LEWIS CREEK ASSOCIATION

Student River Monitoring and Citizenship

A Curriculum Unit

Produced by Lewis Creek Association in collaboration with Champlain Valley Union High School, Mount Abraham Union High School, and Vergennes Union High School

June 2001

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Project History, Acknowledgements, & Community Resources

The Lewis Creek Association (LCA) River Watch Program for Schools worked closely with three watershed area high schools to produce this Vermont standards-based unit for Vermont high schools. The unit includes biological, chemical, and physical tests while emphasizing the importance of water quality monitoring and stewardship in the local community. This project was funded by the Vermont Watershed Fund of the Vermont Department of Fish and Wildlife, an education grant from Lake Champlain Basin Program, and by the citizens and towns in the Lewis Creek watershed. Very special thanks go to three teachers from the Lewis Creek watershed high schools, Gay Mary Craig of Champlain Valley Union High School, Shelly Snyder of Mount Abraham Union High School, and Judy Wiger of Vergennes Union High School. It was their collaboration and ideas that made this project a success. Finally, it is most important to note the invaluable knowledge and encouragement, both in the classroom and in the field, which we have all received from Dr. Dan Bean, Professor Emeritus of Saint Michael's College and board member of the Vermont Academy of Arts and Sciences. Dr. Bean has faithfully shared his great depth of experience and has encouraged us all to develop a more educated citizenry by helping our student citizens gain the skills and understanding needed to actively restore rivers to a healthy and more natural state.

The special features of this unit involve the inclusion of four components--field, laboratory, classroom, and community. Equipment and books were purchased to support this unit. The books used with this unit include Guide to Water Quality Monitoring, Testing the Waters, Guide to Macroinvertebrate Sampling, Living Waters, and The Lake Champlain Basin Atlas (see bibliography). Equipment used in this watershed included boots, trays, and nets for macroinvertebrate sampling. These materials are loaned out by LCA and utilized for community and educational projects in the Lewis Creek watershed. Other materials needed for this unit must be purchased, or might be received through the University of Vermont's extension outreach program, The Watershed Alliance. The Watershed Alliance also provides teacher assistance and support from highly qualified UVM students. Lewis Creek Association and the Watershed Alliance are currently working to pursue the possible creation of a UVM website for Vermont schools and watershed groups to enter their water quality data, view results from other schools and groups, and compare collective results with Vermont Water Quality Standards. Currently, this curriculum may be downloaded from the LCA web site, www.lewiscreek.org.

Community Resources

Lewis Creek Association	www.lewiscreek.org
The Watershed Alliance	lcragin @zoo.uvm.edu (email)
Vt. Agency of Natural Resources	www.anr.state.vt.us
Lake Champlain Basin Program	www.lcbp.org
River Network	www.rivernetwork.org
Lake Champlain Science Center	www.lakechamplainsciencecenter.org
Vermont Water Resources and Lake Studies Center	www.nature.snr.uvm.edu/vtwater
Vermont Center for Geographic Information	www.vcgi.org

Unit Overview

Unit Title: Student River Monitoring and Citizenship

Essential Question: Why is water an important resource?

Unit Goals and Desired Results:

1. Students will use scientific methods to describe, explain, and investigate the physical characteristics, chemistry, and macroinvertebrates of a local river.
2. Students will design and conduct a guided investigation of abiotic and biotic factors of a river ecosystem in the field.
3. Students will complete a mathematical model of a cross section of a river.
4. Students will demonstrate their understanding of the interdependence of the systems that support life in a river ecosystem locally, regionally, and globally.
5. Students will create a poster **or** deliver a presentation of their investigation at the river and use graphs, charts and other visuals to communicate their data.
6. Students will write an argumentation essay **or** statement of position and rationale based on the analysis of their data.

Focus Questions:

Why do living organisms need water?
How healthy is the water in our area?
What are the effects of human activities on water quality?

Summary:

This is a four-week inquiry unit for grades 5 - 12. Students will learn why water is important and use scientific methods to investigate the health of a river ecosystem and the impact of land use choices on water quality. Students will share their findings and conclusions with their peers and communities. Students will formulate questions and hypotheses, investigate current research on local, regional, and global water quality, and design and carry out field research. During this unit students will be introduced to the Vermont Water Quality Standards. They will present their results in a variety of assessments including a lab report, an argumentation essay or a position statement, and a poster or presentation of their results and conclusions. Results and conclusions will be shared with their peers and communities. In this unit, we have included the rubrics for four assessments: lab report, river investigation poster/presentation, and argumentation essay.

Lesson Schedule

This schedule is based on a 90-minute, alternate day block schedule and may need adaptations in each school.

Week one: **Why do living organisms need water?**

1. Introduction of unit: Why is water an important resource?
   Perform a demonstration of the percentage of available fresh water to support life on our planet. (Lesson1) (Behar, Caduto, or Wetzel)
2. Chemistry of water (Lesson 2) (Behar, Mitchell, Stapp,Wetzel)
   Water as a limiting factor (Lesson 2) (Behar, Leopold)
3. "Water-A Miraculous Substance" video, worksheet and discussion. (Lesson 3) (Arts and Humanities film)

Week two: **How healthy is the water in our area?**

4. Review of experimental design: How healthy is the water in our river? (Lesson 4) (Behar, Caduto, Craig, LaMotte, Hoffer, Wetzel)
5. Review lab report format, evaluate student models and mathematical models of river cross-sections (Lesson 4)
6. Demonstrate and practice using chemical test kits and sampling macroinvertebrates. "Water Canaries" (Lesson 5) (see attached, Byrne)

Week three: **What are the effects of human activities on water quality?**

7. Demonstrate watershed and site map symbols. (Lesson 6) (Hoffer, Wetzel)
8. "Riparian Retreat" and "Alice in Waterland" activities (see attached)
9. Oral Histories: land use over time along the river.
10. "Stream Corridor Field Sheet" introduction (Behar)
11. Define your watershed (Hoffer, Snyder)
12. Stream Orders: explanation and identification (Behar, Wetzel)
13. Stream Walk: field trip to the river (Lesson 7)

Week four: **Preparation for performances and assessments**

14. Analysis and discussion of river investigation results and VT Water Quality Criteria. (Lesson 8) (Behar)
    - See Community Resources on page 1 to access VT Water Quality Standards.
15. Discuss models of river investigation posters or argumentation essays. Create paragraph outline for essay or a diagram of the poster. (Lesson 8)
16. Teams research and work to develop position statement and rationale for "Postenbeam Booming Town, or Big Trouble in River City" and/or develop presentations of test results and their meaning for peers and community groups. (Lesson 9 & 10)
    - See Appendices for water quality data sheet examples.

Vermont Standards and Evidences

This document assumes that the *Vermont Framework of Standards and Learning Opportunities* has been adopted as the local curriculum.

Vital Results (VR)

Communication Standards

Writing – Reports

1.8 In written reports, students organize and convey information and ideas accurately and effectively.

All evidences (a-h)

Writing – Persuasive Writing

1.11 In persuasive writing, students judge, propose, and persuade.

All evidences (a-g)

Expression – Speaking

1.15 Students use verbal and nonverbal skills to express themselves effectively.

All evidences (a-g)

Information Technology – Communication of Data

1.20 Students use graphs, charts, and other visual presentations to communicate data accurately and appropriately.

Personal Development Standards

Making Decisions – Environment

3.9 Students take steps to protect and repair the environment. This is evident when students:

aa. Make informed decisions that balance natural resource conservation with sustainable economic development.

Field of Knowledge (FK)

Science, Mathematics, and Technology Standards

Inquiry, Experimentation, and Theory – Scientific Method

7.1 Students Use Scientific methods to describe, explain, and investigate phenomena

All evidences (aa/aaa – ii)

Inquiry, Experimentation, and Theory -- Investigation

7.2 Students design and conduct a variety of their own investigations and projects.

bb. Design and conduct fieldwork

ff. Complete a mathematical model of physical phenomena.

h. Study decision options in business or public planning that involves issues of optimizations, trade-off, cost-benefit projections, and risks.

The Living World – Organisms, Evolution, and Interdependence

7.13 Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life.

ccc. Describe, model and explain the principles of the interdependence of all systems that support life (e.g. flow of energy, ecosystems, life cycles, cooperation and competition, human impacts on the world ecological system) and apply them to local, regional, and global systems.

Learning Opportunities (LO)

Access – Content

A.1 Access to the knowledge and skills described in the standards, Vermont Frameworks.

a. Local curriculum based on the standards of Vermont's Framework.

Instruction – Acquiring Knowledge and Skills

B.1 Learning experiences that engage students in active learning, build on prior knowledge and experiences, and develop conceptual and procedural understanding, along with student independence.

All Evidences

Instruction – Multiple Student Roles

B.3 Opportunities to learn through a variety of roles (e.g. planner, questioner, artist, scientist, historian) alone and with others. For example:

a. Collaboration in both small and large groups.
e. Opportunities for independent learning, work in pairs, and work in larger groups.

Instruction – Application and Reflection

B.4 Projects and assignments that require students to integrate and apply their learning in meaningful contexts, and to reflect on what they have learned. For example:

a. Extended investigation through which students address essential questions.
b. Opportunities to transfer learning from one format or context to another.

Assessment/Standards, Unit Goals/Criteria

Assessments	Standard/Unit Goal	Criteria
Analysis questions based on the demo of available water	FK 7.13 ccc. Goal 4	Answer Key and discussion
Quiz: Chemistry of water and the effects of limiting factors	FK 7.13 ccc. Goal 4	Answer Key and discussion
Listening Guide Worksheet for "Water- A Miraculous Substance" (video)	FK 7.13 ccc. Goal 4	Answer Key and discussion
Written summary of the attributes of the watershed and the relationships between topography and soils, water chemistry and land usage in the area.	FK 7.13 ccc. Goal 4	Answer Key and discussion
Written outline of design, materials, and procedures for the river investigation	FK 7.2 Goal 2	Lab Report Scoring Guide: materials list, procedure, and discussion
Analysis Questions Lab Report of physical, chemical and/or macroinvertebrate test results from river investigation site	FK 7.1 and 7.2 Goals 1,2,4	Answer Key and discussion Lab Report Scoring Guide
Mathematical model demonstrating data, calculations, and graph of the depth, velocity, and volume of water	FK 7.1 and 7.2 Goals 1, 2, 3	Observations Answer Key and discussion
Sketch of riparian investigation site using symbols **or**	VR 1.20 Goal 1	Observations
Stream Corridor Field Sheet	VR 1.20 FK 7.2 Goal 1	Observations
Written summary of interview	VR 1.8 Goal 2	Use of data in culminating products and performances
Argumentation Essay "Is the River Healthy?" **or**	VR 1.11 FK 7.13 ccc, 7.2 h Goals 4, 6	Argumentation Essay Scoring Guide
Statement of position and rationale concerning the balance between natural resources and economics	VR 1.11 FK 7.13 ccc, 7.2 h Goal 4, 6	Answer Key and discussion
River Investigation Poster **or**	VR 1.8 and 1.20 FK 7.13 ccc Goals 4, 5	River Investigation Poster Scoring Guide
Presentation of investigation results and conclusions.	FK 7.1, 7.2, 7.13 VR 1.15, 1.20 Goals 4, 5	Presentation Scoring Guide

Learning/Teaching Activities, Products, and Standards

Learning Activities	Products/Performances	Standards/Learning Opportunities
(I & E) Demonstration of the % fresh water available on earth.	Analysis Questions	FK 7.13 ccc.
(E) Chemistry of water Effects of Limiting Factors	Quiz: constructed response	FK 7.13 ccc.
(E) "Water- A Miraculous Substance" (video)	Listening Guide Worksheet	FK 7.13 ccc. LO B.4 b
(E) Geographic and topographic map study of river watershed.	Written summary of the attributes of the watershed and the relationships between topography and soils, water chemistry and land usage in the area.	FK 7.13 ccc. LO B.4
(E) Review of experimental design.	Design and write an outline of the materials and procedures for the river investigation.	FK 7.2 LO B.3, B.4
(E) Review lab report format and components.	Verbal examples of components	VR 1.8 LO B.1
(E) Demonstration and practice of testing methods for abiotic and biotic factors in the river ecosystem. "Water Canaries" (Project Wild Aquatic)	Analysis Questions Lab Report of chemical and/or macroinvertebrate test results from river investigation site	FK 7.1 and 7.2 LO B.1 and B.3
(E) Practice Embody Float Method of finding depth, velocity, and total discharge in a river. (Wetzel and Likens and M. Caduto)	Mathematical model of river bottom Data, calculations, and graph	FK 7.1 and 7.2 LO B.1 and B.3
(E) Demonstrate and practice site sketch with symbols -- "Riparian Retreat" and "Land Use in the Watershed" (Project Wild Aquatic)	Sketch of riparian investigation site using symbols	VR 1.20 LO B.1
(E) Oral Histories: Changes in Land Use Over Time. Community member sources.	Data in the form of a written summary or tape of interview	VR 1.8 LO B.1, B.3
(E) Stream Walk and/or Field Trip. Identification of abiotic and biotic factors	Stream Corridor Field Sheet completed during field investigation at river site and record of observations	VR 1.20 FK 7.2 LO B.1
(E) Analysis and discussion of data and VT Water Quality Standards	Results of discussion are assessed in the lab report and culminating products and	VR 1.15, 1.20 FK 7.13 ccc

	performances.	LO B.1, B.3
(C) Discuss rubric of argumentation essays and apply to models **or**	Argumentation Essay	VR 1.11 FK 7.13 ccc, 7.2 h LO B.1
(C) Statement of position and rationale in response to development dilemma "Big Trouble in River City"	Statement of Position and rationale	VR 1.11 FK 7.13 ccc, 7.2 h LO A1, B.1 B.3, B.4
(C) Discuss rubric of poster characteristics and apply to models **or**	River Investigation Poster	VR 1.8 and 1.20 FK 7.13 ccc LO B.1
(C) Discussion of criteria and development of a peer and/or public presentation.	Presentation of investigation results and conclusions.	FK 7.1, 7.2, 7.13 VR 1.15, 1.20 LO A1, B.1 B.3, B.4

Introductory Activity (I)
Enabling Activity (E)
Culminating Activity (C)

Field of Knowledge FK
Vital Result VR
Learning Opportunity LO

Bibliography

Behar, Sharon. Testing the Waters Chemical & Physical Vital Signs of a River. Dubuque, Iowa: Kendall/Hunt Publishing Company and River Watch Network, 1996.

- This text contains background information, data sheets, and protocols for all chemical and physical tests in a student-friendly format.

Byrne, Jack, and Geoff Dates. Living Waters Using Benthic Macroinvertebrates and Habitat to Assess Your River's Health. Portland, Oregon: River Network Press, 2001.

- This text has complete information for students to collect, identify and interpret macroinvertebrate samples.

Caduto, Michael. Pond and Brook - A Guide to Nature in Freshwater Environments. Hanover and London: University Press of New England, 1990.

- Mr. Caduto writes excellent background information about rivers and has a diagram and clear explanation of the Embody float method of creating a mathematical model of the river bottom. Data Collection and calculations are also shown.

Craig, Gay. Vermont River Project: Scientific Method A Problem –solving Technique. Hinesburg, Vermont: Champlain Valley Union High School, 1999.

- This is a student packet for this unit of study available from Craig.

Hach. Water Analysis Handbook. Loveland, Colorado: Hach Company, 1997.

- This book contains protocols and error analysis specific to Hach water quality testing kits.

Hoffer, Stacey. Watershed Alliance 2000: Three Week Planning Guide and Land-based Activities. Burlington, Vermont: University of Vermont, School of Natural Resources, May 2000.

- This planning guide has excellent watershed identification and evaluation activities in it.

LaMotte. The Monitor's Handbook. Chestertown, Maryland: LaMotte Company, 1992.

- This book contains brief background information and protocols specific to LaMotte water quality testing kits.

Leopold, Luna B. Waters, Rivers and Creeks. Sausalito, California: University Science Books, 1997.

- This book presents excellent background information for the teacher and/or advanced student about rivers, especially their geology and management.

Mitchell, Mark K., and William B. Stapp. Field Manual for Water Quality Monitoring. Tenth ed. Dexter, Michigan: Thompson – Shore Printers, 1996.

- This handbook has water quality background and protocols written for students.

Northern Cartographic. The Lake Champlain Basin Atlas. South Burlington, Vermont: Northern Cartographic, 1999.

- This atlas is a joint effort by the Lake Champlain Basin Program and many state agencies to produce a comprehensive picture of the Lake Champlain Basin. It has excellent information about the rivers in the basin and background about water quality. Check the Basin Program website noted on page 1.

Western Association of Fish and Wildlife Agencies and Western Regional Environmental

- Education Council. Project Wild Aquatic. USA: 1987.
  This is a collection of activities provided by Vermont Department of Fish And Wildlife in a course about water and water quality for K-12 students.

Snyder, Shelley. Lewis/Baldwin Creek Field Assignment. Bristol, Vermont: Mt. Abraham Union High School, 1999.

- This is a student packet for this unit of study available from Snyder.

Water-A Miraculous Substance. Video. Arts and Humanities Films

- This is one of many school appropriate videos available through catalogues in school libraries.

Wiger, Judy. Stream Inventory—Profile and Water – A Miraculous Substance Listening Guide. Vergennes, Vermont: Vergennes High School, 1999.

- This is a student packet for this unit available from Wiger.

Wetzel, Robert G. and Gene E. Likens. Limnological Analyses. New York, New York: Springer-Verlag Publishing, 1991.

- This is a college level textbook about water and water quality. It has in depth information about the testing and evaluation of water quality.