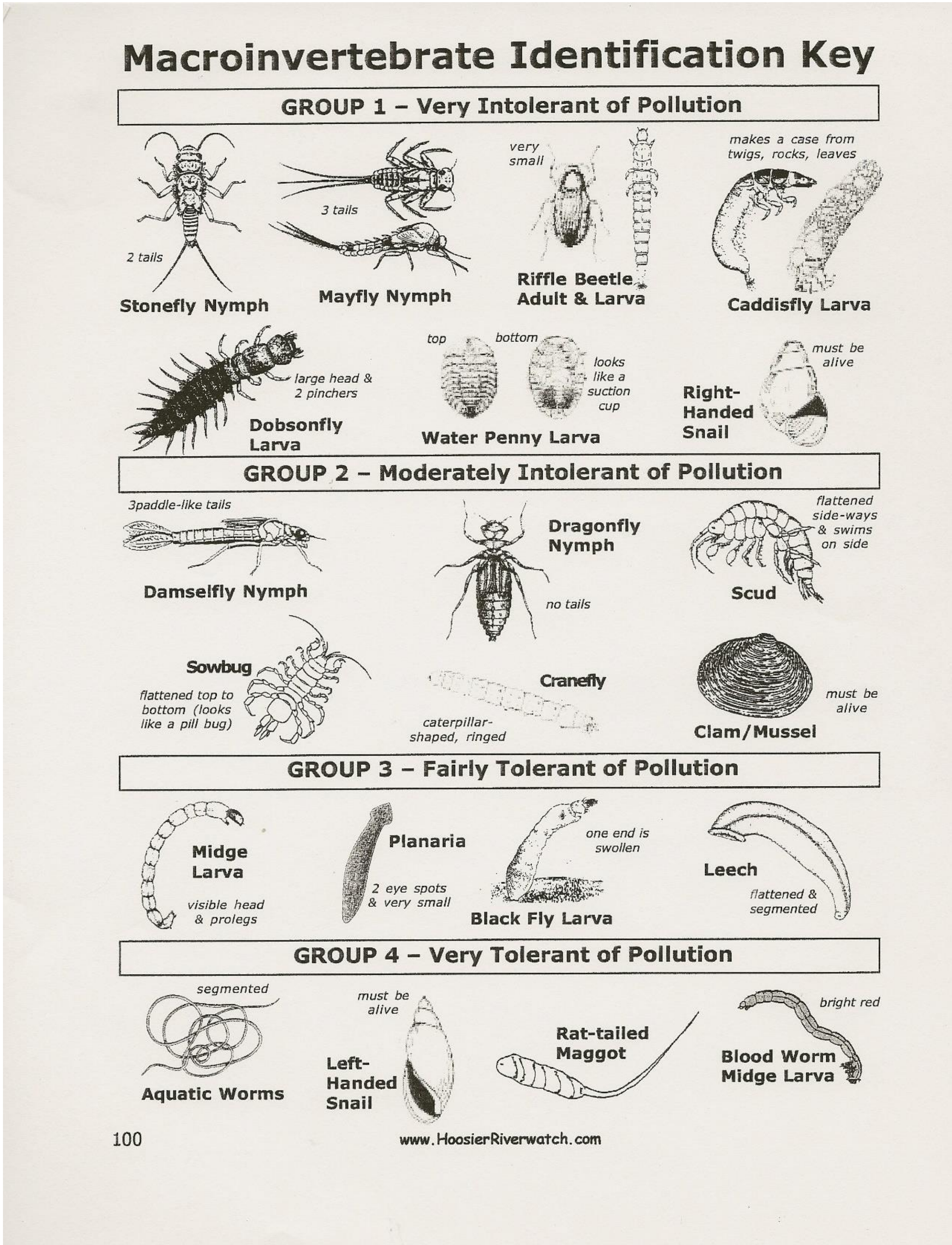
- pH: Is the measurement of the abundance of a substance's Hydrogen ions, and is used to determine acidity or alkalinity. Fresh water aquatic animals need a pH close to neutral (7). In the wild, H2O quality issues arise when water becomes too acidic. This can be the effect of chemical pollutants in the water, though other environmental factors affect pH as well.



- Phosphorous: Element P is one of life's key building blocks. However, high levels of phosphorus in water is associated with a variety of water quality problems. In our part of the world, we want our lakes, streams, and rivers to generally have low levels of phosphorous, under 24ppb (parts per billion) or .1 mg/L. Many pollutants can contribute to excess P, including agricultural run-off laden with fertilizer, and the sewage of livestock, pets, and humans.

- Macroinvertebrates: Macroinvertebrates are organisms visible to the naked eye that lack backbones. Examples include such aquatic animals as worms, snails, diving beetles, and the larva of many different insects. The presence or absence of different types of macroinvertebrates can tell us lots about water quality because some of these creatures are known to be very sensitive to water chemistry and other environmental factors. Water where these sensitive creatures are rare or absent may be contaminated and relatively "unhealthy".

See chart below. ***Note that the presence of group 4 animals in itself does not signify polluted waters; rather, the lack of other groups is a better indicator or poor water quality***.



Standards:

Materials: H2O chemistry and macroinvertebrate collection materials will be set up by Waskowitz staff and can be found at the River Shelter and boot shed, respectively. Discovery Guides and pencils.

Location and Duration:

- Introduction: 15-20min, River Shelter
- Macros: 30min, In the shallows next to the boot shed
- Water Chemistry: 30min, The River Shelter

HS Leader Role: Instruct and facilitate the H2O chemistry rotations. If you have enough leaders, they are also available to assist in macroinvertebrate collection. ***However, teachers must be present at all time to ensure safety for the duration of this activity.***

Procedure

Introduction: This is the South Fork of the Snoqualmie River. Downstream, it joins up with the Middle and North Forks, goes over Snoqualmie Falls, continues through towns like Carnation, Snohomish, and Everett, and eventually flows into Puget Sound. For the next hour or so, we are going to do water quality testing to determine if this is a healthy river. What sort of data do you think scientists might collect to help them decide if a river is healthy or not? What kind of observations can we make? What kinds of things can we measure? There are many good answers:

- Conduct chemical tests to measure the amount of dissolved O2
- Measure pH
- Measure the amount of phosphorous dissolved in the water
- ID the different macroinvertebrates living in the water and on the bottom of the river

Open Discovery Guides to where they can make begin by making some qualitative observations. Do they think the river is healthy? Why or why not? After completing the introduction, divide the class in ½ and begin rotations. Switch after approximately 30min.

Lesson/Activity:

Water Chemistry

1. Divide students evenly between 3 tables. Open Discovery Guides to corresponding pages.
2. Remind students that they are going to be scientists and will collect some chemical data/evidence to see if the river is healthy!
3. Have students at each table divide up jobs: Who will test phosphate? pH? dissolved oxygen? temperature? Who will be the time keeper/team manager?
4. Carefully open test kits, sort materials into different tests. Place extra chemical tabs back into bucket. (match up tube, tablet, direction card, and extra info sheet)
5. Remind tables that they will run one of each kind of test. Have students running chemical tests read their small direction cards carefully.
6. The leader needs to hand out a stopwatch and thermometer to each table manager and check that equipment is sorted correctly BEFORE students get water samples! Use cheat sheet to help:

- **DO: 2 black DO tabs and small glass tube overflowing with water (minimize the time water sits in the tube before testing, as DO will rapidly decrease). Wait 5min after tabs have dissolved to compare color.**

- **Phosphate: 1 Blue "PHOS" tab and tall plastic tube with 5ml of water. Wait 5min after tab has dissolved to compare color.**

- **pH: 1 black "WR pH" tab and tall plastic tube with 10ml of water. Students can immediately compare color.**

- **Temperature: Remove from cover and hold the thermometer on the river bottom for 1min. Read and record temp. in Fahrenheit and Celsius.**

7. Before beginning test, verify that table leaders know how to use the stopwatch, and make sure that everyone records data. Students can bring tubes to the river to collect samples, but must come back to the tables to run the tests (except temperature-taking). ***Supervise river safety while this is happening***. All tests can be run at the same time. Help students run tests, record results, and figure out what the results mean. Ask open-ended questions and model curiosity and enthusiasm!
8. After completing the test, use this guide and laminated resources to help students interpret the results:

    DO chart: A healthy river should have high DO, over 7ppm. Just like we need oxygen, fish and many macroinvertebrates need oxygen to breath, even under water. Waves, rapids, and aquatic plants help mix oxygen into the river. If DO level drops below a certain level (below 4ppm), many organisms become stressed and may die. Cold water can hold more dissolved oxygen than warm water. When organisms like algae die and decompose, oxygen is consumed.

    Phosphate: A healthy river should have low amounts of Phosphate, below 24 *ppb*. Phosphate is a chemical nutrient that plants and animals need. Plants don't grow well if there is too little phosphate. This is why we put lots of phosphate in fertilizer. There is also a lot of phosphate in soaps and detergent. Phosphate is also found in human and animal sewage and industrial waste. A little phosphate is a good thing, but when fertilizers, detergents, and waste collect in rivers and lakes from polluting, then it causes problems. High phosphate levels can cause algae to bloom (like in a super green swimming pool). When algae die and decompose, it consumes dissolved oxygen, which in turn can stress or kill other aquatic life. High levels of phosphate can also cause deformities and other problems inside the bodies of animals.

    Temperature: In Washington, a healthy river should be cold; many of our river plants and animals are adapted to live in a cold environment. For example, salmon, trout, mayflies, and stoneflies like to live in water temperatures below 55°F. Temperatures above 77°F are lethal to many of our fish and insects. Cold water can also hold more dissolved oxygen than warm water.

    pH: A healthy river should have a neutral pH, around 7 (between 6.5 and 8.5). pH measures how acidic or basic a substance is on a scale of 1 to 14. A low number, like 1 or 2, is highly acidic like stomach or battery acid. A high number, like 13 or 14, is highly basic like bleach or oven cleaner. Both extremes are very strong and corrosive, and can do lots of damage to living things. A pH in the middle of the scale (7) is called neutral. Most living things need to live in a nearly neutral environment. Many things can affect pH. For example if carbon dioxide levels or temperature goes up, pH goes down (become more acidic). Pollution can also affect pH.

9. Oversee the cleanup process. You are responsible for making sure the next group has a clean and organized table. Make sure that table managers are taking care of the following:
    - Dump test tube contents into waste water bucket by the sink.
    - Rinse test tubes out in the sink.
    - Put test tubes back into the table bucket with caps off.
    - Throw away any used chemical tab wrappers.
    - Put small test direction cards back in the bucket.
    - Collect the thermometers and stopwatches and leave them on a table.
    - Gather all other large documents (info sheets, maps, etc) into a pile.
    - Check for 5 pairs of goggles per table.
    - Look for any pencils, garbage, or other materials on the ground around/under the table

Macroinvertebrates

At the Boot Shed:

1. Remind students that they are going to be scientists, and will collect some macroinvertebrate data/ evidence to see if the river is healthy.
2. Review: Many of the animals that live in this water are macroinvertebrates. They are big enough to see with your eyes (macro) and don't have a backbone (invertebrate). Examples include crayfish, snails, beetles, and worms, but the kind that we'll likely find are the larval/nymph stages of insects like mayflies and dragonflies. Different kinds of macroinvertebrates are more sensitive to pollution than others. The species we find living in the river can tell us about the river's health.
3. Review the Macroinvertebrate pollution sensitivity chart.
4. Students take off shoes and socks and tell leader what size/color boots they need using the color-coded chart on the shed door.
5. Leaders get in the river and monitor for safety: ***Always stay in the side channel, no running, goofing around, throwing rocks, splashing, etc!*** Be enthusiastic and help kids search!
6. Don't dig or scrape with nets. Look under lots of rocks. Gently transfer critters to the small, plastic collection bin. ***Tips for collecting:***
    - Look in a variety of habitats; both in pools and in flows.
    - Lift up rocks and look under them for any little animals moving around. They might be large or very tiny!
    - When you find macros stuck to rocks, bring the rocks to the collection bin near the shore, hold them in the water filled bin, and gently try to shake off the macros. Sometimes splashing water up onto the rock helps. You can also use the paint brushes and ice cube

trays during collection; the paint brushes are a gentle and safe way to dislodge some creatures. Do not injure the animals!

- Gently place rock back where you found it. Don't throw it.
- Don't give up! Keep looking! Sometimes finding things takes a while…
- Working in pairs, one student can lift a rock up from the bottom, keep it under the water, and shake it around. Another student can hold a net just downstream of the rock. Nets can be gently emptied into the collection bin.
- Nets can also be moved around in the water, especially focusing on areas near the shore around any plant debris. Do not drag nets along the bottom or pick up rocks with them.

7. After collecting, students take boots off, dump out any water and line them up in pairs under the shelter.
8. Nets go back into the bucket.
9. Put boot pairs away in the shed on the correct color shelf
10. Carry collection bin over to viewing tables.

At the Viewing Tables:

1. Bring the ice cube trays and paint brushes with you from the river to continue transferring critters from collection bin to viewers, not the viewer caps! Include some water.
2. Open Discovery Guides to corresponding pages.
3. Help students identify their macros and what group they belong to using the charts at the tables.
4. Help them make a detailed drawing of their macros.
5. Facilitate sharing of observations and data between tables.
6. Help students understand what their data tells them about the river's health. Remember that Group 1 is very sensitive to pollution whereas group 3 are very tolerant of pollution.
7. Facilitate clean up:
    - Gently transfer specimens from viewers back to collection bin; empty bin and return to boot shed.
    - Organize and evenly distribute the viewers and charts on the tables.

Conclusion: Reconvene both groups at the River Shelter and ask students to share the evidence they gathered at each of the stations and what it tells us about the river's health. How do the choices we make at our homes and in our communities affect our rivers and Puget Sound (where all our rivers end up)? How can we better protect and preserve our waterways?

Extension: ***Teachers can also expand and extend this activity by including additional elements like watercolors/oil pastels, River Sense, or the Long Haul. Discuss with Waskowitz staff in advance if you would like to plan for additions to the lesson as described here. For instance, if you wish to add a third rotation (River Sense, etc.) to the typical two station format (macros and chemistry), this will affect timing and material needs. Waskowitz staff needs to be involved in this planning. Ideally, you should indicate this option on your planning form.***

Notes: