

CFWEP Lesson Plan: World Water Monitoring Day Lesson 3: Conclusion

Duration: 1 class period
(45-60 minutes)

Grade Level: 9-12

I. Lesson Topic In this lesson, students will review and analyze data gathered from the prior Water Monitoring Field Trip; review the most current World Water Monitoring Day Annual Report; enter field data into the 2008 World Water Monitoring Day database; and explore and discuss potential follow-up activities and careers in field science.

II. Montana Standards and Benchmarks

Science Standard 1: Grade 12 Benchmarks: 1, 2, 3, 5
Science standard 2
Science Standard 3
Science Standard 4: Grade 12 Benchmarks: 4
Science Standard 5: Grade 12 Benchmarks: 3, 4

For support, equipment and additional information, contact the **Clark Fork Watershed Education Program (CFWEP)** (406) 496-4124
www.cfwep.org

III. Objectives

- Students will determine the health and quality of their local stream or other water body by summarizing and analyzing previously collected data.
- Students will learn about worldwide water quality, and will compare that with their local water quality.
- Students will identify potential causes of water quality issues in their area.
- Students will formulate questions about water quality in their area, and will develop investigations for further exploration.

IV. Materials/Equipment/Resources Needed:

- Copies of the Water Monitoring Pre/Post Test for each student.
- Data collected from the WWMD Field Trip.
- Pre/Post Test answer key.
- *Optional:* Internet access.
- 2007 WWMD Year in Review Report (or the most current WWMD Year in Review Report).
- Teacher Resource Sheet.
- Copies of the Map of the Upper Clark Fork Basin (or a map of the local area) for each student.

V. Vocabulary

Point Source Pollution Nonpoint Source Pollution Total Maximum Daily Load (TMDL)

VI. Assessment

A Pre/Post Test will assess students' content knowledge. A mapping activity will assess students' science process and inquiry skills. A post Stewardship Survey will assess student attitudes.

VII. Procedure

Teacher Input

1. Before class: Prepare copies of Pre/Post Test and the Map of the UCFRB (or local area) for each student.
2. Before class: Write student data collected from the Field Trip on the board.

Objective, Steps 3-4: Students will determine the health and quality of their local stream or other water body by summarizing and analyzing previously collected data.

3. Guide students in an analysis of collected data:
 - a. Begin with the question: "Looking at all of the data collected on the field trip, do you see any data that is very different from most of the collected data? Are there any numbers we need to throw out?" If there is data far removed from the typical data collected, it either must be explained by the students, or removed from the data set.
 - b. Now that the data set has been established, data should be averaged for each water quality parameter (water temperature, dissolved oxygen, turbidity, pH, and any additional parameters collected on the field trip). For pH, this is an opportunity to review the logarithmic nature of

the scale with students, and note that pH should not be averaged, but rather approximated based on the data set observed.

- c. Move to the next question: “Based on the averages, is our water healthy?” The instructor should ask students to explain what each number means, e.g. if the pH is acidic, what would be a potential cause? The class should analyze and explain their measurements for each parameter. To involve the students, a different student should be called upon to explain each parameter.
4. *Optional:* Guide students in entering their collected data into the WWMD online database (refer to the Teacher Resource Guide for this lesson for instructions).

Objective, Step 5: Students will learn about worldwide water quality, and will compare that with their local water quality.

5. Compare local water quality to state, national, and global water quality.
 - a. From the WWMD Year in Review Report, the instructor should write the state water quality values on the board.
 - b. Ask students to observe and explain any differences between state water quality values, and local water quality values they collected. Students should form hypotheses to explain any observed differences.
 - c. Repeat this process for national water quality values.
 - d. Repeat this process by comparing local/state water quality values with water quality measurements from 1-2 foreign countries. Again, students should form hypotheses to explain any observed differences.

Objective, Steps 6-7: Students will identify potential causes of water quality issues in their area.

6. Local Impacts: Teachers should review the list of Potential Local Impacts (refer to the Teachers Resource Guide for this lesson) with students, asking the class if each potential impact is present in their local watershed, and what effect it may have had on their data, or what additional data they would need to collect to determine if each issue had an effect.
7. Mapping Activity.

Objective, Step 8: Students will formulate questions about water quality in their area, and will develop investigations for further exploration.

8. Discuss potential follow-up activities. Begin by asking students: What can we do to scientifically determine if any of the impacts discussed above are definitely impacting our water? Follow-up question: Are any scientists currently undertaking any of the investigations / additional studies suggested by students?
9. Post-Test and Stewardship Survey.

Student Activities

1. Summarize and evaluate data.
2. Based on field data, discuss the health of local waters.
3. Compare local water quality to state, national, and global water quality, developing hypotheses to explain observed differences.
4. Review potential impacts to local waters, and discuss key factors affecting local water quality.
5. Map potential impacts on local water quality.
6. Discuss additional research necessary to determine the extent and significance of key factors affecting local water quality.
7. Complete Post-Test and Stewardship Survey.

VIII. Homework None.

IX. Resources

WWMD Website: <http://www.worldwatermonitoringday.org/>

CFWEP Website: <http://www.cfwep.org>

X. Extensions This lesson is designed as part 3 of a 3-part module. Part 2 involves collection of water quality data in the field, and part 1 is an overview of water monitoring and an introduction into the module.

Considerable options exist for further extension; refer to the resources listed above as a starting point for extended activities. Teachers interested in potential extensions can also contact the CFWEP (see contact info above) for additional suggestions and support.

XI. Notes Teachers should take time to review the Teacher Resource Guide for this lesson prior to delivery. A quick web search or visit to the “News” section of www.cfwep.org can offer recent media stories on current environmental issues that can be used in classroom discussions.

XII. Science Process Skills

1. Knowledge

Students will use computation and calculation in the assessment of field data.

2. Comprehension

Students will generalize and summarize data about field data, attempt to define problems based on their observations, make inferences about potential causes of water quality issues, and attempt to identify the factors affecting water quality.

3. Application

Students will predict what factors impact local water quality, discuss potential methods for solving water quality problems, develop additional investigations, and map water quality impacts.

4. a. Analysis

Students will identify relationships and patterns affecting water quality, formulate questions about water quality, and discuss the procedures of water quality assessment and the results of their own assessment of various water samples.

b. Analysis and Synthesis

Students will report results of water quality assessment, and then debate and persuade one another as to the likely factors impacting local water quality.

5. Evaluation and Synthesis

Students will assess water quality, and critique results of water quality assessment.

XIII. Montana Standards and Benchmarks (Item II in full)

Note: Standards are bolded and Benchmarks are italicized, with connections to this lesson explained in plain text.

Science – Standard 1:

Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate the results and form reasonable conclusions of scientific investigations.

In this lesson, students evaluate and communicate the results and form reasonable conclusions based on their prior scientific investigation of local water quality.

Grade 12 Benchmarks:

1. Generate a question, identify dependent and independent variables, formulate testable, multiple hypotheses, plan an investigation, predict its outcome, safely conduct the scientific investigations, and collect and analyze data.

In this lesson, students analyze data they collected previously regarding local water quality.

2. Select and use appropriate tools including technology to make measurements (in metric units), gather, process and analyze data from scientific investigations using appropriate mathematical analysis, error analysis, and graphical representation.

In this lesson, students use error analysis and mathematical analysis to assess data.

3. Review evidence, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigations. (e.g. through graphical representation or charts).

In this lesson, students review evidence regarding water quality, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigation.

5. Identify strengths, weaknesses, and assess the validity of the experimental design of an investigation through analysis and evaluation.

In the activity for this lesson, students assess their field investigation into water quality, and discuss possible additional investigations that could fill data gaps and make up for weaknesses in their own investigation.

Science – Standard 2:

Students, through the inquiry process, demonstrate knowledge of properties, forms, changes and interactions of physical and chemical systems.

In this lesson, students use the inquiry process to assess the properties, forms, changes and interactions of physical and chemical parameters of natural and human-made water systems.

Science – Standard 3:

Students, through the inquiry process, demonstrate knowledge of characteristics, structures and function of living things, the process and diversity of life, and how living organisms interact with each other and their environment.

In this lesson, students use the inquiry process to study how living organisms interact with each other and their environment, with a particular focus on how water quality impacts ecosystems.

Science – Standard 4:

Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth’s systems and other objects in space.

In this lesson, students use the inquiry process to study the composition, structures, processes and interactions of Earth’s water cycle system.

Grade 12 Benchmarks:

4. Collect and analyze local and regional weather data to make inferences and predictions about weather patterns; explain factors influencing global weather and climate; and describe the impact on earth of fluctuations in weather and climate (e.g., drought, surface and ground water, glacial instability).

In this lesson, students collect and analyze local water data to make inferences and predictions about factors influencing weather and riparian climates and explore fluctuations in weather and riparian climate.

Science – Standard 5:

Students, through the inquiry process, understand how scientific knowledge and technological developments impact communities, cultures and societies.

Through the inquiry process, in this lesson students explore how scientific knowledge and technological developments impact western Montana communities, cultures and societies.

Grade 12 Benchmarks:

3. Evaluate the ongoing, collaborative scientific process by gathering and critiquing information.

In this lesson, students evaluate the ongoing, collaborative scientific process of studying and restoring the Clark Fork Basin by critiquing information about water quality.

4. Analyze benefits, limitations, costs, consequences, and ethics involved in using scientific and technological innovations (e.g., biotechnology, environmental issues).

In this lesson, students analyze the benefits, limitations, costs, consequences, and ethics involved in using scientific and technological innovations in regards to environmental issues in the Clark Fork Basin.