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WEEK ONE: CLASSROOM BASICS LAB MEETING

This manual is intended to supply information necessary to participate in the Miller Foundation Biology Outreach Program by detailing the activities and experiments for each unit, as well as practical tips for the classroom. The manual includes background information for teaching science in the classroom and detailed instructions for each activity.

Please read the following to help prepare you to work with the outreach program and to understand what is expected of Reed teachers. Also, please retain and utilize this document as an information source throughout your time with the Outreach Program.

The main goal of the Outreach Program is to teach students that science is a process. All scientific inquiry is based on the scientific method of problem solving. All grade levels need to understand this concept. Scientists pose questions by determining a hypothesis, problem-solve by doing experiments and persuade peers by presenting their results. All the experiments we do are set up this way and students should also be expected to approach questions in this way.

Sharing Science with Children: A Survival Guide to Entering the Classroom

Utilize your group members. Rotate responsibilities within your group for presenting information, organizing materials, setting up, or communicating with your teacher so that no one volunteer is overburdened.

Prior to visiting the classroom:
• Assemble your notes and materials in advance. Find out if you will have to pick up any extra materials at Reed for the activity. Run through experiments, activities and think about what you will be saying to your class or group.
• Prepare to use terminology that is appropriate. If there are new concepts students need to know, either let the teacher know beforehand to help students learn them or be prepared to spend time going through new vocabulary words.
• Arrive at least 10 minutes early to prepare and set-up for your class time.

In the classroom:
• Share yourself- Let students know of your specialties when they apply but try to keep it to subjects they understand and are familiar with (i.e. you are a cell biology student, did an independent project on plants, etc.). Have a personality & be enthusiastic. Speak loudly, clearly and slowly- keep tangents to a minimum and stay focused on the topic.
• Involve the students in the doing- Your goal is to arouse curiosity and excitement. When you must lecture, bring props, things for the students to handle, or somehow involve the students in your presentation. But remember to keep all lecturing to a minimum and have the students learn about the topic through the experience of doing the activity.
• Apply concept to everyday life- How could you use the steps of the scientific method to solve other sorts of problems? Current events and real-life practical applications are also great for drawing students in.
• Stimulate thinking by asking questions- Have students make predictions, explain, state an opinion or draw a conclusion.
Teaching Tips:

- **LEARN STUDENT NAMES**
  - Make eye contact. Smile. Walk around the classroom or sit with students. We are trying to make this a fun experience.
  - Use a prearranged signal to get students’ attention and wait until you have it before continuing. Ask teachers for help with discipline.
  - Praise attentive, helpful behavior.
  - Organize materials and your lesson plans in advance. Give specific directions to students to keep them on track.
  - Use student volunteers to help distribute materials and handouts.
  - Call on different members of the class. If an incorrect answer is given, help them re-think the facts. Wait a few seconds before calling on students to answer a question so the whole class has time to think about it.
  - Model good safety practices!

**PPS teacher suggestions:**

1. If your prepared material does not last the entire length of time **do not** try and draw something out. It is better to bring things to a conclusion and close than to aimlessly fill time.
2. You should always **plan your lesson ahead of time**.
3. **Do NOT lecture for more than 10 minutes**, including giving directions for the activity or experiment. Students should learn about the subject matter as they independently work through an activity.

**Learning Characteristics of 3-5th Graders**

**As a thinker-**

- Still needs to see in order to believe, begins to understand concepts as well as objects, understands hierarchical classification systems.
- Can combine, sort, multiply, substitute, divide.
- Begins to generalize, formulate hypotheses, use systematic problem-solving strategies, likes to memorize and learn facts.

**As a learner-**

- Understands rules and can follow them.
- Likes group activities and excursions.
- Is a great socializer and eager to fit in.
- Considers fairness to be important.
- Takes initiative and is self-motivated.
- Is becoming an independent learner.
- Is a perfectionist who will practice the same thing over and over again.
- Can sit still and listen for 5-10 minutes.

Always take advantage of student’s natural curiosity by using their questions and interests as examples or to demonstrate the point you are trying to make!
The Scientific Method ~ OHECK!

Every time an experiment is performed in the classroom, students should be expected to know and apply the steps of the scientific method. As students become more comfortable with the process it will be easier for them to approach any problem, scientific or otherwise. Outreach uses OHECK: Observation, Hypothesis, Experiment, Conclusion, Knowledge

Oregon science standards have split scientific inquiry into four main sections:

1. **Forming a Question or Hypothesis**
   - Make observations.
   - Ask questions or form hypotheses based on those observations which can be explored through scientific investigations.

2. **Designing an Investigation**
   - Have control variables.
   - Communicate procedure so that it is repeatable by others.
   - Design an experiment that answers the testable question; one that is reliable and will provide valid data.

3. **Collecting and Presenting Data**
   - Record data accurately and consistently and deal with anomalous data.
   - Create displays for measurement, such as tables.
   - Transform the data into displays, such as graphs.

4. **Analyzing and Interpreting Results**
   - Summarize results and use them to support conclusions that answer the original question.
   - Apply scientific theories, models etc. to provide explanations.
   - Identify possible sources of error.
   - Suggest further experiments or testable questions.
Microscopes

Microscopes are on carts so they can be used in multiple classrooms throughout the day. Always return the microscopes on the cart to their proper storage area so groups following you can utilize the microscopes. As with all supplies, the teachers do not have time to clean up after you following your time in the classroom so return everything where you found it before you leave.

Prior to using the microscopes for the first time, lead the students through quick instructions on how to use the scopes, especially in terms of proper safety and 40X objective lens use, to keep them from being frustrated with the scopes. This is true even with the older students who may be familiar with the scopes already.

Safety Instructions for all microscopes:
- Scopes should always be 6 inches from the edge of the table or counter.
- Always carry the microscope with two hands, supported at the base and arm.

Safety Instructions for compound scopes only:
- After you switch from the low to high objectives ONLY use the fine focus.
- NEVER start at 40X as you can damage the lens by hitting the slide.
- Don’t let the objective touch the cover slip.

Tips for teaching microscope use:
- Show examples of the expected image and describe relative size of objects.
- ALWAYS model the correct way of using the microscope first, then pick one student to copy what you just did, and finally let the whole class go and use their own microscopes.
- When finished remove all slides and watch glasses, turn off the light, cover the scope and tidy up the area.

- Tips for compound scopes only:
  - Go over the basic parts of the microscope: eyepiece, arm/limb, objective lens 4X (low), 10X (medium), 40X (high), slide holders, stage, iris diaphragm, light source, light switch, coarse focus, fine focus, base.
  - Students should always start on low power magnification (4X) and work up to higher magnifications.

A video scope is available for you to demonstrate what students will be observing. The camera fits into the tube behind the eyepiece on the microscope. The cord from the camera is plugged into the A/V input socket on the TV. Finally, you must pull the small knob to the left of the eyepiece in order to direct the image to the camera and not to the eyepiece. Make sure microscope and camera power is turned on and that the TV is on the correct channel for video.
Observation Day and Intro to Reed Outreach

Objectives
1. Briefly introduce yourself and the program
2. Observe your assigned class
3. Learn student names

Purpose
After briefly introducing yourself and the program (5 minutes), you will observe your assigned classroom. Watch the teacher carefully and note their classroom management style. While observing the class you should also create a seating chart with the student’s names, then try to learn those names. You will have a much easier time with class management if you know names. “Hey you, cut it out” is not nearly as effective as “Jane, cut it out”. Or imagine calling on students after asking the class a question if you don’t know the names. “You. No, not you, you behind, with the dark hair, no, the other one with dark hair, yah you, yes, go ahead....” vs. “Jane?”

Things to think about while observing:
1. How does the teacher quiet the class?
2. How much noise/disorder is allowed before teacher intervention?
3. Are there particular students allowed to move about the classroom during instruction?
4. Which students seem the most engaged? Which students are clearly not engaged? Why do you think that is? Teaching style? Lesson content? Hunger?
5. How does the teacher interact with his/her students?
6. Do you have ESL students in your class?
7. How loud is the teacher?
8. Are there students assigned tasks such as paper-passers?
9. What is the energy level of the teacher?
10. What is the energy level of the students?
**LESSON 1: WATERSHEDS**

**WHAT IS YOUR ECOLOGICAL ADDRESS?**

**Objectives**
- Introduce the scientific method (OHECK)
- Introduce the concept of a watershed
- Practice observing and recording observations

**Background**

**The Scientific Method**
Understanding of the scientific method is paramount! By the end of the semester your class should have a full and complete understanding of the scientific method through use of the pneumonic **OHECK**: Observation/question, Hypothesis, Experiment, Conclusion, Knowledge. When we are finished, students should be able to form a hypothesis, design their own simple experiment and relate the results to the original hypothesis to help form their conclusion. This is our goal!

**Watersheds**

The Oregon Department of Fish and Wildlife (ODFW) defines a **watershed** as the land area from which water, sediment and dissolved materials drain to a common watercourse or body of water. Hence, all land on earth is a watershed. The boundaries of a watershed are defined by the surrounding **topography**. Since water flows down hill, points of elevation such as ridgelines, mountains, or hills most commonly define watershed boundaries.

Both Reed College and your elementary school are located in the **Johnson Creek watershed** which is part of the Willamette River watershed which in turn is part of the Columbia River watershed. The Johnson Creek Watershed is our ecological address. In this unit we will be studying the ecology of our watershed, including the charismatic mega-fauna of Johnson Creek: salmon. But first, we need to establish a basic understanding of a watershed and locate ourselves within one.

Johnson Creek flows 26 miles from its headwaters near the Sandy River to its confluence with the Willamette River, passing through four cities (Gresham, Portland, Milwaukie, and Happy Valley) and two counties (Clackamas and Multnomah) along the way (JCWC). The Johnson Creek Watershed is comprised of several smaller watersheds, called subwatersheds. These subwatersheds include Kelley Creek, Crystal Springs, Sunshine Creek, Butler Creek, Veterans Creek, and Badger Creek (JCWC).

Salmon and trout are a part of our community’s history. Salmon runs in Johnson Creek helped feed Clackamas Indians, as well as the farmers and others who settled here later. There are stories told of salmon runs so plentiful the fish could be caught with a pitchfork, and were sold for ten cents. Some people say that the creek was so thick with fish during the fall runs that you could walk across the creek on the fishes’ backs. This is not the case today (JCWC).

Along with raising salmon eggs to fry in the classroom, you will be conducting investigations into different aspects of our watershed. Each experiment will tie back to the watershed by the placement of class data tables and graphs around the Johnson Creek map you will introduce in the classroom today.

Background information sources:
- Johnson Creek Watershed Council (JCWC) [http://www.jcwc.org/johnsonCreek/creek.htm](http://www.jcwc.org/johnsonCreek/creek.htm)
Lesson Plan

Re-introduction and Rules – 4 minutes

1. Remind the class of your names. Set up rules for appropriate behavior, asking questions and conducting labs. Ask how their teacher recaptures the class’ attention (counting down from 5, rhythmically clapping, etc).

Question Box – 1 minute

2. Introduce a question box and encourage kids to write down science questions and put them in the box for you to answer the following week. The box stays in the classroom.

Scientific Method: OHECK - 10 minutes

3. Introduce the scientific method. First ask if anyone knows what the scientific method is or what they think it is. Have them turn to the OHECK worksheet in their folder while you write O H E C K in big letters (vertically) on the board. As you go through the OHECK worksheet write definitions of each step on the board AFTER brainstorming with the kids their definitions. Tell kids the scientific method will be reviewed at the beginning of each class (offer sticker prizes for their Outreach folders).

Watershed Observation: Go Outside!- 10-15 minutes

4. Tell your students that you will all now practice the first part of the scientific method: observation by making detailed observations of their watershed. Part of being a good scientist is making detailed observations and effectively communicating or describing your observations to another person.

Have the students take their folder and a pen or pencil with them and quietly line up to go outside and observe their watershed. This is an individual activity. You will be taking the class out to the school yard, or a park if one is very close. Have them form a circle and then turn to face outside of the circle, take three big steps and sit! They should be fairly evenly spaced with four to five feet between each student. Now they are to write/draw everything they observe for ~5 minutes in silence, no discussion.

Note that you have not defined a watershed yet or even much discussed the topic with the kids. If some ask what they are supposed to observe, direct them to write/draw whatever they see before them (could be houses, buildings, play ground equipment, grass, trees, storm drain, cars, people, squirrels, ants etc.)

Watershed Activity- 10 minutes

5. Transition to watershed activity: Have the class gather around and discuss the different observations they made of their watershed. Ask when rain falls on all of the things they just observed in their watershed, where does it go? Then begin the following activity which will define a watershed:

a. Divide into small groups. Tell the class they will be making model watersheds simply by crumpling up a piece of paper.

b. Pass out one blank sheet of paper, one blue wet erase marker and one small water bottle to each group of three students.

c. One student crinkles the paper into a tight ball and then gently pulls the paper flat again without smoothing the paper entirely. The paper should look
like a mountainous relief map.

d. The second student traces the ridges (high points) on the paper with the blue wet erase marker without going down into any of the valleys. A drop of water will roll down one side of a ridgeline into one watershed or roll down the other side and enter another watershed. The wet ink should show this pattern.

e. STOP and ask the students what will happen when the model watershed is “rained” on? Specifically, ask them where will the water go? Before spraying the model, tell the students you want them to observe the direction of water flow.

f. The third student “rains” on the piece of paper by gently squirting with the water bottle. Enough rain will run the blue marker down the “hills” into “river valleys”.

g. Ask the students what happened to the blue marker? Where did it run? Your discussion should lead them to the understanding that the high points or ridgelines on their model watershed define the boundaries of a watershed. Do they know what watershed they are in now? Bring out the map!

**Johnson Creek Watershed Map – 5 minutes**

6. You will have a large relief map of the Johnson Creek Watershed and the students will have a smaller version in the folders. Have them mark the approximate location of their school in the watershed. Put another star to mark Reed and tell them they will be making a field trip to the Reed College Canyon later in the semester. The map should be displayed in the classroom for the remainder of the unit (do this after class).

   Good things to discuss on the map include: topography, can you see that water falling in the Johnson Creek Watershed will flow into Johnson Creek? Where is Johnson Creek? What river is this (point to Willamette)? What river is this (point to Columbia)?

**Return to Classroom- Wrap Up**

7. Make sure your class is back inside and settled before the end of your hour. If the previous activities move quickly and there are 10 minutes or more left in the class time, introduce the next lesson, pH. Transition by telling the class the first experiment they will conduct to investigate their watershed is a water quality experiment. You can then begin a discussion about pH. This will save you some time next week when you will conduct two experiments.
OCHECK! The Scientific Method

O ________________________________

H ________________________________

E ________________________________

C ________________________________

K ________________________________
Johnson Creek Watershed Observations

Part of being a good scientist is making detailed observations and effectively communicating or describing your observations to another person. In the space below please write a description of everything you observe in your watershed. You may also draw and label what you observe.
LESSON 2: THE RIPARIAN ZONE
BETTER THAN A BRITA?

Objectives
• understand the “basics” of pH
• model the filtration capability of the riparian zone

Background

pH
The pH test is one of the most common analyses in water testing. pH is the concentration of H+ in a solution. The pH scale ranges from 0-14, below 7 is acidic, above 7 is basic and 7 is neutral. Each increase in value away from the neutral point of 7 is 10 times greater than the previous value, therefore, small changes in the acidity or alkalinity of water can have big impacts on aquatic life. Even if fish could survive changes in pH, insects on which they feed and aquatic plants cannot. The food chain can collapse if the pH goes beyond the narrow boundaries optimal for life.

A range of 6.5-8.2 is optimal for most organisms. Acidic, freshly fallen rain water may have a pH of 5.5-6.0. Sea water usually has a pH value close to 8.0. Rapidly growing algae and vegetation remove carbon dioxide from the water during photosynthesis which can result in a significant increase in pH. In the high desert of Eastern Oregon, soils are high in alkali content so the pH of many lakes and streams can be greater than 10. Forested soils are usually slightly acidic and their influence creates a pH near 6 in the streams and lakes near them.

Riparian Zone
The riparian area is a terrestrial zone where annual and intermittent water, a high water table, and wet soils influence vegetation and microclimate. A riparian zone is the green zone of plants along the stream. Riparian areas have several unique properties: they are linear, they have a water transport channel and floodplain, and they are connected to upstream and downstream ecosystems. Water, nutrients and sediments from across the uplands of a watershed move downhill and filter through the riparian zone. Eroded sediments or other pollutants carried by moving water can be filtered out by healthy wetlands and riparian areas before affecting fish spawning habitat or causing other ecological problems.

Riparian zones are extremely important to the health of an ecosystem, not only providing the physical structure for a majority of the insect and amphibian communities but also, the roots of the riparian zone help minimize erosion along the stream corridor (Zac Perry, personal communication). Riparian zones are so important to the health of the watershed that they are protected by Oregon state law as riparian management areas (RMAs) by the Oregon Forest Practices Act which applies to all commercial forest management activities on state and private lands. On federally-owned land in Oregon, the requirements of the Oregon Forest Practices Act must always be met or exceeded.

Overview of Lesson 2
Today you will be introducing pH testing, water quality and the role of the riparian zone in mediating between the land and the stream. First you will test the pH of common liquids and then lab groups will be assigned a pollutant which they will filter through a model riparian zone. Testing the pH will be an important job to monitor water quality in the salmon tank a few weeks from now.

Background information sources:
LaMotte GREEN Water Monitoring Kit Handbook, 31.
Zac Perry, Reed College Canyon Restoration Specialist, Grounds Management
Lesson Plan

**OHECK! 2 minutes**
1. Very quickly review scientific method. Tell them they are allowed to use their notes today but soon they will have to remember OHECK without notes. Give a sticker for a raised hand and correct answer. The whole class should have their hands raised for this quick activity, but obviously only five students will get stickers so try calling on different kids each week. Knowing student names will help move this activity along.

**Question Box- 2 minutes**
2. While one person conducts the OHECK review, someone should be checking the question box and be ready to answer the questions once OHECK wraps up. If there are too many questions, you can always pick the most relevant ones and save the others for another time.

**Watershed Review- < 5 minutes**
3. Review the previous week’s lesson on watersheds, offering stickers for students who can answer questions such as the definition of a watershed, what watershed they live in and whatever else you think is important/relevant.

**pH Discussion- 2 minutes**
4. Transition from watershed review by telling the kids they will be experimenting today with a specific and important part of a watershed: the Riparian Zone. But first we need to learn about pH. While one Reedie asks students what they know about pH, the other(s) hand out materials for the pH Experiment lab. During your discussion good words to put on the board are “acid”, “base” and “neutral” with any examples of these that the kids have come up with (like battery acid or stomach acid for example). *Do not go overboard with detailed explanations of hydrogen ion concentration or hydroxyl anions.*

**pH Experiment- 15 minutes**
5. Ask the class to open their science folders to “pH Experiment”. Using the pH Experiment overhead help lead your students through the Observation/Question and Hypothesis sections of their worksheet (do not put an answer on the overhead, tell the kids you want to know what they think will happen and not copy what you think will happen)
   a. Give instructions on pH testing procedures and instruct the students to write each liquid’s name on the correct location on the pH scale after testing (give an example: “If lemon juice has a pH of 14, I would write it here on my worksheet”)
   b. Groups test their liquids and add them to the pH scale.
   c. Once each group is finished, go back to the overhead for a class conclusion on each liquid tested and a very brief chat about what they learned (the Knowledge section of their worksheet).
   d. Some students may want to go back and change their hypotheses at this point to make them “correct”. Don’t let them! Reinforce the idea that a hypothesis is simply an educated guess and therefore there is no “right” or “wrong” answer, there are only supported or unsupported hypotheses. That last part may be lost on them.....
Model Riparian Zone Discussion- 5 minutes

6. Transition from pH Experiment by telling the class pH is the most common measure of water quality. If the pH of tested water is not close to 7, then we know there is something in the water, perhaps a pollutant, changing the pH.

Introduce the term riparian zone, perhaps write it on the board. Using the background information for this lesson, discuss with your class how a riparian zone can act as a filter to remove pollutants and sediments from water. **See if your class can come up with the experiment on their own** Ask how they would test to see if a riparian zone removed pollutants, etc. While this brief discussion is happening, a Reed teacher should be distributing the model riparian zones and other necessary materials.

Model Riparian Zone Experiment- 10 minutes

7. Have your class open their science folders to the Model Riparian Zone Experiment. With the use of your overhead, lead the class through the Observation/Question and Hypothesis (as before, do not answer the hypothesis).

a. assign one polluted solution to each group. As there are only 3 solutions, some groups may work on the same solution.

b. Once each group has a model, briefly walk through the different layers of the “healthy” riparian zone.

c. Record observations just like the first day. Students need to make careful notes on the color, smell (not taste!), consistency, pH (if appropriate) before and after filtration.

Class Data- 10 minutes

8. Each group now shares their results with the class as you complete the class datasheet to be hung on the Johnson Creek Watershed map. Arrive at a conclusion: did the riparian zone change the water filtering through it?

Knowledge- < 5 minutes

9. In the last minutes of class while one of the Reed teachers is cleaning up, the other should have the class fill in the Knowledge section of their worksheet. Discuss as a class what they learned today about pH, water quality and riparian zones.
pH Experiment

Observation/Question
pH can tell us if a solution is acidic, neutral or basic. What is the pH of common household items?

Hypothesis
I think lemon juice will be a(n): acid base neutral
I think tap water will be a(n): acid base neutral
I think bleach will be a(n): acid base neutral

Experiment
After testing the pH, write the name of each liquid on the pH scale at the correct pH number:

Conclusion
Lemon juice is a(n): acid base neutral
Tap water is a(n): acid base neutral
Bleach is a(n): acid base neutral

Knowledge
What did you learn about pH?
Model Riparian Zone Experiment

Observation/Question
In a watershed, water flows downhill through the riparian zone and into a stream, lake or river. What changes can happen to polluted water filtering through the riparian zone?

Hypothesis
After filtering through our model riparian zone, I think the water will be: (circle one)

- cleaner
- dirtier
- not changed

Experiment

<table>
<thead>
<tr>
<th>Group</th>
<th>Observations</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion
After filtering through our model riparian zone, the water is: (circle one)

- cleaner
- dirtier
- not changed

Knowledge
What did you learn about the riparian zone?
LESSON 3: TEMPERATURE EFFECTS ON AQUATIC ORGANISMS

Objectives
• To understand the relationship between temperature and dissolved oxygen
• To see the effect of temperature change on fish respiration

Background

Temperature and Aquatic Organisms

Aquatic organisms live with a very different set of environmental conditions than terrestrial organisms. One such difference is temperature. On land, temperatures can move quickly from hot to cold. In a 24-hour period, land temperature can easily fluctuate between 85°F down to 60°F and back, a typical Oregon summer day. These fluctuations are even more extreme in desert environments. Water temperatures on the other hand do not generally fluctuate 20 degrees in a 24-hour period and remain within a narrow range. Of course, a shallow puddle will behave differently than a deep lake; however, the general rule is water temperatures do not fluctuate as rapidly as terrestrial temperatures.

Water temperature has an effect on the amount of dissolved oxygen (DO) available to fish. As water warms, it cannot hold as much DO. In contrast, air temperature has little effect on the amount of oxygen in the air we breathe. A fish must pump water across the gills to meet its oxygen needs. If DO in the water is low, the gills must move faster to get enough oxygen for the fish to survive. Also, as a poikilotherm, fish do not regulate their own body temperature (there are exceptions, such as blue fin tuna); and therefore, an increase in environmental temperature increases the internal temperature of the organism, leading to an increase in metabolic activity and respiration. We can count gill movements to estimate the DO requirements of fish in different water temperatures.

Temperature and the Riparian Zone

Riparian areas are important temperature regulators for streams. The plants in the riparian area shade and protect the stream and its banks from the heat of the sun, creating a microclimate along the stream banks. Warm air temperatures may still transfer some heat to the stream, but less total heat energy reaches the stream than if it were unshaded. A good example of riparian zone temperature regulation is the Reed canyon. If you walk along the canyon trail on a hot summer day, the shaded south slope is much cooler than the exposed portions of the north slope. Such temperature differences have important implications for plant and animal community composition.

Overview of Lesson 3

In this lab students will see the effects of temperature on an aquatic organism, the gold fish, by counting gill beats as water temperature increases. Gill beats, or respiration, will increase for two reasons: 1) not enough oxygen in the surrounding water or 2) not enough oxygen in the fish’s blood to support an increase in metabolic activity. When you exercise, you breathe harder due to increased oxygen demand, not because there is less oxygen in the air around you. Fish don’t need to “exercise” to increase metabolic demand, we can simply raise the temperature of the water to increase metabolism. Unfortunately for fish, warm water cannot hold as much dissolved oxygen as cold water and an increase in respiration can quickly lead to a dangerous decrease in dissolved oxygen of the surrounding water, a condition known as hypoxia.

Background information sources:
Lesson Plan

OHECK!  2 minutes
1. Quickly review scientific method with or without notes, at your discretion.

Question Box- 2 minutes
2. While one person conducts the OHECK review, someone should be checking the question box and be ready to answer the questions once OHECK wraps up.

Riparian Zone Review- < 5 minutes
3. Review the previous week’s lesson on the riparian zone, offering stickers for students who can answer your review questions.

Temperature and Dissolved Oxygen Discussion- 5 minutes
4. Write on the board important terms such as dissolved oxygen, temperature, respiration, riparian zone and discuss with the students the meaning of these terms. Ask if they know what a fish breathes? They breathe oxygen just like us, respiration is the scientific word for breathing. How do fish breathe? By pushing water over their gills where oxygen dissolved in the water enters the blood stream of the fish. Your discussion should also cover the effect of temperature on dissolved oxygen levels which will lead right into the lab where the students hypothesize about the effect of temperature on respiration in fish.

Temperature Experiment- 30 minutes
5. Remember to put up your Temperature Experiment overhead as the discussion on temperature and dissolved oxygen is finishing. Have the kids turn to this experiment in their lab folders. Go through the Observation/Question and Hypothesis with the students while another Reed teacher is passing out materials. Complete lab.

Class Data- 10 minutes
6. Construct a class graph of Respiration vs. Temperature. Average the class data for breath counts at each temperature. Have students come forward to add the data points for each temperature to the graph. Connect the points to create a line graph. Hang completed graph on the JCWS map along with the class data from the previous week.

Knowledge- 5 minutes
7. Discuss with your class what knowledge they gained from today’s experiment. Have them write what they learned on their Temperature Experiment worksheet then discuss as a class.

Salmon Egg Reminder!- At the very end of class let the students know you will not be teaching the following week because of Reed’s fall break. But also tell them that the salmon eggs will arrive next week and you will learn about them the week after.
Temperature Experiment

Observation/Question

Fish behave differently at different temperatures. What effect will changing temperature have on fish respiration (breathing) and dissolved oxygen?

Hypothesis

In cold water, I think the fish will breathe (circle one): faster slower
In warm water, I think the fish will breathe (circle one): faster slower

Experiment

<table>
<thead>
<tr>
<th></th>
<th>10°C</th>
<th>15°C</th>
<th>20°C</th>
<th>25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number breaths per 15 seconds</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>Dissolved Oxygen</td>
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</tr>
</tbody>
</table>

Conclusion

In cold water the fish were breathing (circle one): faster slower
In warm water the fish were breathing (circle one): faster slower

Knowledge

What did you learn about temperature, dissolved oxygen and fish?
LESSON 4: THE SALMON LIFE CYCLE

Objectives
• Introduce students to the salmon life cycle
• Introduce food webs
• Begin salmon egg tank daily care duties

Background
The Journey of Wild Pacific Salmon
For nearly 10,000 years, salmon have used the rivers and streams of the Pacific Northwest to travel from their birthing streams to the ocean and back. A century ago, between 10 and 16 million salmon returned from the ocean each year to spawn in Northwest rivers. Today less than a million return.

Pacific salmon are extremely important for several reasons. They have been a critical food source for the people of the region, and a significant food resource worldwide. Second, salmon are an indicator species. Because salmon migrate thousands of miles, moving from streams and rivers through estuaries to the ocean and back, they provide a valuable indication of environmental conditions in those habitats. Third, salmon play a central role in maintaining biologically diverse and productive ecosystems. For example, they are prey for a multitude of species, and their carcasses bring ocean-rich nutrients to relatively nutrient-poor freshwater environments. And finally, Northwest Native American cultures and spiritual beliefs are deeply connected with the great silver fish. In fact, the Chinook salmon takes its name from a Northwest tribe.

The salmon have evolved with incredibly strong instinctive patterns. Born in freshwater streams, anadromous or sea-run species like salmon are uniquely compelled to travel to the ocean. The vast ocean food chain supports a growth rate that freshwater members of the same species cannot achieve. However, travel to and from the ocean is a very risky venture. Traveling up to a thousand miles, migratory fish are inherently vulnerable to a variety of threats, both human and natural, along the way. Only the strongest fish withstand the journey to reproduce. Of the 3,000 to 7,000 eggs in a nest, only one spawning pair will likely make it back to its original spawning habitat.

Egg Stage
Salmon begin their lives in shallow gravel beds within the substrate of the freshwater streams and rivers in which their parents were born. The fertile, reddish-orange eggs develop in the safety of the gravel. Cold, clean sediment-free water must wash the eggs and bring them oxygen. Eggs lie in the gravel through the winter, as the embryos develop. Incubation may take 50 days or longer. For example, the colder the water, the longer the incubation period.

Alevin Stage
In late winter or spring, young translucent fish with large protruding eyes, called alevins (sometimes called yolk-sac fry), hatch and lie protected under the gravel. An orange yolk sac attached to the bellies of the tiny fish carry a food supply consisting of protein, sugars, vitamins and minerals. As the fish grows, the yolk sac gets smaller. They will not leave the protection of the gravel until the yolk is used up, which can be twelve weeks or more. A flow of water is critical to alevin survival.

www.ortrout.org
**Juvenile Stage**

In late spring and summer, with yolk sacs buttoned up, or absorbed, and eyes still protruding, small fish called fry emerge upward through the gravel and begin to forage for food. They are about the length of a fir needle and stay in shallow pools near the edge where the current is slow.

When the young fish reach about two inches in length, they are known as parr (sometimes called fingerlings) and become intense feeders on plankton, small insects, worms, mussels and snails. The parr growth phase is best recognized by the development of dark bars aligned vertically along each side of the fish. The parr phase is the most vulnerable time in a salmon’s life, as they become prey for sculpins, raccoons, kingfishers and large trout. Juvenile (fry and parr) salmon will remain in the river four months to two years depending on the species before moving downstream to the estuary.

**Smolt Stage**

At four to six inches in length, salmon are known as smolts. As the parr marks disappear, most young salmon begin a physical change that triggers their downstream migration and adaptation to saltwater environment. Smolts let the current carry them downstream, tail first. Much of their traveling is done at night to avoid predators.

**Estuaries** occur where coastal rivers enter the ocean, creating a mix of fresh- and saltwater habitats. For salmon, the estuary represents the drastic transition from the river to the sea. Nutrient-rich sediment in estuaries produces nurseries for thousands of tiny organisms, upon which salmon feed. The inner waters of eelgrass beds and salt marshes provide habitat for the fish as they transition from fresh to salt water. This transformation involves complex body-chemistry changes. In addition, other physical changes occur during smolting: scales become larger, color turns silvery, and tails lengthen and become more deeply forked. Depending upon the species, salmon spend from a few days to a few months in an estuary.

Water flow is again a critical factor during downstream smolt migration. High flows mean higher survival rates. Decreased flows can increase the amount of time it takes smolts to reach the ocean and affect their ability to adjust to saltwater conditions. A delay can also increase their susceptibility to predators and disease.

**Adult Ocean Stage**

Some theories suggest that salmon follow a life cycle of going to the ocean in order to overcome the limits of food and space in freshwater habitats. Upon entering the ocean, salmon will turn toward their hereditary feeding grounds. For some it is north to Alaska. Others will feed in the deeper waters off of the California coast. To avoid predators like seals they will remain in large numbers called schools. Their two-tone coloring helps conceal them from enemies. Seen from above, they blend with the dark ocean waters; from below, they blend with lighter sky. They feed heavily on such prey as crab larvae, barnacles, herrings, sand lance, rockfish, anchovies and squid. Time spent at sea varies according to species ranging from one to five years.

**Upstream Migration**

Migration begins with salmon traveling thousands of miles in the open ocean, up to thirty miles a day and returning to their estuary of origin. This is called homing. Although still a mystery, scientists hypothesize that salmon navigate at sea with the aid of an inner magnetic map and a strong sense of day length, thus a salmon knows approximately where it is in relation to its home stream. As changing day length signals the advance of the season, the fish moves more or less directly toward the river mouth. As the salmon gets closer to the river, the salmon’s
keen sense of smell comes into play, drawing it toward water smells encountered during the juvenile phases of life. Salmon can pick up the scent of their home river with noses so sensitive that they can detect dissolved substances in parts per 3,000,000,000,000,000,000!

A unique feature of the life cycle is that salmon migrate and spawn in mass groups called stocks or runs. The fish within each stock or run has a unique “map” with special genetic codes that instruct and direct the fish’s behavior specifically to when and where to migrate and spawn. For example, the Sandy River Fall Chinook is a stock or run of salmon that migrate up the Sandy River in the fall to spawn.

Upon re-entering fresh water to spawn, salmon lose their desire to eat and live off their accumulated fat reserves. In proceeding toward their spawning grounds, the fish move quickly upstream in groups. They make their way by stages upstream, pausing for days at a time to rest in pools, often waiting for improved water flows. They tend to move as long strands, hugging the deeper channels and shaded areas of the stream. At shallow riffles, where the river steps down over a gravel ramp, running fish raise rooster tails of water as they speed over the rocks.

Salmon Courtship
Once they come to their home gravel, females search for suitable egg-laying territories to build nests, called redds. As the sac around the eggs loosen, the urge to spawn quickens. Aggressive displays between the fish occur at this time. Males chase, bite and attack to ward off competitors. Females butt other females that appear to threaten their redd.

At this stage, the final days of the salmon are near, with many changes in color and body apparent. The males of some species get humped backs, hooked jaws, and sharp canine teeth. With muscles softening, skin thickening and body chemistry changing, white fungus may grow over sores or the eyes of the fish. The fins and tail fray from pounding against rocks and wounds from the journey may mark the body.

Spawning Stage
Spawning is the process of reproduction for salmon. When a female salmon arrives at her home stream, she chooses a nesting site with just the right combination of clean gravel, adequate depth, and good flow to provide oxygen for her eggs. Once the female has selected the general location for laying eggs, she turns on her side and uses sweeping or undulating movements of her tail to dig the nest in the gravel. Every so often she checks the depth of the nest by “crouching” or lowering herself into the nest. In time, she eventually produces a cone-shaped nest up to 16 inches deep. Within that site, she may dig several nests and deposit eggs in them over a period of several days.

The digging of redds attracts males. As a male manages to ward off competitors, he joins the female in the nest in a series of courting movements. Eventually, he will move alongside the female and move his body against hers slightly. Frequently he will open his mouth in a “gape.” When the female is ready to deposit her eggs, she too will open her mouth to resist the current and help her lower herself deeper into the nest. Finally, as both rapidly vibrate their tails, the eggs and sperm, or milt, are released. A female may lay up to 7,000 eggs in a series of redds.

Kelt Stage
After the female releases her eggs, she instinctively covers them by moving upstream slightly and repeating her digging motions. This lifts gravel just above the nest, so that the current carries it into the depression. Females will defend their redds until they die, which may be a few hours or a week. Males can spawn more than once and often will leave the female, in search of another that is preparing a nest. Salmon that have spawned are called kelts.
Salmon Carcass
Most salmon spawn only once during their lifetime (semelparous), although some steelhead have the ability to spawn more than once (iteroparous) and can re-generate, return to the ocean, then return to spawn another season. Both the male and female salmon die within a week after spawning. Their carcasses float downstream, get caught in roots and limbs, line beaches and sink to the bottom of the river. Opportunists like bears, gulls, crows, and eagles dine on the dead salmon.

The death of the salmon also serves the next generation. As decaying salmon add nutrients to the rivers, they feed aquatic life that will in turn feed young salmon already growing in the gravel in the streambed. In Cascade streams, as much as 40 percent of the nitrogen and carbon in young fish and 20 percent of the nitrogen in streamside plants come from dead salmon.

Other Salmon Info
The species of salmon we are raising in your classroom is Chinook (Oncorhynchus tshawytscha). Other common names for Chinook include King, Tyee, Columbia River salmon and chub salmon. Other species of salmon found in the Pacific Northwest include Coho (Oncorhynchus kisutch) also known as silver, Chum salmon (Oncorhynchus keta), Pink salmon (Oncorhynchus gorbuscha) also known as humpy, Coastal Cutthroat trout (Oncorhynchus clarki clarki) also known as sea trout, Sockeye (Oncorhynchus nerka) also known as red salmon and “silver trout”, and Steelhead (Oncorhynchus mykiss) also known as rainbow trout.

Overview of Lesson 4
This lesson is all about salmon. You will read a story about the salmon life-cycle to the class and play a game. It is also very important to discuss the salmon egg tank and the daily care activities. You will set-up a schedule and post it next to the tank along with the daily monitoring data sheet. Your class will also have a chance to design their own experiment about temperature and egg development. They will not, however, be carrying out the experiment.
Lesson Plan

**OHECK!**  2 minutes
1. Quickly review scientific method.

**Question Box**- 2 minutes
2. While one person conducts the OHECK review, someone should be checking the question box.

**Temperature Lab Review**- < 5 minutes
3. Review the previous week’s lesson on temperature, offering stickers for students who can answer your review questions.

**Salmon Stream**- 10-15 minutes
4. If the teacher has a rug or reading area, gather the class there. Instead of jumping into an experiment right away today, you will be reading the kids a beautifully illustrated story about the salmon life cycle: *Salmon Stream*. After gathering the class on the rug, ask a few pre-story questions to gauge the children’s knowledge of salmon. Let the class know they need to pay careful attention to the story as they will be playing a game based on what they learned in the book.

As you read, spend time on each page and ask a few relevant questions such as, “Who can name the animals in this picture?” Point out the fish ladder in one picture and name the different species of salmon in another picture. Don’t just read the book, make it an interactive experience. You should also emphasize the different stages in the salmon life cycle and the environmental requirements of each stage as this information will be important in the following game.

**Salmon Life Cycle Game**- 15-20 minutes
5. Teams will be by lab group. You will be given the game instructions in your weekly group meeting. It will be a type of memory game based on your reading and discussion of the book.

**Daily Tank Monitoring Duties**- 10 minutes
6. When the game is finished you should have a complete salmon life cycle on the board including environmental requirements for each stage. Transition to a discussion on the salmon egg tank in their classroom by asking how we are fulfilling the environmental requirements of eggs, alevins and button-up fry in an artificial (tank) environment. Tell them the Oregon Department of Fish and Wildlife (ODFW) requires daily data on the tank environment and because you (the Reed student) cannot be there every day, it is the responsibility of the class to keep accurate data records on mortality and water temp. Show the class how to perform the daily tasks and set-up a care schedule so there is absolutely no confusion about who is caring for the salmon eggs.

**Experimental Design**- Rest of class time
7. This worksheet is a direct test of scientific inquiry benchmark 2 (5th grade). According to the Oregon science content standards, 5th graders are expected to “design a simple
scientific investigation to answer questions or test hypotheses”. Students can work in pairs. I highly recommend you collect these worksheets and review their answers, this will tell you which students need more attention/help during your future classes. It will also serve as a nice pat on the back when students perform well on this “test”.
ADULT SALMON* OF THE PACIFIC NORTHWEST

Chinook female

Chinook male

Coho female

Coho male

Sockeye female

Sockeye male

Chum female

Chum male

Pink female

Pink male

Cutthroat

Steelhead

*Adult spawning colors
Windsor Nature Discovery ©1996
**Salmon Egg Experiment**

**Observation/Question**

Fall run Chinook salmon eggs require cool water temperatures between 9°C and 11°C (48°F to 52°F). As you learned in the Temperature Experiment, water temperature has a big impact on aquatic organisms. What is the effect of temperature on salmon egg development?

Will salmon eggs develop slower in cold water and faster in warmer water?

**Hypothesis**

In colder water I think salmon eggs will develop (circle one): slower faster

In warmer water I think salmon eggs will develop (circle one): slower faster

**Experiment**

Now it is your turn to create your own experiment! How will you test your above hypothesis? Describe your experiment in the space below:
Lesson 5: Nutrient Runoff and Plant Growth
Part One

Objectives
- Set-up a two-week experiment
- Explore the implications of nutrient imbalance in an ecosystem
- Investigate aquatic plant environmental requirements

Background
When water passes through the uplands and riparian corridors, it picks up and carries materials to the stream. Some may be carried intact, such as small pieces of soil or organic material. But water is also an effective solvent, so some materials are dissolved and carried in solution. Even under the most pristine conditions, water in streams carries a complex mix of chemicals, many of which are nutrients necessary to support aquatic life. In small concentrations many of these nutrients are beneficial. But if concentrations are high, then the stream may be considered polluted.

Two nutrients that often create water quality problems are nitrogen (N) and phosphorus (P). Much as a weed is a plant in the wrong place, nitrogen and phosphorus, as pollutants, are nutrients in the wrong place. Both are essential for life and occur naturally in all living cells and in every ecosystem. The problem they pose for water quality is not the presence, but how much is present.

Nitrogen and phosphorus are the two elements most critical to the growth of plants. While increased plant growth might seem desirable, in aquatic environments the effects of that growth can be far from desirable. A shift to higher nutrient levels causes aquatic plants, in general, and algae, in particular, to reproduce and grow at high rates. These rapid growth conditions can have widespread effects on aquatic systems.

An increase of surface plants reduces light penetration, which in turn reduces or eliminates plant growth at greater depths. This, combined with competition for other essential needs and the relatively short life span of many of the individual plants, produces a large amount of dead organic material. Decaying plants increase the biochemical oxygen demand (BOD) in water, reducing the amount of oxygen available for fish and other aquatic life.

During periods of high photosynthesis the withdrawal of carbon dioxide for plant respiration may cause the water to become more alkaline. The change in pH and loss of oxygen from increased BOD can result in the death of other aquatic organisms or a change in the species composition of the aquatic community. This process of increased nutrients leading to a decrease in dissolved oxygen is called eutrophication.

Human activities leading to increased levels of nitrogen in a watershed include septic tanks, livestock waste, runoff from heavily fertilized lawns, gardens and golf courses. Phosphorus is a normal component of most rocks and is therefore attached to soil particles created from the weathering of those rocks. Any human activity that increases soil erosion has the potential to increase phosphorus concentrations in surface water. Industrial discharges, fertilizers, detergents high in phosphates, organic materials such as sewage, leaves and lawn clippings are all also rich sources of phosphorus.

Lesson Plan

**OHECK!  2 minutes**
1. Rapid review of the scientific method.

**Question Box- 2 minutes**
2. While one person conducts the OHECK review, someone should be checking the question box.

**Salmon Tank Duty Update- 5 minutes**
3. Ask for an update on the daily data collection of egg mortality and temperature in the salmon tank. Have there been any problems? How many eggs have died? Has the temperature remained a fairly constant 13 °C (55 °F)? Have any of the eggs hatched? Ask for a volunteer to complete a pH test (have the student complete the pH test now, while you discuss today’s lab). Most important, ask if anyone can describe the changes happening to the eggs in the last week. If you need to make new assignments for daily tank duty for the upcoming week, do that now as well.

**Nutrient Discussion and Lab Introduction- 5-10 minutes**
4. The Plant Growth Experiment is a two-week lab and the first time students write their own hypothesis and also the first introduction to “experimental variables”. Transition into this discussion by relating nutrient runoff to last week’s game on the salmon life cycle and environmental requirements. Nitrogen and phosphorus are very important environmental requirements for the health of an ecosystem; however, too much is bad (see background for lesson).

   After discussing nutrients and the “Observation/Question” for the experiment, direct their attention to the terms “control variable” and “variable” found on Plant Growth Experiment worksheet. Discuss the experiment and the different variables. A quick drawing of the experimental set-up on the board will help. Relay the importance of a control variable. What is it’s purpose? Students should begin to understand that the variables are the only things that are different between each container so we know any differences in plant growth are only due to the different nutrients. The control group is a baseline, it is what we compare all the other groups to. How would we know if the nitrogen or phosphorus really increased growth if we had no baseline of plant growth to compare it to?

**Plant Growth Experiment- 25 minutes**
5. Nothing in this lab will be “prepped” for the kids. Each group will have to label their four containers, measure appropriate amounts of nutrients for the appropriate container, measure a specific volume of DI water for each container and mass and length their aquatic plants and record this data on their Plant Growth Experiment Part One worksheet. There should be a drawing of the experimental set-up on the board from your previous discussion for the students to use as a guide. You will need to teach the class how to use the scale and maybe even how to measure in metric.

   As you walk around and help, someone should be keeping a master data table with each groups’ measurements to calculate a class average for each container. When everyone
is done you can add the averages to the overhead and the class data table which will then be hung on the JCW map. You will update the class data each week of the experiment.

**Plant Growth Experiment Hypothesis- 5 minutes**

6. Once each group has their experiment set-up and in front of them, go back and complete the hypothesis. I put the hypothesis after experimental set-up so the students could have a chance to literally grasp the experiment. Now they can see four different containers, 3 with nutrients and 1 without any additional nutrients (the control) with four plants that they have now weighed and measured. What will happen to the plants in these containers? In the next two weeks, will the control grow more than the other containers? Will the nitrogen grow the most? Ask your students, based on what you taught them about the importance of nutrients for plant growth, to write their own hypothesis for this lab. Walk around and help students individually. This will be a challenge for English language learners so give them some extra attention.

**Plant Growth Experiment Class Data- 5 minutes**

7. Don’t forget to introduce a class data sheet with the average length and mass for each nutrient condition. Hang the datasheet on the JCW map. You will add data to the table over the next couple of weeks.
PLANT GROWTH EXPERIMENT
PART ONE

Observation/Question
Nitrogen and phosphorus are vital for the growth of aquatic plants; however, nutrient over-load can lead to eutrophication. How do nitrogen and phosphorus affect plant growth in an aquatic environment?

Hypothesis

Experiment

<table>
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<th></th>
<th>DI Water (control variable)</th>
<th>Nitrogen (N) (variable)</th>
<th>Phosphorus (P) (variable)</th>
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<td>Length (cm)</td>
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<tr>
<td>Day 14</td>
<td>Mass (g)</td>
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</tr>
<tr>
<td></td>
<td>Length (cm)</td>
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<td></td>
</tr>
</tbody>
</table>

Day 7 Observations
Record interesting observations below. Do any of the containers smell funny? Do any of the containers have cloudy or discolored water? Did any of your plants die?

Day 14 Observations
Record interesting observations below.
LESSON 6: MACROINVERTEBRATES

Objectives
- Students will learn the importance of macroinvertebrates in stream health
- Introduce students to the importance of biodiversity
- Sort and classify organisms based on morphology

Background

A healthy stream is a highly diversified ecosystem. Its complex food chain ranges from microscopic diatoms and algae to large fish, birds and mammals. The amount of food available in a stream is determined by the physical and biological conditions of the area. When producers are plentiful, consumers also flourish. Diatoms coating a rock feed primary consumers such as mayflies which in turn feed higher-order consumers like stoneflies and fish.

A stream that does not support as many fish as it once did is one indication of poor stream health. However, even before changes in fish populations are noticed, biologists can tell if a stream is healthy or not by looking at the diversity of macroinvertebrates in the stream. A macroinvertebrate is an organism without a backbone that one can observe without magnification, so a large insect. A stream with a diversity of insects living in it is usually considered healthy but much can be learned about the stream by looking at the kinds of insects that make up the diversity.

In general, insects can be placed into three groups: tolerant to pollution, somewhat sensitive to pollution and very sensitive to pollution. Finding high numbers of insects tolerant to pollution, such as midges and black flies, to the exclusion of other types of insects indicates a polluted waterway. Finding high numbers of insects very sensitive to pollution such as caddisflies, stoneflies, and mayflies, indicates good water quality. There are also insects somewhat sensitive to pollution such as dragonflies, damselflies, beetles and craneflies and their presence in large numbers (in addition to the absence of sensitive species) may indicate a waterway in decline.

Much like the presence of nitrogen and phosphorus in a watershed is not the problem but the amount of these nutrients, the presence of tolerant insect species does not automatically indicate a polluted stream. Midges and blackflies are tolerant to pollution and so can thrive in a large variety of environments, including pristine and unpolluted waterways. The combination of the absolute numbers of any insect species with the diversity of species found and not found will indicate the health of the stream.

Overview of Lesson 6
You will be provided with buckets containing macroinvertebrates collected from the canyon. The buckets will need to be divided into smaller pans for each lab group to work with. This lab will assess the water quality of the area where we will be releasing the fry a few weeks from now.

Lesson Plan

**OHECK! 2 minutes**
1. Rapid review of the scientific method. It should be memorized by now.

**Question Box- 2 minutes**
2. While one person conducts the OHECK review, someone should be checking the question box.

**Salmon Tank Duty Update- < 5 minutes**
3. Ask for an update on the daily data collection of egg mortality and temperature in the salmon tank. Have there been any problems? How many eggs have died? Has the temperature remained a fairly constant 13 °C (55 °F)? Have any of the eggs hatched? Ask for a volunteer to complete a pH test (have the student complete the pH test now, while you discuss today’s lab). Most important, ask if anyone can describe the changes happening to the eggs in the last week. If you need to make new assignments for daily tank duty for the upcoming week, do that now as well.

**Nutrient Runoff Data Collection- 10 minutes**
4. Today is Day 7 of the Plant Growth Experiment. Lab groups should collect their containers to mass and measure the length of each plant, just as they did last week. Put up the overhead of the Plant Growth Experiment worksheet to show the class exactly where to record their data. Make sure everyone understands that the mass and length of the plant from the “nitrogen” container will be recorded in the “nitrogen” column of the worksheet as will the phosphorus container recorded in the phosphorus column, etc. Tell the class to handle the plants with care as this is not the end of the experiment and we don’t want to hurt or kill any of the plants. Along with the data table, there is space on the worksheet for “Day 7 Observations”. Encourage students to write down observations. For example, “The nitrogen container smells bad” or “The water at the bottom of the N and P container is cloudy”.

*Remember to compile a class average and add to the class dataset attached to the JCW map.*

**Macroinvertebrate Lab Prep- During Macroinvertebrate Discussion**
5. You will have two buckets with one leaf pack per bucket. While one Reed teacher leads the macroinvertebrate discussion, another teacher should be pouring the contents of the two buckets into six different pans. *Hopefully* there will be plenty of macroinvertebrates. Try to distribute the insects evenly, although, this will be difficult. Also, put approximately even amounts of the leaf litter into each pan so the kids will have to hunt around for the insects.

**Macroinvertebrate Discussion- < 10 minutes**
6. Today students are assessing the water quality of the Reed Canyon through a macroinvertebrate analysis. Before distributing the pans of macros, make sure everything is cleaned up from the nutrient data collection. Discuss macroinvertebrates as a measure of stream health. Put the term macroinvertebrate on the board. Can anyone guess what a macroinvertebrate is? Relate insects back to the salmon life cycle by asking students how aquatic insects fit into the salmon life cycle. Begin constructing a food web on the board building off the term...
macroinvertebrate. Who eats them? What do they eat? Other terms to introduce (if you have time) are primary producer, primary consumer, secondary consumer and food web. Discuss with your students that biologists have found insects do not all equally tolerate pollution (see Background information for this lab). Have the class open to the “Macroinvertebrate Key” and put up your overhead copy. Give instructions for the lab as well as careful insect handling as discussed in the lab meeting. Putting up your copy of the “Macroinvertebrate Count” and walking through a brief example with the class may be helpful.

**Macroinvertebrate Lab- 20-25 minutes**

7. Lab groups sort through their pan of leaf litter and pond water, using plastic pipettes to transfer insects into ice cube tray for identification. Reed teachers will have ID cards to help with identifying insects. One student in the group should be in charge of marking off the insects found on the Macroinvertebrate Count worksheet. With ten minutes remaining in class, help each group with the math on the worksheet. Make sure each group is able to calculate a total index value and determine the water quality of their sample. As a Reed teacher begins to clean-up, the other teacher should lead a wrap-up discussion in which each group reports to the class their total index value and water quality.

**Class Macroinvertebrate Data- 5 minutes**

8. A Reed teacher should complete a Macroinvertebrate Count worksheet with combined class data. You can accomplish this in different ways depending on available time. During the class discussion, you can have each group report what insects they found as you mark them off on the overhead worksheet. Then as a class complete the math to arrive at a water quality assessment. Or a Reed teacher could copy from each group the insects they found while the other leads the wrap-up discussion and then do the math as a group. The overhead taped to a piece of white paper or just a completed worksheet of the entire class data should then be added to the JCW map.
# Macroinvertebrate Key

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<td>Stonefly</td>
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# Macroinvertebrate Count

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<td>Clams</td>
<td>Blackfly Larva</td>
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<tr>
<td>Mayfly</td>
<td>Cranefly Larva</td>
<td>Leech</td>
</tr>
<tr>
<td>Stonefly</td>
<td>Crayfish</td>
<td>Midge Larva</td>
</tr>
<tr>
<td>Riffle Beetle (Adult)</td>
<td>Damselfly</td>
<td>Lunged Snails</td>
</tr>
<tr>
<td>Gilled Snails</td>
<td>Dragonfly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scud</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sowbugs</td>
<td></td>
</tr>
</tbody>
</table>

Number of boxes checked times 3 = _______ index value.

Number of boxes checked times 2 = _______ index value.

Number of boxes checked times 1 = _______ index value.

Add the index value for each column together. Total Index Value = _______________

## Water Quality

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>(&gt;22)</td>
</tr>
<tr>
<td>Good</td>
<td>(17-22)</td>
</tr>
<tr>
<td>Fair</td>
<td>(11-16)</td>
</tr>
<tr>
<td>Poor</td>
<td>(&lt;11)</td>
</tr>
</tbody>
</table>

The quality of my water is __________________________.
LESSON 7: NUTRIENT RUN-OFF AND PLANT GROWTH PART TWO

Objectives
• Graph results of the two-week plant experiment
• Explore the implications of nutrient imbalance in an ecosystem
• Investigate aquatic plant environmental requirements

Background
See background for Lesson 5.

Lesson Plan

OHECK! 2 minutes
1. Rapid review of the scientific method. It should be memorized by now.

Question Box- 2 minutes
2. While one person conducts the OHECK review, someone should be checking the question box.

Salmon Tank Duty Update- < 5 minutes
3. Ask for an update on the daily data collection of egg mortality and temperature in the salmon tank. Review the daily log. If salmon eggs are hatching, a Reed teacher should test the ammonia levels in the tank. If the ammonia level is above 5 mg/L then a partial water change is necessary. Please contact me and I will take care of the water change.

Plant Growth Experiment Part Two: Finish Data Collection- 10 minutes
4. Break the class up into their lab groups, open folder to “Plant Growth Experiment, Part One” and have them retrieve their containers. Each group should complete the Day 14 measurements and record their data in the table. You should put up the overhead of this worksheet and remind the class where they need to record their data. As this is their third experience with measuring and recording, it should be a little easier and move faster.
   Give each group a plastic bag for their plants once measurements are finished. Return bags to the Outreach lab for proper disposal. You can dump the water from each container down the sink. *Teaching Moment* Substances dumped down a sink are first put through a sewage treatment process before release into the Willamette River so dumping a small concentration of fertilizer into the sink is not the same as large amounts of fertilizer runoff going directly into a stream. However, dumping paint or other such chemicals down the sink is not legal.

Plant Growth Experiment Part Two: Data Representation- 20-25 minutes
5. Once everything is cleaned up, have the class open to “Plant Growth Experiment Part Two: Graphing Results”. How you proceed will completely depend on your specific class. By this point in the semester, I hope you have a firm grasp of the skills and abilities of your students and will complete the graphing exercise in the most appropriate
manner. The exercise is to create a line graph of their plant growth data over the two week period. The x-axis is left blank. Each group should determine the most appropriate scale for their x-axis. Each experimental variable has been pre-color-coded, as you may have noticed. Those are the colors the kids should use for the appropriate line on their graphs (see the Key on the worksheet). There is one graph for mass and one graph for length.

**Plant Growth Experiment: Conclusion - 10 minutes**

6. Included on the graphing worksheets is an area for the students to write their conclusions. Much like the hypothesis, students should be encouraged to write their own conclusion in their own words. After everyone has finished their graphs and conclusions, you should create class graphs from the averages you have been recording throughout the two-week experiment. To save time, have the x-axis complete and then ask individual students to come up and mark different data points. The graphs, as usual, should be attached to the JCW map.

**Wrap-Up - Final Moments**

7. Remind the class that next week is Thanksgiving so there is no Outreach class. Also, this is your last class at the school! The week after Thanksgiving you will meet your class at Reed for the final lesson, releasing the salmon fry. As you won’t be seeing the students until they arrive at Reed with their fry, remind them the importance of daily monitoring of the salmon tank. It would be sad if their monitoring efforts slacked in your absence and they didn’t have any fry to release in the canyon!
**Plant Growth Experiment: Part Two**

Graphing Results

Plant Mass vs. Time in 4 different nutrient conditions

**Conclusion:** What affect did the different nutrients have on plant mass?
Graphing Results Continued

Plant Length vs. Time in 4 different nutrient conditions

**Conclusion:** What affect did the different nutrients have on plant length?
LESSON 8: RELEASE THE FRY!
FIELD TRIP TO REED COLLEGE

I will provide more details as this lesson approaches. The basic idea is multiple classes from each school will arrive at Reed with their salmon fry. Zac Perry will help with a tour of the canyon and the release of the fry. Other activities may be included but this will be decided at a later date.
CHAPTER 9 - APPENDIX

9.1 How to avoid the monologue
(a.k.a. keeping ALL the elementary school students engaged)

These tips are to help you avoid common teaching mistakes. These mistakes include but are not limited to

1. Having the same students answer every question
2. Ignoring quiet students because they are not disrupting anything
3. Thinking that because the students’ eyes are on you and they are nodding, they understand what you are telling them.
4. When one person answers your question, the whole class understands.
5. Talking, talking, talking….and more talking.

Tip 1 –
Never ever talk for more than 10 minutes straight. A good rule of thumb is to talk only the number of minutes as the students are in age. Hence, if our students are 9-10 years old, you can only keep their attention for 9-10 minutes.

Tip 2 –
Before you ask a question, have students find a blank piece of paper or a blank space on one of our worksheets (could be the back of some worksheets). Tell the students that you want everyone to think of an answer to your question and write down his/her response on that paper. When most people are done writing, you will call on 3-4 people to see what they wrote before giving them the right answer. This way, you can see if some people have no idea what the answer is or where some may be getting confused.

Tip 3 –
A version of think, pair, share – have all students remain silent as you ask them a question. Give them 5-10 seconds to think of their individual response. After the time allotment, they can share their answer with their seat partner/neighbor. Between the two of them, they need to come up with their pair’s response. You then ask for 3-4 answers before telling them what the correct answer is.

Tip 4 –
Call on students who do not have their hands raised. If they don’t know an answer, have them make a guess or gently ask them an easier question that will lead them in the right direction.

Tip 5 –
So you think you can be a scientist? The idea behind this method of questioning is if the person you call on (preferably without a raised hand) cannot answer the question himself/herself, they may enlist the help of another student. You can jazz the game up by offering prizes (stickers or pencils) to the individual.
9.2 Helping Children to Observe

Guidelines for developing observation and promoting its role in learning.

- Always give children sufficient time to observe something; when new material is introduced allow about 10 minutes of free play before starting to discuss or focus observations.

- After the initial period of observation, as appropriate, give definite guidance to go beyond superficial features and into detail. At times, a focus to observation can be given in the form of a defined task - to draw, answer questions, to compare special features.

- Provide plenty of material for children to handle or observe.

- Give thought to selection of materials so that, by observation, children are able to find differences and similarities, sequences of events and evidence on which to base tentative conclusions.

- Organize observation activities so that children can talk in groups about what they find.

- Organize whole-class discussions in which groups or individuals tell each other what they have observed.

- Sometimes provide a stimulus for observation by discussing events or objects beforehand so that children are ready to look out for certain kinds of evidence or information (particularly relevant when observation time is limited, as on a visit).

- Take care in deciding the kind of question to pose as a stimulus to children's observation. Broadly focused questions have the merit of allowing children to decide for themselves what to observe but narrowly focused ones have their place in cases where there is something special that the children might miss.

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9.3 Directions to schools

Beach Elementary
1710 N. Humboldt

Directions to Beach from Reed
To get back to Beach, make a right Woodstock Blvd. then turn right on to SE 28th Ave. Continue through the stop sign at Steele. Make a left onto Holgate. Continue through 3 intersections. Make a right turn heading North on 99E. Stay on 99E for ~2 miles then follow signs to I-5 North by making a left onto the Morrison Bridge. Immediately get in the right hand lane to I-5. Take I-5 North to exit #303- Swan Island/Killingsworth. Get in the right lane and follow signs to Killingsworth. Make a left onto N. Alberta which takes you west, back over the freeway.

Directions to Reed from Beach
From Beach, get on I-5 South at Alberta. Past the 405 split to Beaverton & the I-84 exit, follow the Central East Side Industrial Exit, #300B. Be forewarned-traffic is rarely good on that last stretch because of the I-84 exit - stay in the left lane to avoid the merging. Follow signs to 26 & OMSI/OR City. Get in the left lane following signs to OMSI/99E. Stay in the right lane and veer right following signs to 99E & 26; this will deposit you onto 99E.

Stay on 99E until you see the Holgate exit (past the Ross Island Bridge) on your right. This is a right side exit that allows you to make a “left”. Once on Holgate you will go through 3 signals then make a right at the fourth onto SE 28th. Once on SE 28th, you will pass a 4-way stop sign at the intersection of Steele through which you continue forward. You then come to a 3-way intersection with Woodstock. Make a left onto Woodstock. Reed is on your left.

Once on Woodstock, you will pass another 3-way stop sign. Continue forward past the main campus entrance. Turn left onto the East Parking lot entrance and park. Additional parking can be found in the North and West lots. We will be meeting in the Vollum Lounge. I’ve enclosed a map of the Reed Campus and there will be directional signs posted for you.
Grout Elementary
3119 S. E. Holgate

Walking directions:
Walk across the fields on the North side of campus to Steele Blvd. From here, you may take either 30th or 34th avenue through the residential district between Reed and Grout. Walk approximately ½ mile to Holgate Blvd. Grout is located between 28th and the Kenilworth Park.

Driving directions:
You may follow the above directions or take 28th or 39th streets depending on where you are coming from.
**Lewis Elementary**

4401 SE Evergreen St

**Directions by foot:** Head east up Woodstock towards the Safeway. Pass by Otto’s and take a right on 45th. Follow 45th until you run into the playground. The entrance is on the opposite side of the school.

**Directions by car:** Head east up Woodstock towards the Safeway. Take the right at the stoplight at 46th Street. Follow this as it curves around. Enter the parking lot on the 45th street and exit onto Evergreen Street.
There are many many ways to go, here is one example:

Follow Woodstock east to SE 82\textsuperscript{nd} Avenue.
Turn left on 82\textsuperscript{nd}
Follow 82\textsuperscript{nd} North to Powell.
Turn right on Powell
Follow Powell to SE 122\textsuperscript{nd}
Turn left on SE 122\textsuperscript{nd}
Follow 122\textsuperscript{nd} to Division
Turn right on SE Division St.
Follow Division to SE 130\textsuperscript{th} Ave
Turn left on 130\textsuperscript{th}. *NOTE* SE 130\textsuperscript{th} is not a major through-way, there may not be a light at Division and 130\textsuperscript{th} so keep your eyes peeled for 130\textsuperscript{th}, it can sneak up on you.
Turn right onto SE Lincoln, it dead-ends at the school.

Alternatively, you can continue on SE 122\textsuperscript{nd} past SE Division St and turn right on SE Lincoln. Follow Lincoln to where it dead-ends at the school.