

# Reading the River

# Summer 2001

**A Study of The Water Quality and Aquatic Life**

**Honors Biology Grade 9-10**

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## Overall Unit Goal

The overall goal is to develop a series of lessons on water quality and aquatic life to be taught in the Honors Biology course.

## Unit Goals and Objectives

### Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles from science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned and build on past learning experiences to acquire new information.

### Kentucky State Academic Expectations / Objectives

- 1.3 – Students will be able to interpret various things observed by participating in class discussion and hands on laboratory water testing and macro invertebrate sampling.
- 2.1 – Students will be able to use scientific ways of thinking and working and uses those methods to solve real life problem by learning about water quality and aquatic life and how they could apply to their lives.
- 2.4 – Students will be able to use scientific models such as the Sepup lab model to explain the organization and functions of water analysis and predict other characteristics that might be observed.
- 6.2 – Students will be able to use what is already known to interpret new experiences by understanding water analysis and aquatic life.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

## Program of Studies for Unit

### Scientific Inquiry and Scientific ways of Thinking and Working

Students will

- Identify and refine questions and scientific concepts to guide the design of scientific investigation.
- Conduct different kinds of scientific investigations for a wide variety of reasons.
- Use equipment (water chemistry kits, Sepup kit), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.

### Chemical Reactions

Students will:

- Investigate chemical reactions. (Ph, dissolved oxygen)
  - Investigate factors (temperature) affecting reaction rates.

### Motions and Forces

Students will:

- Investigate forces and the effects of forces on the motion of objects. (Rate of stream flow)

### The interdependence of Organisms

Students will:

- Examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms. (Macro-invertebrate sampling)

### The Behavior of Organisms

Students will:

- Investigate behavioral responses to internal changes and external stimuli. Macro-invertebrate sampling comparison to PH, dissolved oxygen and conductivity.
- Analyze how patterns of behavior ensure reproductive success.

### Applications/Connections

Students will:

- Investigate how science can be used to solve environmental quality problems.
- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.
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## **Core Content for Unit**

### Physical Science

- SC-H-1.3.1 Chemical reactions occur all around us.
- SC-H-1.3.2 Reaction rates depend on concentration, temperature, and properties of reactants.

### Motions and Forces

- SC-H-1.4.1 Objects change their motion only when a net force is applied.
- SC-H-1.4.3 The electric force is a universal force that exists between any two charged objects.

### Life Science: The Behavior of Organisms

- SC-H-3.2.2 Behavioral responses to internal changes and external stimuli can be innate or learned.
- SC-H-3.2.3 The broad patterns of behavior exhibited by organism have changed over time through natural selection to ensure reproductive success.

### Life Science: Biological change

- SC-H-3.4.1 Biological classifications are based on how organisms are related.

### Life Science: The interdependence of Organisms

- SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems.

## Lesson One

### Title: Microcosms

#### Rationale

Students will observe and maintain a microcosm in groups of two for three weeks. Throughout the project, students will take part in discussions about *energy in ecosystems, cycling of nutrients, homeostasis, and population dynamics*. Students will use the microcosm as a model of an ecosystem to observe and study. After three weeks, students will conduct an experiment using HCKL to mimic the affects of acid rain. Submitting a laboratory report on their microcosm study will assess students.

Note: The concepts above in italics are concepts students have learned in a previous class. Class discussions during this unit will serve to review these concepts and relate them to the study at hand.

#### Objectives:

##### Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles form science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned and build on past learning experiences to acquire new information.

##### Kentucky State Academic Expectations / Objectives

- 1.3 – Students will be able to interpret various things observed by participating in class discussion and hands on micro invertebrate sampling.
- 2.1 – Students will be able to use scientific ways of thinking and working and uses those methods to solve real life problem by learning about aquatic life and how they could apply to their lives.
- 6.2 – Students will be able to use what is already know to interpret new experiences by understanding aquatic life requirements.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

## Program of Studies:

### Scientific Inquiry and Scientific ways of Thinking and Working

Students will

- Conduct different kinds of scientific investigations for a wide variety of reasons.
- Use equipment (microcosms), tools, techniques (measuring), technology (microscopes) and mathematics to improve scientific investigations and communications.

### The interdependence of Organisms

Students will:

- Examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms. (Micro-invertebrate sampling)

### The Behavior of Organisms

Students will:

- Analyze how patterns of behavior ensure reproductive success.

### Applications/Connections

Students will:

- Investigate how science can be used to solve environmental quality problems.
- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.

## Core Content:

### Life Science: The Behavior of Organisms

- SC-H-3.2.2 Behavioral responses to internal changes and external stimuli can be innate or learned.
- SC-H-3.2.3 The broad patterns of behavior exhibited by organism have changed over time through natural selection to ensure reproductive success.

### Life Science: Biological change

- SC-H-3.4.1 Biological classifications are based on how organisms are related.

### Life Science: The interdependence of Organisms

SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems

## Student Objectives

1. Students will observe microcosms over a three-week period and identify organisms observed using keys.
2. Students will classify organisms observed in microcosm according to trophic level: autotroph, heterotroph (first consumer, second consumer, etc....), and decomposer.
3. Students will observe, record and interpret interactions among organisms in the microcosm.
4. Students will observe microcosms over a three-week period and identify organisms observed using keys.
5. Students will classify organisms observed in microcosm according to trophic level: autotroph, heterotroph (first consumer, second consumer, etc....), and decomposer.

6. Students will observe, record and interpret interactions among organisms in the microcosm.
7. Students will construct a relative abundance table and discuss findings.
8. Students will use the microcosm as a model of an ecosystem and use this model to predict and explain the behavior of organisms.
9. Students will analyze the processes that return an ecosystem to equilibrium after a disruptive occurrence.
7. Students will formulate and defend ideas such as ecological diversity by analyzing observations of microcosms.

### Materials:

1. Petri plates with agar covering one-half of plate. (See attached directions)
2. Plankton net
3. Tows from a local pond using plankton net to be stored in a small class aquarium.
4. Light source.
5. Plastic droppers/ one per group.
6. Distilled water.
7. Microcosm video. (a silent video made at NKU showing organisms in a microcosm.)
8. VCR/TV
9. Microcosm keys (see attached)
10. Microcosm key activity
11. Microscopes (1 per group, preferably 1 dissecting and 1 compound)
12. Microcosm report sheet (see attached)
13. Microcosm information sheet (source: NKU, see attached)
14. Notebooks for recording observations.
15. Hydrochloric acid (molarity on hand)
16. Slides

### Activity Procedure:

**Note: Each class period is 90 minutes.**

#### Day one

1. Overview: Students will receive *microcosm lab report sheet* and *microcosm information sheet*. The whole class will discuss the procedures and expectations of the project.
2. Students practice identifying pond organisms with keys and microcosm key activity worksheet.
3. Teacher will demonstrate procedures for making microcosm.
  - a. Put water from different levels of the aquarium where class microcosm is stored using small cups and droppers and place these samples in a petri plate.
4. Students create microcosms in groups of two.
5. Students observe microcosm. Students should create slides of from their microcosms and observe them with compound microscope. Students should also make

observations of their entire microcosm using a dissecting microscope. (the entire microcosm can be placed on stage).

6. Students identify organisms using keys, video and teacher.
7. Students make drawings of the organisms they observe.
8. Students continue these organisms until the end of class and then return microcosm to area with a light source. (light source should be turned off at night to mimic nightfall)

Note: during this time, I play the microcosm video in the background over and over and point out the names of organisms seen to assist in identification.

## **Day Two**

1. Overview: Review of terms: autotroph, heterotroph, (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, etc.... consumer), decomposer using microcosm information sheet.
2. Inform students that they can no longer get water samples from aquarium with class microcosm. They must use distilled water to keep their microcosm “wet”.
3. Demonstrate how to make a relative abundance table.
4. Students make the following observations of microcosm:
  - a. written description of what they see. Who is eating whom? What are the organisms doing? What are the examples of each trophic level? How can you tell?
  - b. Drawings of at least one new organism per day. Each drawing should have a title with the name of the organism and the trophic level it occupies.
  - c. Construct a relative abundance table. (see attached sheet)

After day two, students will make observations of the microcosm 2 to 3 times per week for 2.5- 3 weeks and record the information from number 4 under day 2. These observations should take 20-25 minutes per day.

As we progress through the project, we will have class discussions about what we are seeing and how it relates to the concepts of: *energy in ecosystems, cycling of nutrients, homeostasis, and population dynamics*. After three weeks, students will conduct an experiment on the microcosm as follows:

Class is divided into two groups: control and experimental. Students in the control group will add nothing to their microcosms. Students in the experimental group will add acid to their microcosm. Each group should add a different number of drops of acid. Students will observe microcosms for an additional week and a half and record changes.

At the conclusion of the acid experiment, the class will discuss results and students will write individual lab reports according to the lab format sheet.

## **Extensions**

Students will use the knowledge gained from this experiment in their later water studies:

Before visiting the sewage treatment plant students will observe samples of sludge and identify microbes. They will discuss their importance in sewage treatment based on knowledge gained in microcosm study.

Students will use their knowledge of the organisms in pond water to conduct water analysis on a creek. (identification of indicator organisms)

Students will use the results of their acid study and discussions of their results as a lead-in to the discussion of the pollution of our watershed and the implications.

### **Assessment:**

Microcosm report.

## **Lesson Two**

### **Title: How do we determine Water Quality and Aquatic Life?**

#### **Objectives:**

Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles from science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned about water testing and build on past learning experiences to acquire new information.

Kentucky State Academic Expectations / Objectives

- 1.3 – Students will be able to interpret various things observed by participating in class discussion and hands on laboratory water testing and macro invertebrate sampling.
- 2.1 – Students will be able to use scientific ways of thinking and working and use those methods to solve real life problem by learning about water quality and how they could apply to their lives.
- 6.2 – Students will be able to use what is already known to interpret new experiences by understanding water analysis and aquatic life.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

### **Program of Studies:**

Scientific Inquiry and Scientific ways of Thinking and Working

Students will

- Conduct different kinds of scientific investigations for a wide variety of reasons.

- Use equipment (water chemistry kits and macro invertebrate sampling), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.

### Chemical Reactions

Students will:

- Investigate chemical reactions. (Ph, dissolved oxygen)
- Investigate factors (temperature) affecting reaction rates.

### Motions and Forces

Students will:

- Investigate forces and the effects of forces on the motion of objects. (Rate of stream flow)

### Applications/Connections

Students will:

- Investigate how science can be used to solve environmental quality problems.
- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.

## Core Content:

### Physical Science

- SC-H-1.3.1 Chemical reactions occur all around us.
- SC-H-1.3.2 Reaction rates depend on concentration, temperature, and properties of reactants.

### Motions and Forces

- SC-H-1.4.1 Objects change their motion only when a net force is applied.
- SC-H-1.4.3 The electric force is a universal force that exists between any two charged objects.

## Student Objectives:

- Students will be able to conduct different kinds of scientific investigations using laboratory materials.
- Students will be able to use equipment (water chemistry kits and macro invertebrate sampling), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.
- Students will be able to investigate chemical reactions. (Ph, dissolved oxygen)
- Students will be able to investigate factors (temperature) affecting reaction rates.
- Students will be able to investigate how science can be used to solve environmental quality problems.
- Students will be able to use science to investigate natural hazards and human induced hazards.
- Students will be able to analyze the role science plays in everyday life.

### **Materials:**

Lamont testing kit, macro invertebrate key, kick nets, water sample, Kentucky water watch monitoring sheet, sampling methods packet from Watershed Watch.

### **Activity Procedure:**

1. Field trip overview.
2. Discuss Macro invertebrate collection and interpretation procedures.
3. Group practice of Lamont testing kit using water sample.
4. Discuss importance of Watershed.

### **Assessment:**

Observation of student technique.



# Water Monitoring

General Science

Names of Group Members:

Date:

	Sample No. ____	Sample No. ____	Sample No. ____	Control
Temperature				
PH				
Dissolved Oxygen				
Conductivity				

Question:

1) Describe the water quality of each sample using your results and result indicator sheet.

2) Hypothesize the reasons for your results.

## Lesson Three

### Title: Watershed Field Trip

### Objectives:

#### Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles from science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned and build on past learning experiences to acquire new information.

#### Kentucky State Academic Expectations / Objectives

- 1.3 – Students will be able to interpret various things observed by participating in class discussion, water sampling analysis and hands on macro invertebrate sampling.
- 2.1 – Students will be able to use scientific ways of thinking and working and uses those methods to solve real life problem by learning about aquatic life and how they could apply to their lives.
- 6.2 – Students will be able to use what is already know to interpret new experiences by understanding aquatic life requirements.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

### Program of Studies:

#### Scientific Inquiry and Scientific ways of Thinking and Working

##### Students will

- Conduct different kinds of scientific investigations for a wide variety of reasons.
- Use equipment (water sampling kit, macro-invertebrate sampling kits), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.

#### The interdependence of Organisms

##### Students will:

- Examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms. (Macro-invertebrate sampling)

#### The Behavior of Organisms

##### Students will:

- Investigate behavioral responses to internal changes and external stimuli. Macro-invertebrate sampling comparison to PH, dissolved oxygen and conductivity.
- Analyze how patterns of behavior ensure reproductive success.

#### Applications/Connections

##### Students will:

- Investigate how science can be used to solve environmental quality problems.

- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.

## Core Content:

### Life Science: The Behavior of Organisms

- SC-H-3.2.2 Behavioral responses to internal changes and external stimuli can be innate or learned.
- SC-H-3.2.3 the broad patterns of behavior exhibited by organism have changed over time through natural selection to ensure reproductive success.

### Life Science: Biological change

- SC-H-3.4.1 Biological classifications are based on how organisms are related.

### Life Science: The interdependence of Organisms

SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems

## Student Objectives

- Students will be able to conduct different kinds of scientific investigations for a wide variety of reasons by using the Lamont testing kit.
- Students will be able to use equipment (water sampling kit, macro-invertebrate sampling kits), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.
- Students will be able to examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms. (Macro-invertebrate sampling)
- Students will be able to investigate behavioral responses to internal changes and external stimuli. Macro-invertebrate sampling comparison to PH, dissolved oxygen and conductivity.
- Students will be able to analyze how patterns of behavior ensure reproductive success.
- Students will be able to investigate how science can be used to solve environmental quality problems.
- Students will be able to use science to investigate natural hazards and human induced hazards.
- Students will be able to analyze the role science plays in everyday life.

## Materials:

Lamont testing kit, macro invertebrate key, kick nets, clear plastic container with lid, Kentucky water watch monitoring sheet, and sampling methods packet from Watershed Watch.

## Activity Procedure:

1. Discuss rules of procedure (boundaries, depth, etc.)
2. Demonstration / Review of monitoring procedures.
3. Group collections.

4. Group sharing and discussion of results.

### **Assessment:**

Observation of student technique.

## **Lesson Four**

### **Title: Ground Water Testing**

#### **Objectives:**

Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles from science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned about water testing and build on past learning experiences to acquire new information.

Kentucky State Academic Expectations / Objectives

- 1.3 – Students will be able to interpret various things observed by participating in class discussion and hands on SEPUP lab.
- 2.1 – Students will be able to use scientific ways of thinking and working and use those methods to solve real life problem by learning about water quality and how they could apply to their lives.
- 6.2 – Students will be able to use what is already know to interpret new experiences by understanding water analysis.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

### **Program of Studies:**

#### Scientific Inquiry and Scientific ways of Thinking and Working

Students will

- Conduct different kinds of scientific investigations for a wide variety of reasons.
- Use equipment (SEPUP kit), tools, techniques (measuring), technology (calculators, CBL's, LabProbes) and mathematics to improve scientific investigations and communications.

#### Chemical Reactions

Students will:

- Investigate chemical reactions. (Ph)
- Investigate factors (temperature) affecting reaction rates.

#### Motions and Forces

Students will:

- Investigate forces and the effects of forces on the motion of objects. (Rate of stream flow)

## Applications/Connections

Students will:

- Investigate how science can be used to solve environmental quality problems.
- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.

## **Core Content:**

### Physical Science

- SC-H-1.3.1 Chemical reactions occur all around us.
- SC-H-1.3.2 Reaction rates depend on concentration, temperature, and properties of reactants.

### Motions and Forces

- SC-H-1.4.1 Objects change their motion only when a net force is applied.
- SC-H-1.4.3 The electric force is a universal force that exists between any two charged objects.

## **Student Objectives**

- Students will be able to conduct different kinds of scientific investigations for a wide variety of reasons.
- Students will be able to use equipment (SEPUP kit), tools, techniques (measuring), to improve scientific investigations and communications.
- Students will be able to investigate chemical reactions. (Ph)
- Students will be able to investigate how science can be used to solve environmental quality problems.
- Students will be able to use science to investigate natural hazards and human induced hazards.
- Students will be able to analyze the role science plays in everyday life.

## **Materials:**

Non-point source pollution handout from “Splashing in Kentucky”, Fruitvale SEPUP module with supplement for Fernald Nuclear Power Plant, and Porosity and Permeability from “Splashing in Kentucky”.

## **Activity Procedure:**

Day One

1. Discuss ground water and point and non-point source pollution.
2. Do Porosity and Permeability activity.

Day Two

1. Complete Fernald Ground Water contamination using SEPUP module.

## **Assessment:**

SEPUP module student activity packet.

## References

- Lab-Aids Inc. Investigating Ground Water: The Fruitvale Story. SEPUP.
- Neeley, C. L. (1998). Splashing in Kentucky. Kentucky Waterways Alliance.  
Kentucky Division of Water.

## Lesson Five

### Title: What is the Human Impact?

#### Objectives:

Kentucky State Learner Goals

- Goal 2 – Students develop their abilities to apply core concepts and principles form science to what they encounter throughout their lives.
- Goal 4 – Students develop their abilities to become responsible members of a work group and community.
- Goal 6 – Students develop their abilities to connect and integrate experiences and new knowledge from what they have previously learned and build on past learning experiences to acquire new information.

Kentucky State Academic Expectations / Objectives

- 2.1 – Students will be able to use scientific ways of thinking and working and use those methods to solve real life problems by learning about water quality and aquatic life and how they could apply to their lives.
- 6.2 – Students will be able to use what is already know to interpret new experiences by understanding the aquatic life requirements and water analysis.
- 6.3 – Students will be able to expand the understanding of existing knowledge by making connections with new knowledge, skills and experiences.

#### Program of Studies:

##### Scientific Inquiry and Scientific ways of Thinking and Working

Students will

- Identify and refine questions and scientific concepts to guide the design of scientific investigation.

##### The interdependence of Organisms

Students will:

- Examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms.

##### Applications/Connections

Students will:

- Investigate how science can be used to solve environmental quality problems.
- Use science to investigate natural hazards and human induced hazards.
- Analyze the role science plays in everyday life.

## Core Content:

### Life Science: The interdependence of Organisms

- SC-H-3.5.5 Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems.

## Student Objectives:

- Students will be able to identify and refine questions and scientific concepts to guide the design of scientific investigation.
- Students will be able to examine interrelationships and interdependencies of organisms in ecosystems and the factors that influence the interactions between organisms.
- Students will be able to investigate how science can be used to solve environmental quality problems.
- Students will be able to use science to investigate natural hazards and human induced hazards.
- Students will be able to analyze the role science plays in everyday life.

## Materials:

Urban Runoff handout from “Splashing in Kentucky”, Secret Sink from “Splashing in Kentucky”.

## Activity Procedure:

1. Discuss runoff and possible water pollution sources.
2. Do Secret Sink activity in groups of three.

## Assessment:

Development of watershed plan.

## References

Neeley, C. L. (1998). Splashing in Kentucky. Kentucky Waterways Alliance. Kentucky Division of Water.