Water Quality in the Columbia River Watershed

Mrs. Debra Berg's Columbia Middle School Students
Fort Spokane. 2009 Photo taken by Tonilee Hanson

A 6th - 12th Grade Environmental Science Unit

Place is important! How does geographic and geologic information help us understand the current conditions of the Columbia River Watershed? Consider your river or lake study location and the nearby area. How have your study location, the Upper Columbia River or Lake Roosevelt changed in the past 5 years? What changes occurred as a result of building Grand Coulee Dam? What can changes over the past 500 years tell us about possible future changes to this place we call "our home"? How do local water quality conditions compare to global water quality conditions?

Protocols are important! Water quality testing, analyzing and interpreting the results are the primary focus of this unit. Systematic sampling methodology and consistent procedures are vital for reliability of data. Water quality testing is a critical part of gauging the ecological health of the Columbia River Watershed and Lake Roosevelt. Water quality data can show evidence of past or current human impact, ecological needs, and stewardship activities within the Columbia River Watershed's complex ecosystem.

Thinking, reflecting and scientific inquiry are important! Understanding the Columbia River Watershed is so much more than just knowing historical, geographical, physical, chemical and biological conditions. Understanding requires asking your own questions, considering complex interrelationships within watersheds, between atmospheric conditions, the shoreline and water bodies, the presence of native, domesticated and invasive species, and human impacts over time. Understanding results from developing inquiry questions, conducting research, and implementing stewardship projects that attempt to answer questions and solve problems that are **important to you!**

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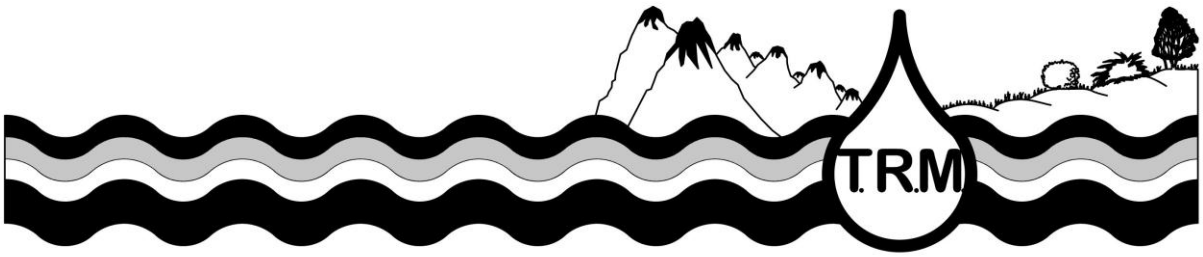

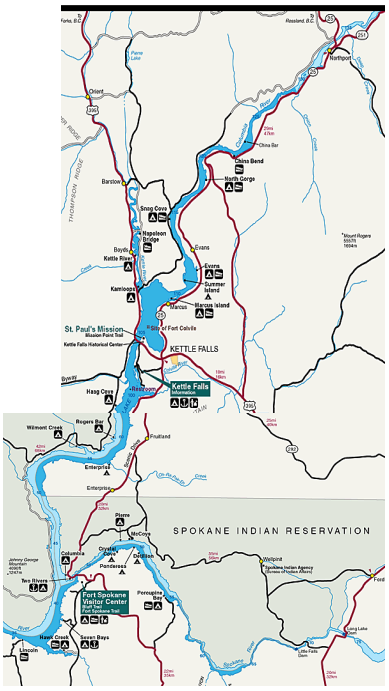

Preface and Acknowledgements

Water Quality in the Upper Columbia River & Lake Roosevelt is designed such that students apply science content knowledge and inquiry, investigation and problem solving skills within the context of community service and stewardship. Students are empowered to think and take actions as members of a community that lives, works, and recreates near the Upper Columbia River & Lake Roosevelt. Students learn to collect and analyze water quality data and consider the interrelationships between human activities, changing watershed conditions and lake water quality.

This unit strategically builds upon the exemplary lesson plans, protocols, and resources created by programs such as Floating Classroom, Project Wet, Project Wild, Nature Mapping, and multiple internet resources. Washington State Department of Ecology (ECY) and the Environmental Protection Agency EPA web resources were used for validated data. These exemplary programs and resources serve as a foundation for launching Lake Roosevelt based student inquiry and investigation. Every attempt was made to gratefully acknowledge and cite the contributions of others who have developed the tools which this unit will use in support of teachers and students implementing "The River Mile" (TRM) a program of the National Park Service Program.

See citations (page 23) for complete list of resources used in this unit

UNIT AT A GLANCE

Grade levels: 6 - 12

Content Area: Science
Environmental
Physics
Chemistry
Biology

Suggested Timeframe:
3 weeks / Options
Each lesson can stand alone.

Lesson sequence can be reorganized.

Supplemental lessons are provided that could extend the time frame for this unit.

EALRS Addressed:
- 2 Inquiry
- 3 Application

Washington State Content Standards:
- PS2 -2A, 2B, 2C, 2D, 2E
- PS3- 3B, 3C, 3E
- ES2-2A, 2B,2C, (review)
- ES2-2D, 2G
- LS1-1F
- LS2-2A, 2D, 2E
- LS3-3E,3F

http://www.k12.wa.us/CurriculumInstruct/default.aspx

UNIT OVERVIEW
Water Quality in the Upper Columbia & Lake Roosevelt

UNIT DESCRIPTION

Water Quality in the Upper Columbia River & Lake Roosevelt asks students to apply knowledge from chemistry, physics, geology, and biology and think about factors that impact water quality. Students use systematic protocols to collect, present, analyze and interpret water quality data. In collaborative groups, students consider implications from the data to identify interrelationships between human activities, changing conditions and water quality.
This unit invites students to reflect on their learning, plan a local stewardship project and take action as members of a community that lives, works, and recreates near the Upper Columbia River and Lake Roosevelt.

ENDURING UNDERSTANDINGS:
- Water quality results from complex interactions between biological, chemical, physical and environmental factors.
- Data is a powerful tool for explaining the world and communicating with others about world conditions.
- Actions have intended results and unforeseen consequences.

ESSENTIAL QUESTIONS:
- How is water quality affected by interactions in a watershed?
- How do we simultaneously use and protect our water and watershed?
- What leadership can I bring to my community?

STANDARDS ADDRESSED:
- Physical Science: Matter Properties and Change (PS2)
- Physical Science: Energy Transfer Transformation & Conservation (PS3)
- Earth & Space: Earth Systems, Structures, & Processes (ES2)
- Life Science: Structure & Function of Organisms (LS1)
- Life Science: Ecosystems (LS2)
- Life Science: Biological Evolution – Variation & Adaptation (LS3)

UNIT AT A GLANCE

Assessment Summary:

Pre-Assessment
Lesson 1: Water Quality Prior Knowledge

Formative Assessment
Lesson 2: Design a Water Filter

Formative Assessment
Lesson 10: Water Footprint - Data Collection, Analysis & Personal Action

Summative Assessment: Task:
Lesson 11: Watershed Research, Investigation, and Presentation

Application of Content understanding:

Lesson 12: The River Mile Academic Excursion/ Site Visit

UNIT OVERVIEW continued

Water Quality in the Upper Columbia & Lake Roosevelt

ASSESSMENT OVERVIEW:

This unit is designed to develop the scientific inquiry skills of asking a researchable question, literature research, data collection, presentation, analysis, interpretation and drawing conclusions and real world application. The scientific inquiry skills are developed in relationship to watershed content knowledge, understanding water quality and water quantity issues, and placed in the local context of the Columbia River /Lake Roosevelt. Students are given multiple opportunities within this unit to apply the inquiry/investigation skills. The unit culminates with an academic excursion (site-visit) to a River Mile location where water quality data is collected.

Each lesson is designed to develop a specific aspect of the scientific inquiry & investigation process and specific water quality content.

- Lesson 1: Pre assessment: What determines water quality?
- Lesson 2: Experimental design/water filter/fecal coliform
- Lesson 3: Writing factual observations/erosion/turbidity
- Lesson 4: Data Comparison & graphic presentation/pH
- Lesson 5: Data tables/temperature/species survival
- Lesson 6: Data analysis/nitrogen/phosphorus/ dissolved oxygen
- Lesson 7: Variables/water transport/point & non-point pollution
- Lesson 8: Interpretation & conclusion/bioaccumulation & survival
- Lesson 9: Communicating ideas/climate change/Socratic Seminar
- Lesson 10: Using data to inform personal action/water footprint
- Lesson 11: WQ literature review, scientific research/presentation
- Lesson 12: Application/TRM site visit/water quality

UNIT AT A GLANCE
Skills: Design an investigation Test variables Collect data Analyze data Draw conclusions Present findings **Content/concepts:** Clean water is essential to the survival of life.

UNIT OVERVIEW continued
Water Quality in the Upper Columbia & Lake Roosevelt

KNOW/DO/UNDERSTAND

Students are introduced to the global & local water quality & quantity issues. They discover water quality parameters and use testing protocols. Students collect, analyze and interpret data from classroom, field and validated sources. Students choose a local water issue to research and develop a community stewardship project to impact water quality.

MODIFICATIONS FOR DIFFERENTIATING INSTRUCTION IN THIS UNIT:

- Identify students specific learning strengths, needs, working styles and dominant intelligences for successful collaborative work
- Increase amount of vocabulary development by: encouraging the use of dictionaries (including bilingual), employing visuals and gestures, using music, role play, graphic organizers, and concept posters.
- Pair ELL with bilingual student
- Modifications for special needs such as extended time or read aloud
- Demo skills/ instructions or present outcome samples for guidance
- Chunk tasks

Upon completion of this unit, what students will **know,** be **able to do** and **understand**?

Know	Do	Understand
Water quality parameters and protocols for testing temperature, pH, dissolved oxygen, nitrogen (nitrates), phosphorus (phosphates), turbidity & conductivity. Water is a solvent. Substances in water can mix, suspend, dissolve and form compounds. Temperature changes the properties of water. Erosion & weathering of landforms introduces substance into the water.	Design & conduct an inquiry investigation & build a water filter. Use protocols to conduct water quality tests, lab investigations & field studies. Collect, analyze & interpret data. Use various resources (primary and secondary). Discuss/ debate a scientific issue in Socratic Seminar format. Present research using power point, video, or research report. Cite sources using APA style. Design & implement a community stewardship project.	Water quality is a function of the interrelated conditions and interactions among land, air, water and living organisms. Living organisms are dependent on water for survival. How human activity can negatively & positively impact the quantity & quality of water. Each person can demonstrate leadership and make a positive impact.

UNIT OVERVIEW continued

Time Frame/Planning Sketch

Week 1	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Time	90 minutes	90 minutes	90 minutes	90 minutes	90 minutes
Introduction	Water Quality a Global & Local Issue	Water Quality: Fecal Coliform	Water Quality: Turbidity & Conductivity	Water Quality: pH and acid rain	Water Quality: Temperature
Assessment: Pre, Formative, Summative	(P) What determines water quality?	(F) Effective design & accurate data collection	(F) Writing factual, specific observations	(F) Selection of graph to display data	(F) Data presentation for interpretation
Inquiry/Literacy	Putting the Issue in context – Initiating Inquiry Questions	Design & conduct experiment, collect data, multiple trials	Observational data	Data table, comparison bar, line or scatter graph	Data Collection and analysis
Investigation	Culminating Project Research project	Design & test a Water Filter	Van Cleave Erosion Stations: 43, 45, 46, 50 GLOBE Transparency & Conductivity Labs	Optional GLOBE pH Lab	Optional GLOBE Temperature Protocol and Lab
Activities	Video "Water for Life" Article: "Waste on Lake Roosevelt Shores" Discussion	Test sample of polluted water, filter & retest. Document Δ, record data Teach classmates to use your filtration process	Show WQ Overview PP Erosion & deposition, changing lake levels, & draw down	Test wide range of pH samples Discuss Acid Rain Grand Coulee & Hawk Creek data analysis	Discuss WQ parameters & species survival by degree C
Take Action	Ask questions that lead to research & investigation	(O) No pet waste or Fences for livestock campaign	Riparian zone replanting	No idle zone -bike to work & school -reduce auto emissions	Tree planting & riparian vegetation restoration
Materials	Article, journal YouTube	Funnel, cheesecloth, sand, gravel, etc.	TRM Water Sample RS	TRM Water Sample RS	TRM Water Sample RS TRM Core Parameters RS
Google Earth Mapping	(O) Water Aid Google map	Hawk Creek	Locate dams on the Columbia River	Acid rain impact	Climate Change map NOAA - trends
Resource Specialists	LRF, NPS, LARO	Dept of Ecology	Spokane Tribe of Indians Fisheries	Spokane Regional Clean Air Agency	Lands Council Kat Hall
Optional (O) Homework (HW)	(O) Water Carrying activity (HW) How can water be purified?	(HW) Refine your filter design, sketch & write instructions for use	(O) Research landslide 2009 Porcupine Bay	(HW) Test pH of home cleaning products and cosmetics and their impact on water	(O) Tree Canopy, temp & WQ Hydropower & changes in precipitation

Week 2	Lesson 6	Lesson 7	Lesson 8	Lesson 9	Lesson 10
Time	90 minutes	90 minutes	90 minutes	90 minutes	90 minutes
Introduction	Nutrient loading phosphorus, nitrogen & dissolved oxygen	Point source & non-point source pollution	Bioaccumulation and Biomagnification	Climate Change Precipitation	Water Use and Conservation Awareness
Assessment	Data analysis from Ecology reports	Variables: controlled, dependent independent	Draw Conclusions	Data Analysis Fact vs. opinion	Water Footprint Collect Statistical Data
Inquiry Literacy	Fish survival & DO!	Where is it coming from?	Who will survive?	What do you mean, "We might run out of water?"	How much water does my family use?
Investigation	Phosphorous, Nitrogen & DO Lab	Don't Dump that here! Watershed & Toxic dump	You ate what? - Simulation Game	Socratic Seminar Discussion	Home Water Audit
Activities	Ph Ni & DO lab Compare the interrelationship between nutrient levels, dissolved oxygen levels, temperature and fish survival	Students use a simple watershed model to observe the storm water transport of PS & NPS pollution. Students use points, plots & transects to record observation.	How do the benthic organisms & aquatic plants determine which other organisms survive?	View You Tube Video Clips Of climate change proponents & skeptics Engage in Socratic Seminar Analysis of the climate change data and rebuttal.	Students identify the many ways we use water daily in all we do and all we consume. Student calculates their weekly water use and its cost compared to gasoline.
Google Earth Mapping	Ecology Test WQ test sites at North Port, Kettle River, Hawk Creek & Grand Coulee	EPA Scorecard on PS polluters and animal waste by county	Tracing the potential contaminant path from Trail BC Canada to large mouth bass I just caught	NOAA Climate change indicators NASA global precipitation changes	What path did this water take to get into my home?
Take Action	Public Awareness Campaign: Storm water runoff	What are best management practices to reduce pollution?	Fish Health Advisory Awareness campaign	General public interviews & surveys	Develop plan to reduce household water use by 3-5%, implement, analyze
Materials	TRM Water Sample RS Ecology TMDL data	You Tube Videos Exploratorium - Stream table set-up River cutters Toxic waste	LRF Public Guide	Socratic Seminar Protocol: Excerpts from pro & con climate change videos and EPA Climate change data	Water Use How Big Is My Water Footprint? Student Guide
Optional (O) Homework (HW)	HW Research Report Benchmark	HW Research Report Benchmark	HW Research Report Benchmark	HW Research Report Benchmark	Interview family members RE: behavior changes for conservation

Week 3	Lesson 11		Lesson 12
Time	Intro Day 1 – 2 WK as Homework	2 Day for Presentations or as needed	1 Day Field Trip
Introduction	Culminating Project Water/Watershed Investigation & Research	Student Presentations of Water Research Project	Academic Excursion to The River Mile site
Assessment	Presentation Written, PP, Oral, Video Rubric for content & presentation	Presentation Written, PP, Oral, Video	Student Journal w/ land & water observations and water quality sampling numeric data
Inquiry Research	Communication	Asking new questions based on research findings	Apply WQ testing processes and knowledge to an Inquiry Field Investigation of The River Mile site
Investigation	List of possible investigations provided but students have choice to develop a unique study	Discuss the method of investigation	Conduct field tests that were practiced in labs. What do the conditions at this site reveal about interactions among the population species, land, air & water?
Activities	Research compare & contrast local & global WQ issue	Student use a rubric to peer evaluate presentations	Observation of land water interface, animal and plant populations and water quality testing
Google Earth Mapping	Include a Google map	Show a map of a local and global area impacted by research	Map of The River Mile site or alternate field study location
Take Action	Community Service/ Stewardship as part of research	Students discuss actions they have or will take that would positively impact the community	Students earn their seat on a trip by completing research on a chosen topic before the trip
Materials	Research project packet Internet access Assessment rubric	Peer Evaluation Rubrics	Field guides water quality testing protocol personal science journal
Optional (O) Homework (HW)	Students are given benchmarks to meet during the 2 week preparation	Reflective journal on personal presentation and learning from classmate presentations	Compare field study data to lab testing data to assess the water quality at your field site.

Suggested duration:
[90 minutes]

Inquiry Question:
What determines water quality?

Inquiry Process:
Identify variables
Develop questions

Standards:
LS2 Ecosystems
LS3 Adaptation

Pre-Assessment:
- WQ prior knowledge
- Ability to generate testable inquiry questions

Materials:
Science journal
Computer
LCD projector

Handouts:
Student Handout
Seattle Times Article "Human waste plagues Lake Roosevelt, other outdoor locations".

Lesson 11
WQ Research Project Requirement & Timeline

Credits/Citations:
Adole Douglas, Biology Teacher Charlotte, NC original pp guidelines and research criteria which were modified for this unit.
You Tube videos

LESSON #1
Water Quality a Global and Local Issue

INTRODUCTION:
Students think about and discuss water quality (WQ) issues from a global and local context. The unit and culminating research project assessment are introduced. Students are invited to begin thinking about a question that they will turn into a testable inquiry investigation and that puts them into a leadership roll focused on The River Mile site or a community stewardship project.

STUDENT WORK AND ASSESSMENT
Pre-Assessment: [10 minutes (m)] Students write everything they already know about factors that impact, alter or are used to measure the quality of water.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. View "Water for Life" video (12 m) - http://www.youtube.com/watch?v=6q9WPXz94LE
2. What questions arise from watching this video? (15 m)
    a. Give students time to (5m) quick write (notes, thoughts, ideas &questions)
    b. Pair Share (2m each) thoughts & questions. Discuss (6 m)
3. (20m) Read and discuss in small groups the 11/07 Seattle Times Article *"Human waste plagues Lake Roosevelt, other outdoor locations."* As a group, create a Venn diagram comparing & contrasting the global & local water quality issue. Be sure to include prior knowledge from your journals.
4. What new questions arise from the video, article and group discussions? How could you investigate or test a WQ question?
5. Culminating Research project: Intro-Lesson 11 requirements and timeline
    a. [Optional] View **Water Crisis -** Discuss ideas for making student videos about local water issues as a culminating project. http://www.youtube.com/watch?v=BkNY78B2Jio
6. [Optional] African Water Carrying Activity: Go outside and select a water carrying course. Divide into 4-5 teams. Each team is given a towel to use as a head support and a gallon of water. Students race the clock and try to get the most water home to their family.

RESOURCES: Lesson 11 Culminating Project Guidelines & Rubric

Suggested duration:
[90 minutes]

Inquiry Question:
How do you know if it is safe to drink the water?

Inquiry Process:
Experimental design
Multiple trials

Standards:
LS1, LS2, LS3

Formative Assessment:
Reliable data collection
Written Communication for filter design replication

Materials:
Funnel, plastic bottle or Beaker, Mesh cloth (panty hose), cheesecloth, or filter paper, sand, mulch, gravel, soil with or without grass, plants and roots, Lake Roosevelt water, pond samples, or "polluted test samples Alum, Water quality testing probe

Handouts:
Student Handout: Water Quality: Fecal Coliform – Design a Water Filter
Teacher Information Ecology Focus on *"Fecal Coliform Bacteria"*

Credits/Citations:
WA Dept of Ecology
Mary Carroll Alexander NC – Water Filter Lesson idea
MEEC Pathogen data

LESSON # 2

Water Quality: Fecal Coliform

INTRODUCTION:
Many countries, like Kenya in Africa and India do not have access to enough clean water as seen in the video, "Water for Life." Here in Washington State, according to a Seattle Time article, dated 11/18/07, Lake Roosevelt is plagued by human waste which is, "… a great threat to the health and vitality of the recreation area". In Lake Roosevelt the issue is a serious annoyance to vacationers and potential death to fish & wildlife from decomposition and the resultant lack of oxygen, but around the world a child dies every 15 seconds due to fecal coliform, water born illnesses and dehydration. Clean water is a matter of life and death.

STUDENT WORK AND ASSESSMENT
Explore how water quality altered by the natural process of filtration through various types of soils?

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE
Build a Water filter: What is the most effective design for a simple water filter made of natural materials?

1. Observe and describe the water sample (provided by teacher)
2. Work in teams to design a water filter. Use any of the materials available. Discuss the water cycle how the land filters water.
3. Draw a detailed diagram of your model that could be replicated.
4. Observe and describe the water sample after filtration.
5. Perform multiple filtration trials. Does the appearance change significantly after 1, 3, or 6 filtrations?
6. Is your experimental filter effective? Do you have ideas for a redesign? How will you know when it is safe to drink? What other tests are available to determine water quality?

View & Discuss - Fecal Coliform Power point (PP can be used as an introduction or follow-up to building the water filters.)

Homework or Optional Activities

7. Analyze the data provided by the Department of Ecology, on Hawk Creek. Why do FC levels change with the seasons? www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=53C070
8. Research how Waste Water Treatment Facilities reclaim water

RESOURCES

- Leave No Trace – NPS Video 9min 42 sec www.nps.gov/features/wilderness/leavenotrace/popup.html
- Lake Roosevelt Shoreline Plan www.nps.gov/laro/parkmgmt/

Suggested duration:
[90 minutes to optional multi day]

Inquiry Question:
How do suspended & dissolved substances impact water quality? What role does runoff play in changing turbidity & conductivity**?**

Inquiry Process:
Scientific observation

Standards:
PS2 & ES2

Formative Assessment:
Objective, precise, descriptive, observations using scientific terminology & symbols

Materials:
Lesson 2 "dirty" water samples & Water filters
Secci disc
Turbidity tube
Lake or pond water
GLOBE Turbidity lab
GLOBE Conductivity lab
Conductivity test probe
Janice Van Cleave's Erosion & Deposition Activities 43, 45,46, & 50

Handouts:
Student Handout

Credits/Citations:
PP Slides: Lake Roosevelt Forum, NPS and Eric Starkey
Van Cleave Earth Science
TRM Turbidity Protocol
Globe: Turbidity Lab
Globe: Conductivity Lab

LESSON # 3
Water Quality: Turbidity & Conductivity

INTRODUCTION:

Turbidity measures the cloudiness caused by the presence of suspended solids, such as clay and silt particles from erosion or runoff, re-suspended bottom sediments & microscopic organisms in the water. The greater the amount of total suspended solids in the water (not to be confused with total dissolved solids), the murkier water appears and the higher the measured turbidity.

Turbidity can greatly affect water quality in many ways. Some examples include reducing the amount of light available for plant growth, damaging sensitive gill structures in fish and aquatic organisms, as well as increasing their susceptibility to disease, and preventing proper egg and larval development.

Conductivity and Total Dissolved Solids - Conductivity is a measure of how well water can transmit an electrical current. In the Lake Roosevelt watershed, conductivity is primarily used to determine the mineralization of water (commonly called total dissolved solids). Information from the amount of total dissolved solids can be used to determine changes in water at different times of the year and can also be used to determine certain physiological effects on plants and animals.

STUDENT WORK AND ASSESSMENT

Formative Assessment: Recording detailed observational data

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Students reflect on experience in Lesson 2: Design a water filter. Why is a system to measure and compare WQ important?
2. View the WQ Investigation PP (23 slides) as an introduction to Water Quality indicators that will be investigated in Lessons 3-8
3. Questions for discussion and analysis: How do turbidity and conductivity measures compare on each water sample tested. What are the relationships between turbidity, conductivity, runoff and natural filtration?

Option 1: Use samples of the "dirty" water from Lesson 2. Record observations of the water sample and measure using a turbidity tube. Filter using the student built filters, observe, measure, and compare.

Option 2: Erosion and Deposition Activities 43, 45, 46, & 50 (Van Cleave) as class demonstration or experimental stations

Option 3: Take water samples at one site each month (or seasonally) and compare conductivity.

Option 4: Check conductivity on wind eroded points to see if it differs from non-eroded locations or in coves or streams that feed the body of water. ***Note***: *GLOBE lab details are provided in the unit appendices.*

Suggested duration:
90 minutes to optional multi day

Inquiry Questions:
How does pH impact water quality? What causes pH to change?

Inquiry Process:
Data comparison & presentation

Standards:
PS2

Formative Assessment:
Graphing Data

Materials:
pH Power point
Data presentation examples
pH paper
pH meter
liquids of pH range (vinegar to baking soda solution)
Lake or pond water

Handouts:
Science Journal
EPA Acid Rain

Credits/Citations:
Globe pH Lab
www.ecy.gov/
http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html

http://www.epa.gov/acidrain/

LESSON # 4
Water Quality: pH

INTRODUCTION:

pH - How acidic or basic something is is measured by its pH factor. pH is measured on a scale from 0 to 14, with 7 being neutral. Fresh water generally has a pH between 6.0 and 8.5. If the pH of water becomes too high (basic) or too low (acidic), aquatic organisms begin to die. At extremely high or low pH levels all aquatic life will die. Pure water has a pH of 7.0. However, normal rain is slightly acidic because carbon dioxide (CO2) dissolves into it forming weak carbonic acid, giving the resulting mixture a pH of approximately 5.6 at typical atmospheric concentrations of CO2. pH is probably the single most important factor initiating all chemical reactions in water.

Acid rain is a broad term referring to a mixture of wet and dry deposited material from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. Emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) result from fossil fuel combustion. In the United States, roughly 2/3 of all SO_2 and 1/4 of all NO_x come from electric power generation that relies on burning fossil fuels, like coal. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles. As of 2000, the most acidic rain falling in the U.S. has a pH of about 4.3.

STUDENT WORK AND ASSESSMENT

Presenting data graphically and selecting an appropriate format to compare data from different locations.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Students reflect on experiences with turbidity and overview of WQ indicators. Introduce pH power point. Discuss acid rain and the impact on plants, buildings air and water quality.
   Option 1: Test & record the pH of a variety of common liquids.
   Option 2: Conduct GLOBE pH Investigation lab ***Note***: *Full lab details are provided in the unit appendices*
   Option 3: Test a water sample before and after dry ice is added. Example at http://www.stevespanglerscience.com/experiment/dry-ice-bubbling-acid
   Also http://www.epa.gov/teachers/water.htm
2. Use a variety graphs for the Ecology data from Grand Coulee & Hawk Creek (e.g., bar, line, radar; mean, median, mode). What are the strengths & weaknesses of each format?
3. Analyze the Ecology data for Grand Coulee and Hawk Creek. What do the data tell about pH levels and LR WQ?
4. Which plants & animals are most likely to be impacted by the changing pH levels?

Suggested duration:
90 minutes to optional multi day

Inquiry Question:
How does temperature impact water quality?

Inquiry Process:
Interpreting data to understand implications

Standards:
PS3 – energy & heat

Formative Assessment:
Analysis based on comparing Ecology temperature data for Grand Coulee, Hawk Creek and North Port

Materials:
Thermometers, beakers, water samples of varying temperatures
Or trip to water body location for testing

Handouts:
Student science journal
L5 Student Handout
Canary in the Coal Mine
Optional
GLOBE Temperature Lab
Project Introduction:
Water Footprint Intro: Lesson 10

Credits/Citations:
http://www.bpa.gov/corporate/education/kidsinthecreek/water.cfm

Globe Temperature Lab

LESSON # 5
Water Quality: Temperature

INTRODUCTION:

Temperature - Certain types of fish, like rainbow trout, kokanee salmon and other aquatic organisms need cold water temperatures to thrive. Temperature is monitored to observe changes from month to month, season to season, and overall trends from year to year. Temperature may also directly affect the amount and location of aquatic plant growth.

Scientists studied the Columbia and Snake River systems to understand what causes increased temperatures. They analyzed everything from climate change to paper mills. They found that the biggest influence on temperature is hydroelectric reservoirs. Scientists estimate that the reservoir (Lake Roosevelt) behind Grand Coulee can increase water temperature in the Columbia River by as much as 3-5 degrees Celsius above natural conditions. Logging practices and the removal of shading vegetation next to waterways can also have a major impact on water temperatures. Global climate changes have and will continue to alter temperatures. In general it is not the temperature itself that kills fish, it is low dissolved oxygen caused by high temps. As temperature increases, less oxygen can been dissolved in the water.

STUDENT WORK AND ASSESSMENT

Student formative assessment is based on teacher observation, student reflection, and evidence of accurate data analysis and interpretation.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Introduce Temperature Investigation by using the power point provided. Students first write their ideas in the handout provided and then add information from the presentation
2. Mini lesson 1: Students use graphed pH data from 4 Columbia River & Lake Roosevelt locations and reflect their experience in Lesson 4 of testing pH
3. Compare, analyze and present temperature data using data tables, line, bar & radar graphs
4. Activity: The Canary in the Coal Mine - Analyze Department of Ecology WQ Data for CR & LR and determine which fish will die first when water temperature increases.
5. Option: test water of different temperatures for dissolved oxygen. A basic test kit would work well for this. How do these values compare to what they saw in Lake Roosevelt during the field trip? GLOBE Temperature Lab: ***Note***: *Full details are provided in the unit appendices.*

HOMEWORK: (15 m)

Introduce Lesson 10: Water Footprint. Students begin recording data over the weekend and continue for 3-5 days with 2 days to implement their water reduction plan before Lesson 10 results analysis.

Suggested duration:
90 minutes

Inquiry Question:
How do excess nutrients affect dissolved oxygen levels and impact water quality?

Inquiry Process:
Synthesizing information
Compare & contrast data

Standards:
PS2, Ls1, LS2, LS3

Assessment:
Analyze data, make inferences and draw data based conclusions

Materials:
Nutrients & DO PPP
Computer
LCD projector
WQ CD

Handouts:
Student Handout
DO Data tables from ECY reports on Hawk Creek Grand Coulee & North Port

Credits/Citations:
BPA
EPA
GLOBE
MEEC
Nature Mapping
USGS
WA Dept of Ecology

LESSON #6
Water Quality: Nutrient Loading and Dissolved Oxygen

INTRODUCTION:
Dissolved oxygen is molecular oxygen freely available in water and necessary for the respiration of aquatic life and the oxidation of organic material. **Nutrients** are beneficial but too much of anything is a problem especially when aquatic plants & microorganisms take over. **Sources of nitrogen and phosphorus** include discharge (effluent) from waste water treatment plants, runoff from municipal and agricultural fertilizer, livestock manure and leaky septic systems. The excess nutrients support the rapid growth of an overabundance of aquatic plants and subsequent death. Plant decomposition uses oxygen and reduces the dissolved oxygen available to support other aquatic inhabitants. Algae tend to grow and decompose faster in warm water.

STUDENT WORK AND ASSESSMENT
Analyze data on nitrogen, phosphorus, and dissolved oxygen levels provided by the Washington Department of Ecology Water Quality tests at Grand Coulee, Hawk Creek and North Port. Make inferences and draw data based conclusions about the relationship between nutrient levels and available dissolved oxygen.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE
1. Introduce Nutrient Loading and Dissolved Oxygen by viewing the power point presentation which incorporates resources from EPA, WA Dept of Ecology, and the United States Geological Society. Source documents are provided for each agency resourced
2. Students analyze Department of Ecology data to determine relationships.
3. Prepare for TRM visit by testing various water samples using the YSI probe (Probe is obtained from NPS Ranger and Education Specialist Janice Elvidge. See lesson 12 for probe operating instructions.
4. Test dissolved oxygen from two sources. The first source is a clean bucket of water, which has been sitting at room temperature for 1 week. The second source could be a bucket with decomposing plant matter (leaves, algae etc.) This bucket would also be setup a week prior to the experiment. Is there a difference? Why?

Additional Resources: DO, Nitrogen & Phosphorus testing protocols on CD; BPA Kids in the Creek DO testing; GLOBE Nitrogen and DO protocols; and EPA Phosphorus Monitoring protocol.

DISCUSSION:
What can the general public do? What are citizen scientists? Who is monitoring and removing excess aquatic weeds? What can the government do?

Suggested duration:
90 minutes

Inquiry Question:
How do metals and chemicals such as mercury, zinc, dioxins, furans and PCBs get into the water?

Inquiry Process:
Variables: controlled, dependent & independent

Standards:
PS2, PS3, ES2, LS2

Assessment:
Mapping PS pollution

Materials:
Watershed model trays, soil, rocks, small plants, Watering bottle
Sprinkler top
Food coloring
Pink & green sprinkles
Chocolate sprinkles
Oregano or parsley
Vinegar
Baking soda
Ph paper

Handouts:
Stream Table Model
Toxic Dump lab
Points, Plots &Transects

Credits/Citations:
FOSS Earth Forms Kit
Exploratorium
You Tube Videos
www.scorecard.org

LESSON # 7

Water Quality: Point & Non-Point Source Pollution

INTRODUCTION:

Point Source: Near the Canadian border, the upper Columbia River is still flowing before it becomes the reservoir Lake Roosevelt. In the Northport area there are striking black sand beaches caused by slag (from mining operations in Canada. Currently EPA is investigating human health & ecological damage caused by this point source. Other examples of point source pollution are pulp mills, aluminum plants, waste water treatment plants that discharge into rivers. In point source contamination the contaminant origin is known.

Non-point sources are non-specific and often associated with storm water and agricultural runoff. Contaminants from a variety of sources, such as streets and farms, are picked up by storm water, and enter groundwater or travel directly into lakes and rivers untreated. Hydroelectric facilities are grouped into the category of non-point source pollution. Other examples of non-point source pollution are erosion and removal of shading vegetation next to waterways.

STUDENT WORK AND ASSESSMENT: Mapping Skills

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Students view & discuss one or more of the You Tube videos, on Point source & Non-Point Source pollution
2. Introduce the concept of Point & Non Point source Pollution. Make a class list of possible sources for the Columbia River & Lake Roosevelt including possible sources in the local community.
3. Research the EPA listed point source polluter by zip code at www.scorecard.org . Map the PS in your community
4. Observe, draw and test watershed models to demonstrate PS & NPS pollution movement due to storm events
    a. *Storm water: Don't dump that here!*
    b. *Toxic Dump: Where is it coming from?*
5. **Optional**: Students write to a Classroom EPA team requesting a study of their (stream table) Watershed. Identify concerns and the evidence collected to determine the sources of pollution.
6. Each team becomes the EPA team for another group's watershed and investigates the complaint. EPA teams propose best management practices, clean up efforts and new laws to reduce or eliminate the impact of PS & NPS pollution?

Suggested duration:
90 minutes to optional multi day

Inquiry Question:
How do contaminants in water impact the food web?

Inquiry Process:
Draw conclusions based on data

Standards:
LS2, LS3

Assessment:
- Collaboration and team participation

Materials:
Computer, projector
Bioaccumulation ppt
Simulation Game

Handouts:
"You Ate What?"
Bioaccumulation

Credits/Citations:
Lake Roosevelt Forum Remedial Investigation and Feasibility Study "A Public guide"
MEEC Simulation
You Tube Videos
Game Variations
* BioM and PCB's
* BioM - Hg & Algebra
*Up the Food Chain
* Population Dynamics

LESSON # 8

Water Quality: Bioaccumulation & Biomagnification

INTRODUCTION:
Sediment contaminants can accumulate in the tissues of worms, clams, insect larvae and other organisms (called the benthic community) that inhabit the lake bottom.

Organic contaminants (like PCBs and mercury can biomagnify (increase) in the tissues of species as they move higher in the food chain, e.g., - a single fish will eat many stoneflies, an eagle will eat many fish, etc.

For fish species that accumulate contaminants in their tissue and organs, these toxins can move up the food chain to human, birds, and other species consuming fish. (source LRF Remedial Investigation and Feasibility Study)

STUDENT WORK AND ASSESSMENT
Students compete to survive in a life and death contaminated food web mystery. "Who Will Survive?"

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE
1. Show You Tube Videos on Bioaccumulation and Biomagnification
2. Group activity: You Ate What? *Appendix Lesson 8 handouts*
   a. Trace the contaminant path from mining in Canada 100 years ago to that big mouth bass I just ate. LRF Public Guide Bioaccumulation pages
3. Contaminated Food Web: Who will survive?
4. Understand the role of benthic organisms and aquatic plant life in determining which other organisms survive.
   a. In the field students can collect benthic organisms. Determine which feeding groups are more likely to contain contaminates (filter feeders, Shredders, etc.
5. An example activity for junior high/high school kids can be seen at:

http://www.uwsp.edu/cnr/wcee/envsci/Framework/pdf/LivingResources/BioaccumulationinWisconsinFisheries.doc
http://www.bigelow.org/edhab/tracing_toxins.html

OPTIONAL ACTIVITIES:
Research health effects of toxic metals and persistent organic pollutants

HOMEWORK: Continue Unit End Research Project and consider incorporating ideas from this lesson.

Suggested duration:
90 minutes

Inquiry Question:
How is water quality altered by changes in temperature and precipitation?

Inquiry Process:
Asking new questions based on results of an inquiry.

Standards:
PS2, PS3, ES2, LS2, LS3

Assessment:
Write 3 new questions that could be developed into a research study

Materials:
You Tube video excerpts from Climate Change proponents and skeptics

PPP Climate Change Indicators NOAA & NASA

Handouts:
EPA Climate Change Science Facts

EPA FAQ About Global Warming & Climate Change: Back to Basics.

Socratic Seminar

Credits/Citations:
Socratic Seminar
www.socratic.com
You Tube
www.youtube.com/

LESSON # 9

Water Quality: Climate Change

INTRODUCTION:
What is the difference between climate and weather? Weather is what's going on right now and climate is a long term pattern. Climate determines the clothes you buy and weather determines the clothes you wear on any given day. What are the indicators that scientist track to predict climate? Scientists create models to look at annual patterns of temperature and precipitation. They add indicators to the models like: the amount of solar energy, ocean temperature, clouds, color of the ground, things in the atmosphere like, smoke, sulfates, nitrates, ozone, methane, and carbon dioxide. Then they calculate how much each of these contributes to warming or cooling and test how well their model matches the results over time. As climate changes occur, how could local and global precipitation be affected? How might precipitation changes alter the Columbia River flow, Lake Roosevelt levels and available fresh water?

STUDENT WORK AND ASSESSMENT
View and discuss varying positions on the theory of climate change. What additional questions do you think should be studied?

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE
1. Introduce Climate Change as a scientific theory using the power point and handouts from EPA, NOAA, & NASA
2. Discuss what data constitute scientific evidence?
3. View video excerpts from climate change proponents and skeptics. *Links to videos provided in Appendix Lesson 9*
4. Identify and distinguish between scientific evidence, scientifically valid questions, personal opinions and propaganda techniques
5. Prepare questions and supporting evidence for a discussion of climate change
6. Engage in a group discussion using the Socratic Seminar guidelines. *Note: Socratic Seminar procedures are provided in full detail in the appendix: Lesson 9 handouts.*

OPTIONAL HOMEWORK ACTIVITY
Interview 5 people regarding their views on climate change. What evidence do they provide for their point of view?

Suggested duration:
15 m intro in L 5
3-5 days data collection
90 m analyzing results

Inquiry Question:
What is our water consumption level and how much can we reduce our water use?

Inquiry Process:
Collecting data and statistical analysis

Standards:
PS3

Formative Assessments:
- Data collection
- Statistical analysis
- Use Reduction
- Reflection

Materials:
Science journal

Handouts:
Water Use Home Audit
How Big is Our Water Footprint?

Credits/Citations:
Adapted from Water Water... Math Task by Sean McGrath, Academy for Global Studies, Austin, TX

LESSON # 10

Water Use: How Big Is My Water Footprint?

INTRODUCTION:

Water quality and quantity are a result of choices we make every day in the products we use, the energy required to power our lifestyles and our household water consumption. How much water does my family used for watering lawns, washing clothes, cleaning and consumption? In this lesson students document and measure their family water consumption and develop a plan to reduce water use by 5-10%.

STUDENT WORK AND ASSESSMENT

Detailed water use observations, accurate consistent measurement of water consumption and journal reflections on water use reduction.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Introduce the Water Footprint study as homework one week prior to this lesson
2. Students research their home water consumption for 5 days making observation, measurements and reading the water meter. *Full details are provided in the project guidelines*
3. Based on the data collected students create a plan to reduce their personal consumption by 5-10 % and ask family members to participate in the plan.
4. Students keep a reflective journal in addition to the measurements and water meter readings to determine the percent reduction in water consumption achieved.
5. Today students present their water use data, observations and reflections. They statistically compare household water use to determine the mean, median and mode. Students discuss their water use reduction plans, the percent savings and compare statistically to determine actions that produced the most significant reduction in water use.

OPTIONAL ACTIVITY:

Based on the analysis of student water use and reduction data, students may wish to implement water use reduction ideas shared by classmates

Suggested duration:
2 weeks research &
2-3 days to present research

Inquiry Question:
How does my water quality research lead to a local action project?

Inquiry Process:
Presenting and Communicating research findings

Standards:
Content standards vary based on research project EALRS 2 & 3 for inquiry and application

Assessment:
- Written Research Paper
- Presentation
- Peer Review

Materials:
Power point, video
Internet access

Handouts:
Research Rubric and guidelines
Research topics
Presentation guidelines & rubric

Credits/Citations:
Adole Douglas

LESSON # 11

Summative Assessment: Water Research and Action

INTRODUCTION:

Students select a water quality or quantity focus of interest and conduct a research study. The research looks at a local water quality or quantity issue and compares the local conditions to another area in the world. Students investigate possible solutions and actions to positively impact the issue. Students propose a community stewardship action project. If and when possible students implement their action ideas and include reflections and data on the results.

STUDENT WORK AND ASSESSMENT

Assessment is based on completing the research project criteria as detailed in the rubric provided. Students are also assessed on their presentation and communication. They may select the media of their choice e.g., power point, video, poster session. Finally, students will receive peer reviews.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Introduce the research project at the end of Lesson 1 or at least two weeks in advance of due date
2. Provide students with Research packet which includes:
    a. Overview of Water Quality/Quantity research project
    b. Connection to community stewardship action plan
    c. Water Quality Research topic options
    d. Benchmark timeline
    e. Format for Research paper and assessment rubric
    f. Presentation options & guidelines & assessment rubric
    g. Peer review rubric
3. Check in with students on each benchmark date to support the timely completion of the research
4. Work with ELA teachers to provide additional research time or support in the writing of a research paper.
5. Make on-going connections between research projects and content of lesson 1-10.

Suggested duration:
1 Day Field Trip

Inquiry Questions:
What is the relationship between the land & water at TRM field site?

What do the water quality indicators at TRM field site tell us about the health of the CR & LR?

Inquiry Process:
Real world Application of learning to TRM

Standards:
PS2, PS3, ES2, LS2,

Assessment:
Application of WQ testing protocols
Observational data collection
Journal reflections

Materials:
Transportation to TRM field site
Science journals
GPS
WQ testing equipment
Field guides to LR plants & animals

Handouts:
TRM Core parameters
TRM Water Sample Record Sheet

Credits/Citations:
Janice Elvidge Education Specialist NPS LARO

LESSON 12
Water Quality:
The River Mile Site Visit

INTRODUCTION:
Students have been introduced to water and crisis of inadequate clean water for populations around the globe. Students have investigated water quality indicators, conducted classroom experiments and learned to use measurement protocols. They have audited their personal family water consumption and identified ways to personally reduce water consumption. Students have chosen an aspect of water to research and proposed a community project to positively impact an area of water quality or quantity. Successful completion of the required study has earned the students an academic excursion to study water quality conditions in the field at The River Mile-Adopt a Mile study site.

STUDENT WORK AND ASSESSMENT
Students apply their learning about water quality, quantity, scientific observation and WQ indicator testing protocols at a local Lake Roosevelt watershed site. Data collected is contributed to the National Park Service - The River Mile project.

QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE

1. Prior to the site visit trip review all WQ testing protocols practiced in Lessons 3-8. Discuss any changes in procedure needed to accommodate for field location.
2. Establish team for each test: Turbidity, conductivity, temperature, ph, dissolved oxygen, nitrogen, phosphorus and the multi-test probe.
3. Review GPS and latitude and longitude coordinates.
4. Establish 4-6 data collection locations at TRM and the GPS coordinates
5. Review the importance of making specific, detailed written observations and sketches
6. Schedule two quiet observation times (sit spots) into the day's schedule
7. Focus observations, test and discussion on the inquiry questions
8. What do turbidity, pH, dissolved oxygen etc. tell you about the condition of this site?
   a. How do you think these values would change if you tested them 2 hours from now? 2 Days? 2 Months? Years?
   b. Do your water chemistry results differ between location X and location Y?
   c. Use what you learned in the other lessons to explain why. Where did they find more macroinvertebrates? In sand, gravel, mud, vegetation?
9. Subsequent to the site visit, analyze the data collected and ask students

to provide evidence on the health of the LR watershed. Develop new questions that could be researched.

10. Collect macroinvertebrates and identify them to order using a visual key. Determine if these are tolerant or intolerant species.
    a. What does it tell you about the water quality? Does that fit with the water chemistry results? Where did they find more macroinvertebrates? In sand, gravel, mud, vegetation?
    b. Macroinvertebrates are much less costly to sample than water chemistry yet can tell students a lot about conditions in the lake/stream. Looking at bugs is more exciting to most students than dealing with water chemistry.
11. Students could map the site, describe local impacts on water quality (erosion, streams entering the lake, campsites, plant/algae growth, etc.).
    a. What things did they see on the trip from the school to the park that have an impact on water quality?
    b. What things are beyond the immediate region that influences water quality? Did their data suggest that the issues they mapped and listed are affecting water quality?
12. Samples for the coliform and E coli PetriFilm tests could be collected from multiple locations (beach, off a point, in a cove, etc.) Each group could make predictions about which sample will have the highest levels. All samples could be compared to the control (a sample of distilled water).
13. Younger students might benefit from identifying animals (visually or from sign [scat, tracks, nests]) and determining how each might be impacted by a polluted lake.

RESOURCES

See The River Mile's website at:

http://www.nps.gov/laro/forteachers/laro-river-mile.htm

Appendix

Teacher Materials, Student Handouts & Resources

CD ROM Table of Contents Key:

S# = Student Handout
T# - Teacher Materials
X# = Resources and optional materials

Water Quality Unit Overview

Lesson 1: **Water Quality a Global and Local Issue**

- L1-S1 WQ a Global & Local Issue Cover
- L1-S2 WQ a Global & Local Issue Student Handout
- L1-T1 You Tube links to Global Issue
- L1-X1 Human Waste Plagues Lake Roosevelt Seattle Times

Lesson 2: Water Quality: Fecal Coliform

- L2-S1 WQ Fecal Coliform Cover
- L2-S2 WQ Fecal Coliform Student Handouts
- L2-T1 WQ Fecal Coliform Teacher Suggestions Build a Water Filter
- L2-T2 WQ Fecal Coliform (Power Point Presentation)
- L2-X1 WA Health Dept Fecal Coliform Web Article
- L2-X2 MEEC Disease Contaminants
- L2-X3 Global Water Issues Article 3.5.10

Lesson 3: Water Quality: Turbidity and Conductivity

- L3-S1 WQ Turbidity & Conductivity Cover
- L3-S2 WQ Turbidity & Conductivity Student Handouts
- L3-S3 #43 Run Off
- L3-S4 #45 Speedy
- L3-S5 #46 Wander
- L3-S6 #50 Shake Up
- L3-T1 WQ Overview (Power Point Presentation)
- L3-X1 Option 1 Globe Transparency
- L3-X2 Option 2 Globe Conductivity
- L3-X3 EPA Conductivity

Lesson 4: Water Quality: pH

- L4-S1 WQ pH Cover

- L4-S2 WQ pH Student Handouts
- L4-T1 WQ pH (Power Point Presentation)
- L4-X1 ECY-2009 Grand Coulee & Hawk Creek pH Data (Excel)
- L4-X2 Option Globe pH

Lesson 5: Water Quality: Temperature

- L5-S1 WQ Temperature Cover
- L5-S2 WQ Temperature Student Handouts
- L5-T1 WQ Temperature & ECY Testing (Power Point Presentation)
- L5-T2 WQ Canary In a Coal Mine – Key (Excel)
- L5-X1 ECY 2009 Temp Data Grand Coulee Hawk Creek North Port (Excel)
- L5-X2 Option Globe Temperature

Lesson 6: Water Quality: Nutrient Loading & Dissolved Oxygen

- L6-S1 WQ Nutrients & DO Cover
- L6-S2 WQ Nutrients & DO Student Handouts
- L6-T1 WQ Nutrients & DO (Power Point Presentation)
- L6-X1 ECY 2009 Data Grand Coulee Hawk Creek North Port (Excel)
- L6-X2 ECY 2009 Data GC, NP, HC, KB 13 WQ Indicators
- L6-X3 MEEC Nutrients & DO
- L6-X4 USGS Water measurement DO
- L6-X5 EPA Eutrophication & DO
- L6-X5 EPA Phosphorus
- L6-X7 WA leg DO Limits for Freshwater Fish
- L6-X8 Nature mapping LaMotte
- L6-X10 Option Globe Dissolved Oxygen Protocol
- L6-X9 Option Globe Nitrogen Protocol
- L6-X11 BPA Kids In the Creek

Lesson 7: Water Quality: Point & Non-Point Source Pollution

- L7-S1 WQ PS NPSP Cover
- L7-S2 WQ PS NPSP Student Handouts
- L7-T1 WQ You Tube Video Links PS NPS
- L7-T2 www.scorecard.org PS by County- Answer KEY
- L7-T3 WQ PS NPSP Watershed Runoff simulation
- L7-X1 FOSS Stream Table Set up

Lesson 8: Water Quality: Bioaccumulation

- L8-S1 WQ Bioaccumulation Cover
- L8-S2 WQ Bioaccumulation Student Handouts
- L8-T1 WQ Bioaccumulation (Power Point Presentation)
- L8-T2 WQ You Tube Video Links Bioaccumulation
- L8-X1 ECY 2009 Metals Data – North Port (Excel)
- L8-X2 DOH Lake Roosevelt fs 0210

- L8-X3 MEEC Toxic Chemicals
- Folder – Optional Biomagnification Simulation Activities

Lesson 9: Water Quality: Climate Change

- L9-S1 WQ Climate Change Cover
- L9-S2 WQ Climate Change Student Handouts
- L9-S3 Socratic Seminar Guidelines
- L9-T1 WQ NOAA & NASA Climate Change (Power Point Presentation)
- L9-T2 WQ You Tube Video Links Climate Change
- L9-X1 EPA Climate Change Science Facts
- L9-X2 EPA Climate Basics
- L9-X3 EPA Water Resources
- L9-X4 NASA.gov Precipitation USA Change 1901-2000
- L9-X5 NASA.gov Precipitation World Change 1901-2000

Lesson 10: How Big Is My Family's Water Footprint?

- L10-S1 WQ Water Footprint Cover
- L10-S2 WQ Water Footprint Student Handouts

Lesson 11: Culminating Assessment Research Project

- L11-S1 WQ Research Cover
- L11-S2 WQ Research Student Handouts
- L11-S3 WQ Project Presentation Scoring Guide
- L11-S4 WFFE Student Grant Application
- L11-S5 AFN 2011 Application Guidelines
- L11-S6 Eco-Hero 2010 Awards Guidelines
- L11-S7 Eco-Hero 2010 Awards Application

Lesson 12: Academic Excursion to The River Mile Site

- L12-S1 TRM Site Visit Cover
- L12-S2 TRM Core Parameters Record Sheet '09R
- L12-S3 TRM Water Record Buddy Sheet K3 0809
- L12-S4 TRM Water Record Sheet 09R
- L12-S5 TRM Habitat Observation Form '09
- L12-S6 TRM Habitat Observation Form HS '09
- L12-S7 TRM Human Activities 2011
- L12-T1 TRM Educator's Guide 2010
- L12-T2 TRM WQ data Collection Procedures '09
- L12-T3 TRM WQ SOPs 2009
- L12-T4 TRM YSI Meter Handling procedures '09

Citations and Credits

What follows is a partial list of references, and credits (TBD)

50 Simple Things You Can Do To Save the Earth, The Earth Works Group. Earthworks Press. Berkeley, CA. 1989
*Kids in the Creek Bonneville Power Administration www.**bpa**.gov/corporate/education/**kidsinthecreek**/*
Bronx River Alliance, Bronx River Classroom: Inside track for Educators. 2007 Vanguard Direct New York, NY 10018

GLOBE Protocols for testing - Nitrogen, Dissolved Oxygen, Temperature, pH

Healthy Watersheds, Healthy People Department of Ecology publication # 08-01-018 (3 pages of state and local resources

*MEECS Water Quality Unit **http://techalive.mtu.edu/meec_index.htm***

Springer, Mark, Watershed a successful voyage into integrative learning. National Middle School Assn. 1994

University of NC at Chapel Hill PCB Biomagnification Activity
www.ie.unc/erp/PCB_Biomagnification_Activity_with_signs.pdf
USGS Water Quality for Schools - http://ga.water.usgs.gov/edu/dissolvedoxygen.html
Van Cleave, Janice. Earth Science for Every Kid. John Wiley & Sons, Inc. NY1991

WOW Water Quality Parameters

You Tube www.youtube.com

Natural Resource Specialists and Community Organizations

Environmental Protection Agency http://omp.gso.uri.edu/ompweb/doee/science/physical/choxy2.htm

State Water Quality Council • 101 N. Fourth Ave., Suite 105 • Sandpoint, Idaho 83864 Phone: 208-265-9092 • Fax 208-265-0754 • Email: info@tristatecouncil.org

WA State Department of Ecology (ECY) http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html
Grand Coulee - http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=53A070
Hawk Creek
http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?theyear=&tab=notes&scrolly=339&wria=53&sta=53C070
http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?theyear=&tab=wqi&scrolly=394&wria=53&sta=53C070
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http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/usa.shtml#annual

http://www.ncdc.noaa.gov/oa/ncdc.html
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WA State legislature http://apps.leg.wa.gov/WAC/default.aspx?dispo=true&cite=173-201A-200