A STUDY TO DEVELOP
AN ENVIRONMENTAL EDUCATION TRAINING CURRICULUM
FOR WISCONSIN INSERVICE TEACHERS
by
Nancy H. Cripe

APPENDICES

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A Thesis
submitted in partial fulfillment of the
requirements for the degree of
MASTER OF SCIENCE
in
Natural Resources (Environmental Education)
College of Natural Resources

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UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

May 1991
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Teacher Outreach
In
Environmental
Education:

Course One:

Principles
Of
Environmental
Education

Natural Resources 411/611

A Project Of
The College of Natural Resources
and
The Office of Continuing Education

The University of Wisconsin-Stevens Point
1990

Written by Nancy H. Cripe

Teacher Outreach Program Coordinator:
Dr. Dan Sivek
Welcome to *Principles of Environmental Education*, the first of four outreach courses to be offered statewide to Wisconsin K-12 teachers. This curriculum for *Principles of Environmental Education* is intended to provide you, the instructor, with a basic framework for teaching the course.

Instructors played a key role in developing the goals and objectives for this course during the November 1989 planning session. The ten lessons in *Principles of Environmental Education* are based on those goals and objectives. While you might choose not to teach each lesson exactly as written, the overarching goals and objectives must be addressed through your instructional methods.

The format for each of the ten lessons is the same:

1. Objectives
2. Method
3. Instructional Time
4. Readings
5. Background
6. Materials
7. Procedure
8. Extensions
9. Evaluation

For clarity, certain terms used throughout the curriculum are defined here:

1. **Instructor**: instructional academic staff selected by the University of Wisconsin-Stevens Point to teach outreach courses in environmental education to K-12 teachers in Wisconsin.

2. **Student**: any K-12 teacher enrolled in the outreach course.

3. **Instructional Time**: the approximate amount of time which instructors will need to teach a lesson. The total amount of instructional time for the entire course, *Principles of Environmental Education*, is 16 hours.

4. **Readings**: selected articles on environmental education contained in the student Book of Readings (BR). There is no formal text for the course other than the Book of Readings.

5. **Background**: general information provided in each lesson for instructor reference.

6. **Extensions**: optional activities provided at the end of each lesson which the instructor might incorporate. The instructional time given for each lesson does not include the use of extensions.

7. **Evaluation**: informal activities, strategies, and questions which the instructor might use to assess student learning at the conclusion of each lesson.

8. **Assignments**: three specific projects which each student will complete during (or shortly after) the course. These assignments are listed in the evaluation section of lessons two, three, and five.

9. **EE Sub-goals**: to be consistent with current terminology and the new version (1990) of the Wisconsin DPI Guide to Curriculum Planning in EE, the terms "citizen action skills" and "citizen action experience" replace the terms "skills" and "participation", respectively.
The College of Natural Resources at the University of Wisconsin-Stevens Point believes your experience and commitment to the field of environmental education will greatly benefit Wisconsin's teachers. Thank you for serving as an instructor for *Principles of Environmental Education*. Your contribution will significantly improve the quality and quantity of environmental education available to both teachers and students throughout the state of Wisconsin.

Dr. Alan Haney  
Dean  
College of Natural Resources  
University of Wisconsin-Stevens Point

Dr. Richard Wilke  
Associate Dean  
College of Natural Resources  
University of Wisconsin-Stevens Point

Dr. Dan Sivek  
Assistant Professor  
College of Natural Resources  
University of Wisconsin-Stevens Point

Dr. Michael Offerman  
Director  
Office of Continuing Education  
University of Wisconsin-Stevens Point

Nancy Cripe  
Graduate Student  
College of Natural Resources  
University of Wisconsin-Stevens Point
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<tr>
<td>1</td>
<td>One</td>
<td>&quot;To Begin With...&quot;: Students reflect on personal attitudes toward EE by completing a questionnaire and discussing it.</td>
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<td>2</td>
<td>Two</td>
<td>&quot;What in the World's Going On?: Students examine the proliferation of environmentally-related events by constructing a timeline; simulate the Tragedy of the Commons; investigate the variety of environmental topics in the news; and are introduced to EE resources. Assignment 1 given.</td>
</tr>
<tr>
<td>1.25</td>
<td>Three</td>
<td>&quot;Introducing Environmental Education&quot;: Students view a slide show summary of EE; examine and share current philosophies of EE, and synthesize a definition of EE. Assignment 2 given.</td>
</tr>
<tr>
<td>1</td>
<td>Four</td>
<td>&quot;What's An Environment?&quot;: Students visit an environment and explore ways of using school site resources in teaching EE.</td>
</tr>
<tr>
<td>2</td>
<td>Five</td>
<td>&quot;Goals of EE&quot;: Students investigate five vignettes of EE in the classroom and assess how each addresses the goal and sub-goals of EE. Assignment 3 given.</td>
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<tr>
<td>2</td>
<td>Six</td>
<td>&quot;Anatomy of an Issue&quot;: Educational movements related to EE are described. Students view a video depicting an environmental issue and identify the players' beliefs and values. Students participate in &quot;Ethi-Reasoning&quot; to explore how their own beliefs and values affect their views. Finally, small groups practice analyzing the players, beliefs, and values in an environmental issue and report their findings.</td>
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<td>1</td>
<td>Seven</td>
<td>&quot;The Method of Environmental Issue Investigation&quot;: Students examine a case study of an issue investigation, identify the phases of investigation and types of citizen action used. Teaching methods effective in issue investigation are identified.</td>
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<tr>
<td>TIME (hours)</td>
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<td>DESCRIPTION</td>
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<td>1.25</td>
<td>Eight</td>
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</tr>
<tr>
<td>0.5</td>
<td>Nine</td>
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</tr>
<tr>
<td>4</td>
<td>Ten</td>
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**POSSIBLE COURSE FORMATS:**

*Principles of Environmental Education* is a 16 hour course which can be taught in a variety of formats. Instructors are encouraged to design the format of the course to accommodate the schedules and preferences of students enrolled. Three possible formats are suggested:

**Weekend Format**

Five Session Format (approximately three hours each)
Eight Session Format (approximately two hours each)

**Weekend Format**

<table>
<thead>
<tr>
<th>Session Time</th>
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<th>Duration</th>
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<tr>
<td>Friday Night:</td>
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<tr>
<td>Saturday Morning:</td>
<td>Lessons Three - Five</td>
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<td>Saturday Afternoon:</td>
<td>Lessons Six and Seven</td>
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<td>Saturday Evening:</td>
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<td>Sunday Morning:</td>
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**Five Session Format**

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<tr>
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<td>Lessons One and Two</td>
<td>3 hours</td>
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<tr>
<td>Session 2</td>
<td>Lessons Three and Five</td>
<td>3.25 hours</td>
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<td>Session 3</td>
<td>Lessons Four and Six</td>
<td>3 hours</td>
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<td>Lessons Seven/Eight/Nine</td>
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<tr>
<td>Session 5</td>
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**Eight Session Format**

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<tr>
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<td>Lesson Two</td>
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<tr>
<td>Session 3</td>
<td>Lessons Three and Nine</td>
<td>1.75 hours</td>
</tr>
<tr>
<td>Session 4</td>
<td>Lesson Five</td>
<td>2 hours</td>
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<tr>
<td>Session 5</td>
<td>Lesson Six</td>
<td>2 hours</td>
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<tr>
<td>Session 6</td>
<td>Lessons Seven and Eight</td>
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<tr>
<td>Session 8</td>
<td>Lesson Ten</td>
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<tr>
<td></td>
<td></td>
<td><strong>16 hours total</strong></td>
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Summary of Assignments for
Principles of Environmental Education, NR 411/611

A letter grade will be given based on the three course assignments. These three assignments are described below, and total 100 possible points. Attendance is required at all class meetings. Grade categories are:

<table>
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<tr>
<td>93-100</td>
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<tr>
<td>83-86</td>
<td>B</td>
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<tr>
<td>77-79</td>
<td>C+</td>
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<tr>
<td>65-66</td>
<td>D+</td>
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<tr>
<td>0-56</td>
<td>F</td>
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Due dates for each assignment are set by the course instructor at the time each assignment is given.

Assignment #1:

1) The student is to choose 3 current environmental topics which most interest him or her, and about which he/she would like to teach.

2) The student is to research the 3 topics (using resource people, newspapers, magazines, journals, information from organizations and agencies, reference materials and other sources).

3) The student is to compile a current "resource file" containing a minimum of 5 pieces of information (news articles, interview notes, educational materials from agencies, etc.) for each topic.

Grading:

Assignment #1 is worth 15 possible points.

15 points are given for 5 or more pieces of information for each of 3 environmental topics (15 or more pieces total).

1 point is deducted for each piece of information less than the required 15 piece total (5 pieces for each of 3 environmental topics).

Assignment #2:

1) Each student is to synthesize a personal philosophy of environmental education which incorporates tenets of current philosophies as appropriate:
   a) each student is encouraged to edit/combine/delete/modify current philosophies and add original ideas to best represent his/her own thinking.
   b) each student is to then compile edited statements and original ideas into a personal "I believe" philosophy about the nature of environmental education (e.g., "I believe EE is/is not...."; "I believe EE should/should not....")
Grading:

The student's personal philosophy should be approximately two to four typewritten, double-spaced pages.

Assignment #2 is worth 25 total possible points. Points will be assigned based on:
- support and defense of the philosophy; and
- evidence of thoughtful preparation and clarity of expression.

Assignment #3:

1) Each student is to choose one of the three environmental topics researched by him/her in Assignment #1. The student is to write a unit plan outline for the topic incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed). Specifically:

a) elementary teachers: develop a multidisciplinary unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed);

or

b) secondary teachers: by collaborating with a teacher from a different subject area, jointly develop a unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed);

2) Assignment #3 is to be a unit outline, not a fully prepared, ready-to-teach unit.

Grading:

Assignment #3 is worth 60 possible points. Students working in pairs will receive the same grade.

Points will be assigned based on the extent to which the unit plan outline creatively and thoroughly addresses the following seven components:

1. an identified local environmental issue;
2. the identified area of the yearly curriculum where the unit will be infused;
3. specific, learner-centered objectives aimed toward the achievement of appropriate EE sub-goals;
4. a general description of the environmental knowledge and skills to be learned during the unit;
5. an outline of the instructional procedures to be used in teaching the unit (e.g., cooperative learning, research, Project WILD activities);

6. an outline of the daily progression of the unit (day one, day two...);

7. a general description of evaluation methods for both the learners (to what extent did they learn?) and the unit (strengths and ways to improve?).

GRADUATE INCREMENT:

All students enrolled in Principles of Environmental Education for graduate credit (NR 611) are required to develop a one week portion (five consecutive lessons) of their unit plan outline into an actual unit plan. Specifically, this unit plan should be "ready-to-teach", addressing all seven points of the unit plan outline. Additionally:

a) instructional procedures should be fully described;

b) all needed materials listed;

c) resources and references cited.

Grading:

For students enrolled for graduate credit, the unit plan outline and the unit plan will be graded together as Assignment #3. Assignment #3 is worth 60 possible points.
MASTER MATERIALS LIST

Lesson One Materials:
OPTION 1:
1) one copy of the questionnaire "Preliminary Thoughts About Environmental Education" per student (Appendix A)

OPTION 2:
1) one environmental timeline packet per student (strips A to Z of historical environmental occurrences, cut up and put in an envelope); answer key (Appendix B)
2) overhead transparencies of blank timeline and answer key timeline
3) erasable overhead transparency markers

Lesson Two Materials:
OPTION 1:
1) one copy of the questionnaire "Preliminary Thoughts About Environmental Education" per student (Appendix A)

OPTION 2:
1) one environmental timeline packet per student (strips A to Z of historical environmental occurrences, cut up and put in an envelope); answer key (Appendix B)
2) overhead transparencies of blank timeline and answer key timeline
3) erasable overhead transparency markers

IN ADDITION TO OPTION 1 OR OPTION 2 MATERIALS:
4) two pounds of peanuts in the shell; one bowl for every four students
5) collections of current magazines (e.g., TIME, Newsweek, US News and World Report, National Wildlife, Audubon, National Geographic, journals) and newspapers (especially the local ones; also major Wisconsin city papers; national papers like the Christian Science Monitor and New York Times). Depending on the timetable of the course, students bring in these materials or the instructor brings these materials for students use.
6) markers of different colors and scissors
7) ten 5X7 cards
8) EE resources (books, pamphlets, audio-visual listings, posters, activity guides, bibliographies, and other materials)

Lesson Three Materials:
1) "Introduction to EE" slide show (also available on video)
2) EE philosophies (contained in students' Book of Readings)
3) butcher paper, colored markers, tape

Lesson Four Materials:
Instructor choice

Lesson Five Materials:
1) overhead transparencies (4) of EE goal and sub-goals, triangle models, and DPI grade level emphases
2) video tape (Langton, Roosevelt, Landfried)
3) slides (Donner: '10; Johannes: '15)
Lesson Six Materials:
1) copies of "dilemma cards" from "Ethi-Reasoning": Project WILD, pages 197-200, secondary guide (Appendix F)
2) video of environmental issue
3) one copy per student of "Controversy on the Prairie" (Milwaukee Journal) or "Deposit poll: Readers say Yes by 2-1" (Wausau Sunday Herald) (Appendix G). Other issues may be substituted based on instructor preference.

Lesson Seven Materials:
1) overhead transparencies (3) of: phases of issue investigation; types of citizen action; 13 criteria for action
2) slides (10) of Martha Kronholm's Timber Wolf Recovery Plan issue investigation.

Lesson Eight Materials:
1) overhead transparencies (4) of: Piaget; Kohlberg; Bloom; factors for environmental sensitivity
2) video of David Brower
3) one copy of the environmental sensitivity survey per student (Appendix I)

Lesson Nine Materials:
1) overhead transparency (1) of single subject and infusion models

Lesson Ten Materials:
1) Students will need to bring their own curriculum (district, school, grade level or subject). Advance notice to students about this is necessary. Students should bring the curriculum which they actually use, or their yearly unit/lesson plans, or their textbook (last choice!) if they follow directly from a text. Students are strongly encouraged to bring curricula of Wisconsin DPI focus areas for EE infusion. Those whose schools or districts already have an EE plan should bring it as well.
2) Students should be encouraged to bring any personal EE resources which they have to this session (e.g., Project WILD, Project Learning Tree, OBIS, Naturescopes).
3) UW-SP EE resource library
PRINCIPLES OF ENVIRONMENTAL EDUCATION

NR 411/611

Teacher Outreach in Environmental Education
Course Outline

A. Philosophy and Rationale of EE
B. Goals of EE
   1. Forerunners of EE
   2. Investigating Environmental Issues
   3. Sub-goals of EE
      a. Awareness
      b. Knowledge
      c. Values and Attitudes
      d. Citizen Action Skills
      e. Citizen Action Experience
C. Teaching Methods in EE
   1. Environmental Issue Investigation
D. Theory Base for EE
E. Curriculum Planning in EE
   1. The Infusion Process
   2. Practicum in Curriculum Development

GOALS FOR PRINCIPLES OF ENVIRONMENTAL EDUCATION

NR 411/611

As a result of this course, students will:

1. understand the goals of environmental education (from the Tbilisi Declaration, 1977):
   a) to promote awareness and concern for the economic, cultural, political, and ecological interdependence which exists worldwide.
   b) to provide every person the opportunity to acquire the knowledge, values, commitment, and skills necessary to protect and improve the environment.
   c) to create in individuals and society new, positive patterns of behavior toward the environment.

2. acquire and be able to apply the knowledge, skills and attitudes inherent in environmental education (Hungerford and Peyton, 1986), including:
   a) knowledge of environmental issues
   b) knowledge of the role of human values in environmental issues
   c) competencies in environmental problem-solving (identification, investigation, evaluation, and action)

3. experience and utilize a wide variety of environmental education instructional materials.
4. understand methods for using the classroom, school site, and community as primary locations for environmental education.

5. develop motivation to teach environmental education at all grade levels and in all subject areas.

OBJECTIVES FOR PRINCIPLES OF ENVIRONMENTAL EDUCATION, NR 411/611

PART A: OBJECTIVES FOR PHILOSOPHY AND RATIONALE OF EE

During or upon completion of this course, students will be able to:

1. demonstrate the need for EE by tracking on a timeline the escalation of human impact on the environment;

2. explain the "Tragedy of the Commons" concept by identifying the "commons" and the "tragedy" for any given resource depletion issue.

3. identify and describe three global environmental issues, three regional or state environmental issues, and three local environmental issues.

4. state at least one way in which any given local environmental issue is related to a global issue.

5. describe one environmental issue and how it demonstrates the relationship between the quality of life and the quality of the environment.

6. identify and communicate at least one way any given environmental issue impacts their lives.

7. examine and summarize current philosophies of EE (Tbilisi Declaration; Wisconsin Department of Public Instruction; Hungerford, Peyton and Wilke, "Goals for Curriculum Development in EE", 1980).

8. synthesize a personal written philosophy of environmental education which incorporates the tenets of current philosophies as appropriate.

9. define "environment" as all the surroundings --- natural, built, and social (economic, political, cultural, historical, moral, aesthetic) --- which influence a living thing.

10. distinguish between an environmental issue and an environmental problem, and give one example of each.
11. identify conflicting beliefs and values as the basis for environmental issues.

12. analyze an environmental issue by identifying all the "players" involved and naming at least one belief and one value held by each.

13. give one example of the role of education in resolving an environmental issue.

14. summarize the three major provisions of Wisconsin's EE curriculum mandate.

15. explain at least two reasons EE is considered "multidisciplinary" in nature and state at least two implications this has for curriculum development.

16. compare and contrast the infusion and single subject strategies for implementing EE, providing at least one advantage and one disadvantage for each approach.

PART B: OBJECTIVES FOR GOALS OF EE

During or upon completion of this course, students will be able to:

1. demonstrate an understanding of the primary goal and sub-goals of EE by writing a unit plan outline incorporating each of the five EE subgoals.

"The goal of EE is to help students become environmentally knowledgeable, skilled, dedicated citizens who are willing to work individually and collectively toward achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment." (Wisconsin Department of Public Instruction, 1986)

The sub-goals of EE (Tbilisi, 1977):

- Awareness
- Knowledge
- Values and Attitudes
- Citizen Action Skills
- Citizen Action Experience

2. compare and contrast the goals of educational movements related to EE (outdoor education, nature study, conservation education). Identify at least one contribution of each to the field of EE.

3. compare and contrast the subject of ecology with the field of EE.
PART C: OBJECTIVES FOR TEACHING METHODS AND STRATEGIES IN EE

During or upon completion of this course, students will be able to:

1. describe at least ten general teaching methods which can be effective in accomplishing the goals of EE;

2. identify the components of investigation, evaluation, and action in the method of environmental issue investigation; and

3. describe at least five categories of citizen action which could be used in resolving an environmental issue.

PART D: OBJECTIVES FOR THEORY BASE FOR EE

During or upon completion of this course, students will be able to:

1. identify educational models of Piaget (theory of cognitive development), Kohlberg (theory of moral development), and Bloom (taxonomy of educational objectives) as contributors to EE theory.

2. identify at least six factors which can help predict environmental sensitivity and describe one way each factor can be incorporated into environmental education.

PART E: OBJECTIVES FOR CURRICULUM PLANNING IN EE

During or upon completion of this course, students will be able to:

1. assess their own curriculum (district, school, grade level or subject) and identify at least five areas suitable for infusion of EE.

2. identify 10 sources of EE curriculum materials and how to obtain them.

3. identify 3 school site or local community resources for use in environmental education.

4. [elementary teachers]: develop a multidisciplinary unit outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit is designed).
5. [secondary teachers]: by collaborating with a teacher from a different subject area, jointly develop a unit outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit is designed).
Lesson One:
To Begin With........

Objectives: Students will be able to:
1) assess their preliminary ideas and attitudes toward the field of EE; and
2) reflect on their teaching style and what they will need in order to teach EE effectively.

Method: Students complete a questionnaire, analyze what they have written, and discuss with a small group.

Instructional Time: 1 hour

Readings: None

Background: K-12 teachers need to be aware of their own attitudes and ideas about EE. This awareness lays the foundation for commitment, motivation, and skills to masterfully teach environmental education.

"Not somehow, but triumphantly."
V. Raymond Edman

Materials:
OPTION 1:
1) one copy of the questionnaire "Preliminary Thoughts About Environmental Education" per student (Appendix A)

OPTION 2:
1) one environmental timeline packet per student (strips A to Z of historical environmental occurrences, cut up and put in an envelope); answer key (Appendix B)
2) overhead transparencies of blank timeline and answer key timeline
3) erasable overhead transparency markers

Procedure:
1) Introductions (15 minutes):
   a) Introduce yourself to the students.
   b) Give a general overview to the course and its goals.
   c) Explain class meeting schedule (dates, times, location) and attendance expectations.
d) Review with students the course grading criteria in the "Summary of Assignments"; details for completing the three assignments need not be given at this time.

2) A brief (15 minute) "get acquainted" activity of the instructor's choice may be used to begin Lesson One.

Otherwise, follow either OPTION 1 or OPTION 2:

OPTION 1: (30 minutes total) Complete steps 3-8 which follow:

3) Introduce the questionnaire by briefly reviewing the lesson objectives. Explain the importance of taking a few minutes to examine personal thoughts on EE and if/where EE fits in their educational and personal philosophy.

4) Explain that small group discussion (3-4 students per group) will follow the completion of the questionnaire. Students do not need to share all parts of their questionnaire if they do not feel comfortable in doing so.

5) Distribute the questionnaire and allow approximately 10 minutes for its completion.

6) After all have completed the questionnaire, have groups of 3-4 students discuss their answers together for 10 minutes. Visit in each group for a few minutes to sample the ideas being expressed.

7) Reconvene as a large group and summarize common themes expressed for 10-15 minutes. Use the process to diagnose/discuss students' goals for taking the course.

8) Collect the questionnaires. Review them outside of class. Responses might be illuminating to you, the instructor, and have bearing on how you structure the course. Return the questionnaires to students during the next class session. (Questionnaires can be collected without names, should you wish to preserve confidentiality. Number them instead.)

OPTION 2: (30 minutes total) Complete the environmental timeline activity in Lesson Two (step 2 of the Procedure section, page 19).
Evaluation: Have students keep their questionnaires in order to compare these preliminary ideas about EE with those that develop during the course. As appropriate throughout the course, refer back to these initial ideas and discuss any changes that emerge.

WHAT IS GOOD EE?

it is "...having a participant-centered design involving each learner/participant in choosing priorities both as to the issues to be studied and the solutions that seem most appropriate. This design allows the participant to learn how to learn about new situations, how to weigh alternatives and how to test solutions."

(The U. S. Office of Education definition)
Lesson Two: What In The World's Going On?

Objectives: Students will be able to:
1) demonstrate the need for EE by tracking on a timeline the increasing magnitude of human impact on the environment;
2) explain the "Tragedy of the Commons" concept by identifying the "commons" and the "tragedy" for any given resource depletion issue;
3) identify and describe three global environmental issues, three regional or state environmental issues, and three local environmental issues;
4) state at least one way in which any given local environmental issue is related to a global issue;
5) describe one environmental issue which demonstrates how the quality of life is directly related to the quality of the environment, and identify that relationship;
6) identify and communicate at least one way any given environmental issue impacts their lives; and
7) identify 10 sources of EE curriculum materials and how to obtain them.

Method: Students:
1) trace environmental change on a timeline;
2) simulate the "Tragedy of the Commons";
3) investigate and analyze global and local issues reported in magazines, newspapers, radio, television, and other media; and
4) explore a variety of EE resources.

Instructional Time: 2 hours

Readings:
1) "Milestones" (BR pg. 1)
2) "The Tragedy of the Commons" (BR pp. 2-7)
3) "Guide to EE Curriculum Materials" (BR pp. 8-9)
4) "Where Do I Look?" (BR pp. 10-13)
5) "List of Agencies and Organizations" (BR pg. 14)

Background: Garrett Hardin's classic account of the "Tragedy of the Commons" relates in simple story form the basis of our environmental dilemma. Combine this with a study of our environmental history, and current human impact on the environment can better be put in perspective.

There seems to be no shortage of environmentally-related news in our times. Some reports are about places most of us have never been to (like the Amazon rain forest). We
find it hard to imagine the scope of the problems, much less the solutions, facing the people in these places. Other news concerns us more directly: national issues, regional issues, state issues, and issues right in our own hometown. The problems seem more acute at home; we see the landfills, we drink the water, we watch development occur on our favorite old field.

What are the connections between massive global issues and the ones we face everyday, right at home? How do increasing human populations strain natural resources? What are the "commons" and what are the "tragedies" of our times?

The major purpose of this activity is for students to investigate past and present environmental issues (local to global in scope) and relate these to the "Tragedy of the Commons".

**Materials:**

**OPTION 1:**
1) one copy of the questionnaire "Preliminary Thoughts About Environmental Education" per student (Appendix A)

**OPTION 2:**
1) one environmental timeline packet per student (strips A to Z of historical environmental occurrences, cut up and put in an envelope); answer key (Appendix B)
2) overhead transparencies of blank timeline and answer key timeline
3) erasable overhead transparency markers

**IN ADDITION TO OPTION 1 OR OPTION 2 MATERIALS:**
4) two pounds of peanuts in the shell; one bowl for every four students
5) collections of current magazines (e.g., TIME, Newsweek, US News and World Report, National Wildlife, Audubon, National Geographic, journals) and newspapers (especially the local ones; also major Wisconsin city papers; national papers like the Christian Science Monitor and New York Times). Depending on the timetable of the course, students bring in these materials or the instructor brings these materials for students use.
6) markers of different colors and scissors
7) ten 5X7 cards
* Note to Instructor: depending on the time framework of the course (multi-week or one weekend), you may need to collect the necessary magazines and newspapers prior to this lesson; or, students may bring in the needed sources. Other sources of current events (e.g., television, radio, newsletters) should be utilized as available and relevant.

8) EE resources (books, pamphlets, audio-visual listings, posters, activity guides, bibliographies, and other materials)

* Note to Instructor: UW-SP has a number of "resource libraries" containing such materials for loan to you and your students during the course.

Procedure:

1) Introduce the lesson. You might read a small portion of a news article about a particular environmental issue. Or, ask students if/how any of them have been directly affected by an environmental issue. Generate interest for the investigation they are about to undertake.

Note to Instructor: if the timeline (OPTION 2) was utilized in Lesson One, substitute the questionnaire (OPTION 1, page 15, steps 3-8) for step 2 which follows:

2) Environmental timeline (30 minutes total): distribute an environmental timeline packet to each student. Explain their mission: to arrange the 26 historical environmental occurrences in the correct chronological order on the timeline. Each student should work individually, but may circulate and consult with other students. After students have done their best with arranging the timeline, review the proper sequence.

   (One way to do this is to record students’ estimates for the year each event occurred on the blank timeline overhead transparency. Then, superimpose the answer key overhead transparency onto the first transparency.)

   In conclusion, emphasize the increasing rate of environmental degradation and resource depletion as justification for EE. (This activity was developed and contributed by Suzanne Wade.)
3) "Tragedy of the Commons" simulation (30 minutes total): demonstrate the "Tragedy of the Commons" principle.


OPTION II: use the Greenhouse Gas-ette "Taking from the Commons" simulation (Climate Protection Institute, 1990; adapted from Thinking Globally and Acting Locally, Mann and Stapp, editors, ERIC Clearinghouse, 1982). The complete activity is also found in Appendix C for instructor reference.

After the activity, discuss the following:

a) In the simulation, what type of resource management strategy worked "best" for individuals? for the group? for future generations? (Possible answers: cooperation, greed, self-restraint, exploitation)

b) What is the "tragedy"? (Possible answers: "Even if I recognize that my actions deplete/destroy the resource, I do it anyway because if I don't, someone else will"; "Those who deplete/destroy the resource believe they are ultimately benefitting society by providing goods and services."

c) What are some modern day "commons" and what is the "tragedy" of each?

d) Review the 4 basic needs for life (food, water, shelter, space). If the quality of the environment is degraded by resource depletion (e.g., toxic waste in water, eroded agricultural lands that won't support food production, overcrowded living conditions), how is the quality of life affected?

e) Try to focus on lesser-developed countries and the difficulties of achieving a meaningful quality of life when basic needs are threatened. Contrast this situation with the contemporary U.S. lifestyle (6% of the world's population consuming up to 50% of the world's resources). Does "having it all" mean an optimal quality of life?

f) Is there hope? Yes! Conclude by reiterating the principles of cooperation and self-restraint.
4) The Environment in the News (30 minutes total): the following portion of Lesson Two is adapted from "Identifying Issues", The C.L.A.S.S. Project (pp. 27-28, National Wildlife Federation, 1982.) The complete activity is found in Appendix D for instructor reference.

Divide the students into working teams (or groups of three). Distribute news sources among the groups, or have students use the news sources which they brought in. Assign each team the task of reviewing current news for 10 minutes and making a list of all the environmentally-related topics reported in the news. Each team should find a minimum of three different global issues and three different local/regional issues reported.

a) Optional: Teams can mark/outline all articles dealing with global issues with one color marker (e.g., red) and all articles dealing with local/regional issues with another color marker (e.g., green).

b) Each team should tally their results by type of issue (e.g., greenhouse effect) and whether it is a global or local issue. Teams can list global issues on one side of a 5X7 card, local issues on the flip side. Try to have students place the issue as one or the other, even though there will be difficulties in doing so.

c) After teams have concluded their review, compile results for the entire class. As the instructor, you might wish to delineate the categories for "types of issues" ahead of time. Or; the students can assist in the "lumping and splitting" of categories as they emerge. Note whether the issue (as reported) was global or local.

d) As a group, analyze the data. Are certain issues dominant in the news? Omitted? Is there a greater prevalence of global or local issues? Can students hypothesize reasons for patterns (or lack thereof) in the news? Were they surprised at the amount of environmentally-related news they found?

e) Discuss the interrelationships between global and local environmental issues. Was it easy or difficult to place issues in the "either/or categories" of global issue or local issue? Why or why not? Analyze the class data to determine if any of the tallied local issues are components of tallied global issues. Which ones?

"We love to wonder, and that is the seed of science."
R. W. Emerson
f) Choose one of the global issues reviewed in the news by students; quickly brainstorm some solutions. How many of the proposed solutions are "local", or have local implications? What part could a student take in bringing about one of these local solutions? (This might be a good time to discuss the idea of "Think Globally, Act Locally."

5) Explain Assignment #1 which follows at the end of Lesson Two (5 minutes).

6) Overview of EE Resources (25 minutes): to assist students in gathering information for Assignment #1, the topic of EE resources is introduced early in the course. This also provides students with the greatest possible amount of course time to use and become familiar with these EE resources.

   UW-SP will provide you and your students with a "resource library", which you may supplement if desired. Highlight resources in the library with which you are familiar and would recommend (your "top five", perhaps). Hold up and describe a few resources that are available for students' immediate use. Emphasize that many of these resources are available to educators at low/no cost; encourage them to send for materials and start a collection of EE resource materials for their teaching (which could be shared with colleagues).

   Direct students to the EE resource listings in their Book of Readings, pages 8-14. Recommend that some very helpful information for Assignment #1 can be obtained by writing to the appropriate organizations.

Extensions:

1) Individually, have students list 5 ways environmental issues (both global and local) impact their lives. Ask for specific examples. Then have students list 5 specific actions, habits, priorities, or values they have which impact the environment. (These can be positive or negative impacts.) Discuss lists as a group to illustrate the principle that human activities and individual choices impact the environment.

2) Have each student identify one change in their lifestyle they would be willing to make to reduce their contribution to an environmental issue. Distribute pre-stamped postcards (available at the local post office) on which students should write this lifestyle change and address it to themselves. (For total anonymity, use sealed letters.) Collect and mail to students at the
3) To conduct a more in-depth examination of personal environmental ethics, use Project WILD's "Enviro-Ethics" (secondary guide, pages 41-42). This activity guides students in the development of a "personal code of environmental ethics" and its implementation.

4) Have each student choose three EE resources listed in the book of readings and write each for information, free materials, and resources. This can be done in the beginning of a multi-week course, and students can update the group on worthwhile materials which they receive. Pre-stamped postcards are good for this project (available at the post office).

* Note to Instructor: try to avoid having your entire group write to the same resource agency. Spread the wealth around. Be as specific as possible [avoid "send me everything you have, I needed it yesterday" requests].

**Evaluation: Assignment #1:**

1) The student is to choose 3 current environmental topics which most interest him or her, and about which he/she would like to teach.

2) The student is to research the 3 topics (using resource people, newspapers, magazines, journals, information from organizations and agencies, reference materials and other sources).

3) The student is to compile a current "resource file" containing a minimum of 5 pieces of information (news articles, interview notes, educational materials from agencies, etc.) for each topic.
Grading:

Assignment #1 is worth 15 possible points.

15 points are given for 5 or more pieces of information for each of 3 environmental topics (15 or more pieces total).

1 point is deducted for each piece of information less than the required 15 piece total (5 pieces for each of 3 environmental topics).

* Note to Instructor: look ahead to the readings for Lesson Three. Depending on the class timetable, you might choose to assign these as homework readings.
Lesson Three: Introducing Environmental Education!

Objectives: Students will be able to:
1) examine and summarize current philosophies of EE (Tbilisi Declaration; Wisconsin Department of Public Instruction; Hungerford, Peyton and Wilke, "Goals for Curriculum Development in EE", 1980); and
2) synthesize a personal written philosophy of environmental education which incorporates the tenets of current philosophies as appropriate.

Method: Students view a multimedia slide presentation introducing EE. Following this, small groups read and discuss several current philosophies of EE, and begin the process of formulating their own personal philosophy of EE.

Instructional Time: 1 hour 15 minutes

Readings:
1) "The Tbilisi Declaration" (BR pp. 15-19)
2) "Philosophy, Goal, and Objectives of EE" (Wisconsin DPI), (BR pp. 20-21)
3) "Goals for Curriculum Development in EE", (BR pp. 22-27)

Background: An accurate understanding of the scope and nature of EE is needed by teachers. Possessing this, they are better able to environmentalize their curriculum and prepare their students as environmentally literate citizens. Investigating major statements of EE philosophy (Tbilisi Declaration; Wisconsin DPI; Hungerford, Peyton and Wilke) is tackled in a cooperative learning format. Each person is then to begin the course-long process of formulating a personal philosophy of EE based upon these major tenets.

Materials:
1) "Introduction to EE" slide show (also available on video)
2) EE philosophies (contained in students' Book of Readings)
3) butcher paper, colored markers, tape
Procedure:

1) Show the slide show "Introduction to EE" (20 minutes).

2) Break the class into groups of three. Explain that each student in the group will read (to himself/herself) a different EE philosophy found in the Book of Readings. Then each student will orally summarize the major points of that philosophy for other group members. (Reading and summarizing: 20 minutes.) The philosophies:

   a) "The Tbilisi Declaration" (BR pg. 15-19)
   b) "Philosophy, Goal, and Objectives of EE" (Wisconsin DPI), (BR pp. 20-21)
   c) "Goals for Curriculum Development in EE" (Hungerford, Peyton, and Wilke), (BR pp. 22-27)

3) After all three philosophies have been summarized, the group should synthesize the major themes of the three philosophies into a working definition (15 minutes). OPTIONS:
   a) depict on a large sheet of butcher paper (in pictures, words, diagrams) the distinctive characteristics of EE based on their readings.
   b) illustrate major themes by creating a "song and dance" routine such as "The Tbilisi Tango", "The DPI Do-Bop", or the "Hungerford Hoot".

4) Have each group share its work with the rest of the class (10 minutes).

5) Conclude by explaining assignment #2 which follows at the end of Lesson Three (10 minutes).

Extensions:

1) As a group, generate possible endings to the phrase "Environmental Education is like....." (Other alternative phrases: "EE is....."; "EE isn't....."; "EE is like a boat because....."; "EE is like a washing machine because.....") This might be an effective opener for Lesson Three. Or, this can be done as a "free writing" exercise with each student individually completing the phrase on paper.
2) A variation of the first extension is to use pictures of many different objects (e.g., silverware, camera, butterfly, car). Each student receives a picture and then completes the phrase "EE is like (their picture)...."

3) Concept mapping or semantic mapping on environmental education: record on the board (or a large sheet of paper) all the ideas/terms/phrases stimulated by the term "environmental education". Have students suggest ways to connect ideas in a semantic map to show the interrelationships among them.

Evaluation: Assignment #2:

1) Each student is to synthesize a personal philosophy of environmental education which incorporates tenets of current philosophies as appropriate:
   a) each student is encouraged to edit/combine/delete/modify current philosophies and add original ideas to best represent his/her own thinking.
   b) each student is to then compile edited statements and original ideas into a personal "I believe" philosophy about the nature of environmental education (e.g., "I believe EE is/is not...."; "I believe EE should/should not....")

Grading:

The student's personal philosophy should be approximately two to four typewritten, double-spaced pages in length.

Assignment #2 is worth 25 total possible points. Points will be assigned based on:
   a) support and defense of the philosophy;
   b) evidence of thoughtful preparation and clarity of expression.

"And the world cannot be discovered by a journey of miles, no matter how long, but only by a spiritual journey, a journey of one inch, very arduous and humbling and joyful, by which we arrive at the frond at our feet and learn to be at home. It is a journey we can make only by the acceptance of mystery and mystification--by yielding to the condition that what we have expected is not there."

Wendall Berry in The One Inch Journey.
Lesson Four: What's An Environment?

Objectives: Students will be able to:
1) define "environment" as all the surroundings --- natural, built, and social (economic, political, cultural, historical, moral, aesthetic) --- which influence a living thing.

Method: Lesson Four is a block of time for you and your students to go outside and actively explore part of the local environment. The actual location and procedures are determined by you, the instructor. Integral to a course in environmental education is first-hand experience with the environment (natural, built, and social components).

* Note to Instructor: use Lesson Four at whatever point in the course you choose, in whatever sequence with the other lessons you feel best meets course goals and objectives.

Instructional Time: 1 hour

Readings: none

Background: One definition of environmental education is "education about the environment, education for the environment, and education in the environment." (Linke, 1980)

As educators it's tempting, but misguided, to believe that "there's too much material to cover, and there isn't enough time to go outside." However, being able to utilize the resources of the outdoor environment is not just a nice addition to the day, but a significant part of any curriculum that attempts to infuse EE. "Going outdoors" can have many connotations, from a wilderness trek to the traditional elementary morning recess.... even a few well-spent minutes probing a crack in the sidewalk can be a fascinating educational experience. Why? Because empathy for the environment develops through wind-tossed hair, wet sneakers, red cheeks and slightly earthy hands. Not just once. Twice. And then again. Lots of times, even if the time is short. Research suggests that sensitivity toward the earth plays an important part in creating students who are committed to protecting and improving the quality of the environment.

"I am tired of four walls and a ceiling; I have need of the grass."

Richard Hovey
The major purpose of this activity is for students to learn first-hand about the "environment" by being directly involved with an environment under study.

**Materials:** Optional. You, as the instructor, decide.

**Procedure:**

1) Visit a chosen local environment with your students and explore it (one hour) using activities which you, the instructor, select.

* This is to be more an aesthetic, affective encounter with the environment than a cognitive one. A major outcome of this experience should be student motivation for environmental education: *about, for,* and *in* the environment.

**Instructor: pre-Lesson preparation:**

Identify a nearby environment for study, meeting as many of the following criteria as possible:

1. on the school site (or nearby);
2. to which students can return (as teachers, with their K-12 students);
3. with a variety of natural, built, and social dimensions of the environment present and identifiable.

Evaluate the environment and determine learning activities which would best accomplish the lesson objectives (defining an "environment"). For example, a school site containing a pond environment could be:

1. studied for water analysis/aquatic plants/animals;
2. used as a contemplative niche for journalling;
3. traced historically as the tributary of a major waterway.

In designing Lesson Four of the course, consider the backgrounds, subject specialties, personal goals, and grade levels being taught by your students.

*The First Law of EE: An experience is worth 1000 pictures.*

Noel McInnis
Extensions: Many portions of this course are well-suited for outdoor instruction. Try to model environmental education ("about, for, and in the environment") by teaching this course in a variety of settings.

Evaluation:

1) Have students choose one of the three environmental issues they identified in Assignment #1. Each student should describe at least two local or school site "environments" which could be utilized in lesson planning to help students learn about this issue.

"Ye who love the haunts of nature
love the sunshine of the meadow
love the shadow of the forest
love the wind among the branches
and the rain-shower and the snow-storm
and the rushing of great rivers
through their palisade of pine trees
and the thunder of the mountains..."

Longfellow, *The Song of Hiawatha*
Lesson Five: Goals of EE

Objectives: Students will be able to:
1) demonstrate an understanding of the primary goal and sub-goals of EE by writing a unit plan outline incorporating each of the five EE subgoals as appropriate.

"The goal of EE is to help students become environmentally knowledgeable, skilled, dedicated citizens who are willing to work individually and collectively toward achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment." (Wisconsin Department of Public Instruction, 1986)

The sub-goals of EE (Tbilisi, 1977):
- Awareness
- Knowledge
- Values and Attitudes
- Citizen Action Skills
- Citizen Action Experience

Method: Students investigate five case studies of EE from various grade levels and subject areas. Case studies are assessed to determine validity as EE in light of stated goals. Finally, students write an EE unit plan outline based on the sub-goal progression (awareness to citizen action experience).

Instructional Time: 2 hours

Readings:
1) "The Monday Group: From Awareness to Action" (BR pp. 28-35)
2) "Introduction to Foxfire" (BR pp. 36-41)
3) "La Crosse Third Graders Win Prestigious Award" (BR pg. 42)

Background: Environmental education has a distinct niche in the school curriculum. EE has the specific goal of preparing environmentally active citizens through a process beginning with awareness and culminating with action. Unfortunately, many "environmental education" programs stress only awareness and knowledge, assuming that if a student is aware and informed about an issue, action will follow. There is little support for this assumption. Research suggests that knowledge and awareness alone do little to develop positive environmental behaviors. Additional training in issue investigation and action skills, however, results in increased positive behaviors.
Therefore, it is essential that an environmental education curriculum encompass the entire five sub-goal progression (awareness, knowledge, values and attitudes, skills, and action experience).

However, varying emphasis is placed on each EE sub-goal depending on the age and grade level of the students. Investigating the appropriate emphasis for each age and grade level is prerequisite to designing effective EE curricula.

One way of viewing the grade level emphasis of the five sub-goals of EE is through a "triangle" model:
Awareness is primarily emphasized at the kindergarten level, and gradually lessens as the student progresses to higher grades. Citizen action experience is primarily emphasized at the grade 12 level, with gradually decreasing importance in lower grade levels. However, awareness is not absent from the grade 12 curriculum, and neither is the action experience absent from the kindergarten curriculum.

Following from the model, development of positive environmental attitudes is of great importance for middle grades. Awareness and knowledge combine with attitudes as the focus for K-6; skills and action experience combine with attitudes as the focus for grades 7-12.
Another helpful perspective is found in *A Guide to Curriculum Planning in EE* (Wisconsin Department of Public Instruction, 1989 draft of new edition) and is included here:

### WISCONSIN CURRICULUM MODEL FOR EDUCATION ABOUT THE ENVIRONMENT

<table>
<thead>
<tr>
<th>GRADE LEVEL RANGES</th>
<th>SUBGOALS: MAJOR EMPHASIS</th>
<th>SUBGOALS: MINOR EMPHASIS</th>
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<tbody>
<tr>
<td>K-3</td>
<td>AWARENESS</td>
<td>KNOWLEDGE</td>
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<tr>
<td></td>
<td>ATTITUDES AND VALUES</td>
<td>CITIZEN ACTION SKILLS</td>
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<td>CITIZEN ACTION EXPERIENCE</td>
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<td>3-6</td>
<td>KNOWLEDGE</td>
<td>AWARENESS</td>
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<td>ATTITUDES AND VALUES</td>
<td>CITIZEN ACTION SKILLS</td>
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<td>CITIZEN ACTION EXPERIENCE</td>
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<td>6-9</td>
<td>KNOWLEDGE</td>
<td>AWARENESS</td>
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<td>CITIZEN ACTION SKILLS</td>
<td>CITIZEN ACTION EXPERIENCE</td>
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<td>9-12</td>
<td>CITIZEN ACTION SKILLS</td>
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<td>ATTITUDES AND VALUES</td>
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To demonstrate the actual implementation of environmental education at various grade levels in Wisconsin classrooms, five different case studies are presented:

1. Milwaukee's Roosevelt Middle School of the Arts and their Gallery exhibit, "Not In My Backyard";
2. Jan Langton and her Stevens Point sixth grade students investigating population and world resources distribution;
3. Jeffrey Johannes and his Wisconsin Rapids senior high art students utilizing Project Learning Tree activities;
4. Margaret Donner and her La Crosse third grade students taking action on "Frog Pond";
5. Steve Landfried and two of his senior high students investigating toxic waste in a "Contemporary Political Affairs" class.

The major purpose of this lesson is for students to understand the significance of the goal and sub-goals of EE, and explore ways to implement these in actual unit plans.

*Telling is not teaching; listening is not learning.*

Dawson Trotman

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**Materials:**
1) overhead transparencies (4) of EE goal and sub-goals, triangle models, and DPI grade level emphases
2) video tape (Langton, Roosevelt, Landfried)
3) slides (Donner: 10; Johannes: 15)

**Procedure:**

1) Goal and sub-goals of EE (10 minutes): briefly review introductory information about EE gained by students from Lesson Three. Build on this general understanding to present the "Goal of EE" and five sub-goals. An overhead transparency is provided; or you may refer students to the Book of Readings, pg. 21.

2) Grade level emphases of EE sub-goals (5 minutes): using the two triangle overheads and/or the DPI overhead "Wisconsin Curriculum Model for Education about the Environment", provide a brief overview of the major EE sub-goal emphases for K-3, 3-6, 6-9, and 9-12.

3) "Vignettes" of EE in Wisconsin classrooms (1 hour total): introduce the following case studies, providing the background information on each. Ask students while viewing each case study to write down the sub-goal(s) which each addresses.

* Note to Instructor: additional information for instructor reference on the Roosevelt Gallery and Johannes' senior high school art projects are contained in Appendix E.

a) Milwaukee's Roosevelt Middle School of the Arts and their Gallery exhibit, "Not In My Backyard". Video: 8 minutes.

The Roosevelt School is an inner city Milwaukee Public school which provides students with an enriched educational program in the arts (creative writing, dance, drama, music, computer arts, and visual arts). The Gallery at Roosevelt has five exhibitions each year, with contributions from teachers, students, parents, and the community. From October to December 1988, the Gallery theme was "Not In My Backyard", concentrating on ecological problems in the urban community. A few highlights contained in the Gallery were:
He did not want to weaken by presentation the force of a truth which, in discovery, would have its full effect.  

George MacDonald

* Exhibits on the water table, composting, live animals, the Milwaukee River, antique costumes, sludge, sewers, and garbage.

* Recycling bins for aluminum, glass, plastic, and newspaper; clothing drive and mitten tree (with proceeds going to a community charitable organization).

* Artwork by six local artists on the theme of recycling.

The Roosevelt School was awarded the Wisconsin Association for Environmental Education’s "Earth Guard Award" in 1988-89 for their project.

SHOW VIDEO: 8 MINUTES.

b) Jan Langton and her Stevens Point sixth grade students investigating population and world resources distribution. Video: 9 minutes.

Jan Langton received one of two "Teacher of the Year" awards given in 1989 by the Wisconsin Association for Environmental Education. In this video segment, she dramatizes the "Tragedy of the Commons" for population and world resources distribution through classroom allocation of "rice krispy treats". As the video begins, Jan has just completed dividing her students into six groups (A-F), with group size from 1-14 students.

SHOW VIDEO: 9 MINUTES.

c) Jeffrey Johannes and his Wisconsin Rapids senior high art students utilizing Project Learning Tree activities. 15 slides.

Jeffrey infused three PLT activities into his art curriculum (grades 10-12). Using variations for visual arts projects, students designed environmentally-related artwork.

* Using PLT's "The Power of Literature", students compared and contrasted text and illustrations of The Lorax (Dr. Seuss) and A Tree is Nice (Janice May Udry). Each student then created a T-shirt design which would make a
positive environmental statement. Some of their designs:

SHOW SLIDES 1-5.

* Using PLT's "Shades of Meaning", advanced art students created visual statements communicating a personal interpretation of the environment. Some of their interpretations:

SHOW SLIDES 6-10.

* Using PLT's "Predator Prey" and "Endangered Species", students researched a Wisconsin bird or mammal contained in the art department's extensive mounted animal collection. After information on the chosen birds or mammals was gathered, students illustrated the animal while trying to capture the mood suggested by the mount's pose or expression. Some of their illustrations:

SHOW SLIDES 11-15.

d) Margaret Donner and her La Crosse third grade students taking action on "Frog Pond", 10 slides.

Begin this case study by having students read the one page description of "La Crosse Third Graders Win Prestigious Award" in the Book of Readings (pg. 42). To introduce or accompany the 10 slides, provide the following additional information on the "Frog Pond" project:

SHOW SLIDES 1-10

* Over 50 people helped in the 3 hour cleanup.

* In less than 3 weeks, the local PTA raised over $7000 (by craft and bake sales, pancake breakfasts and chicken barbecues, business and private donations) to send all 20 of the third graders (and 10 parent chaperones) to Washington in November of 1988 to receive the President's Environmental Youth Award.

* Successive cleanups of the pond have been necessary. (The pond is adjacent to numerous apartment complexes, and many footpaths skirt the perimeter of the pond.) On Earth Day 1990,

*If a child is to keep alive his inborn sense of wonder... he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in.*

Rachel Carson
all classes from Summit School participated in a cleanup.

* Extensive media coverage (television, radio, local and state newspapers, national conservation magazines) has followed the project.

* A controversy has arisen over current uses of Frog Pond. Land including Frog Pond shoreline was rezoned to allow development of a mobile home park. Prior to the rezoning, students had negotiated with town leaders for a town park to be built which included Frog Pond shoreline. Says Margaret Donner, "you're never done."

e) Steve Landfried and two of his senior high students investigating toxic waste in a "Contemporary Political Affairs" class. Video: 10 minutes.

Two senior high students, Robert Barnett and Julie Gyland (gee-land), investigated the issue of toxic waste buried in Stoughton landfills as a project in their "Contemporary Political Affairs" class. Their efforts resulted in a 42 minute documentary produced in cooperation with Stoughton Community television. Barnett and Gyland interviewed then-Governor Tony Earl; past and present mayors of Stoughton; residents; DNR representatives; UW-Madison State Lab of Hygiene scientists (who conducted groundwater tests); the State Attorney General's office; television producers; attorneys representing Stoughton residents; Stoughton's Public Works director; a town alderman; and the editor of the local newspaper. Stoughton Uniroyal Plant representatives chose not to consent to interviews, as did Waste Management, Inc. (Uniroyal's waste, disposed of by Waste Management, Inc., is suspected as a major source of the toxic chemicals infiltrating Stoughton's groundwater.) The Environmental Protection Agency placed Stoughton on its "Superfund" cleanup list.

SHOW VIDEO: 10 MINUTES.

4) At the conclusion of the "vignettes", brainstorm with students (2 minutes) aspects which they believe make each case study effective as environmental education.
5) Using the definition of EE goals and sub-goals, have small groups of students analyze each of the five case studies and assess the following (15 minutes):
   a) Does it meet the criteria found in the Wisconsin DPI definition for EE? Why or why not?
   b) Identify components of the case study which specifically address any of the five EE sub-goals.
   c) Is emphasis placed on any one particular sub-goal? If so, which one? Why?
   d) Could this case study of EE be adapted for other grade levels? If so, which ones?

6) Share the results of each group's assessment with the others (5 minutes).

7) Summarize the lesson by emphasizing the major goal and sub-goals of EE (3 minutes).

8) Conclude Lesson Five by explaining Assignment #3 which follows (10 minutes):

**Evaluation: Assignment #3:**

* Note to Instructor: inform students that later in the course (Lesson Ten) there is a 4 hour guided work session on this assignment. However, Assignment #3 is given at this point in the course to allow students time to begin the process of choosing the unit topic and gathering resources.

1) Each student is to choose one of the three environmental topics researched by him/her in Assignment #1. The student is to write a unit plan outline for the topic incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed). Specifically:

   a) **elementary teachers:** develop a multidisciplinary unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed);

   or

   b) **secondary teachers:** by collaborating with a teacher from a different subject area, jointly develop a unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit designed);

2) Assignment #3 is to be a unit outline, NOT a fully prepared, ready-to-teach unit.
Grading:

Assignment #3 is worth 60 possible points. Students working in pairs will receive the same grade.

Points will be assigned based on the extent to which the unit plan outline creatively and thoroughly includes the following seven components:

1. an identified local environmental issue;

2. the identified area of the yearly curriculum where the unit will be infused;

3. specific, learner-centered objectives aimed toward the achievement of appropriate EE sub-goals;

4. a general description of the environmental knowledge to be learned during the unit;

5. an outline of the instructional procedures to be used in teaching the unit (e.g., cooperative learning, research, Project WILD activities);

6. an outline of the daily progression of the unit (day one, day two...);

7. a general description of evaluation methods for both the learners (to what extent did they learn?) and the unit (strengths and ways to improve?).

GRADUATE INCREMENT:

All students enrolled in Principles of Environmental Education for graduate credit (NR 611) are required to develop a one week portion (five consecutive lessons) of their unit plan outline into an actual unit plan. Specifically, this unit plan should be "ready-to-teach", addressing all seven points of the unit plan outline. Additionally:

a) instructional procedures should be fully described;
b) all needed materials listed;
c) resources and references cited.

Grading:

For students enrolled for graduate credit, the unit plan outline and the unit plan will be graded together as Assignment #3. Assignment #3 is worth 60 possible points.
Lesson Six: "Anatomy Of An Issue"

Objectives: Students will be able to:
1) compare and contrast the goals of educational movements related to EE (outdoor education, nature study, conservation education). Identify at least one contribution of each to the field of EE;
2) compare and contrast the subject of ecology with the field of EE;
3) distinguish between an environmental issue and an environmental problem, and give one example of each;
4) identify conflicting beliefs and values as the basis for environmental issues;
5) analyze an environmental issue by identifying all the "players" involved and naming at least one belief and one value held by each; and
6) give one example of the role of education in resolving an environmental issue.

Methods: Students investigate the role conflicting beliefs and values play in environmental issues, and practice analyzing environmental issues on the basis of the "players", their beliefs, and their values.

Instructional Time: 2 hours

Readings:
1) "Forerunners to Environmental Education" (BR pp. 43-50)
2) "A Technique for Analyzing Environmental Issues" (BR pp. 51-61)

Background: The emergence of environmental issues spawned several forerunners to environmental education: nature study, outdoor education, and conservation education. Each contributed to the field of EE and yet none successfully addressed the need for issue investigation and resolution. Nature study focuses on developing appreciation for the natural world and is considered a forerunner of elementary school science. Outdoor education is a method of teaching a variety of subjects outdoors; it laid the foundation for the school camping movement. Conservation education emphasizes prescribed wise management of resources such as forests, water, wildlife, air, and soil. "Ecology" is a term often misused as a synonym for environmental education. However, ecology is the scientific study of interrelationships between living things and their environment. Ecology provides a scientific basis from which to examine environmental issues. Environmental education alone,

"To teach a child so to love his native land that he will never sit by complacently and see any part of it destroyed or needlessly exploited is the highest type of patriotism either parent or teacher can render to his or her country."

Wilhelmine LaBudde
however, tries to strike at the root of environmental issues by including issue investigation and resolution skills.

Environmental issues are complex, multi-sided affairs involving many "players" who may have different beliefs and values. Resolution of environmental issues depends on the ability to identify the nature of the conflict. (Are beliefs in conflict? Are values in conflict? Are both in conflict? Is there sufficient, accurate scientific/technical information to clarify the issue?) Education can play an important role in the resolution of environmental issues by addressing these points of conflict. Environmental educators believe that rethinking long-held beliefs, values, and practices in light of accurate information often results in behaviors aligned on the side of ecological integrity.

Often environmental issues relate to the type of natural resource, i.e., whether the resource is a renewable resource (a living thing with the capacity for regeneration) or a non-renewable resource (a non-living thing which can only be replenished through natural processes over tremendously long periods of time).

What is the basis of an environmental issue? What role does education play in resolving issues? The major purpose of this lesson is to discover answers to these two questions.

Materials:
1) copies of "dilemma cards" from "Ethi-Reasoning": Project WILD, pages 197-200, secondary guide (Appendix F)
2) video of environmental issue
3) one copy per student of "Controversy on the Prairie" (Milwaukee Journal) or "Deposit poll: Readers say Yes by 2-1" (Wausau Sunday Herald) (Appendix G). Other issues may be substituted based on instructor preference.

Procedure:

1) Briefly (5-10 minutes) compare and contrast EE-related educational movements (nature study, outdoor education, and conservation education). Define ecology and contrast it to EE. Outline the contributions of each to the field of EE. Emphasize that issue investigation and resolution is distinctive of EE. An overhead transparency is provided.

2) View the 10 minute video segment depicting an environmental issue. Have students write down the "players" involved and their viewpoints during the video.
OTHER INSTRUCTOR OPTIONS:
a) you might choose to make your own video from local news coverage of an environmental issue of interest to your class;
b) the movie "The Lorax" by Dr. Seuss (25 minutes) could be viewed instead of a video.

3) Discuss students' roster of "players" and the viewpoints held by each. Each student should then develop their own brief definition for "belief" and "value". (5 minutes)

4) Introduce Peyton's definitions for the following terms used in issue analysis. Compare students' definitions with Peyton's and come to common ground (5 minutes).
a) Define belief ("an idea held to be true, whether true or false").
b) Define value ("the relative worth placed on an issue").
c) Define environmental problem ("a natural phenomenon which jeopardizes the status or safety of someone or something").
d) Define environmental issue ("disagreement based on conflicting beliefs and values").

5) Analyze all the "players" involved in the video issue (10 minutes).
a) name at least one belief held by each.

* Note to Instructor: Hungerford's "Issue Analysis: An Example", BR pg. 56, contains good examples of belief statements for your reference.)

b) Refer students to Hungerford's "Examples of Value Descriptors" (Figure 3, BR pg. 60). Name at least one value held by each of the "players".

c) Emphasize the nature of an environmental issue: **conflicting beliefs and/or values**.

6) **Project WILD's "Ethi-Reasoning"** (30-40 minutes): students will now be given the opportunity to examine their own beliefs and values about the environment. Use the format of Project WILD's "Ethi-Reasoning" (Western Regional Environmental Education Council, 1985.) The complete activity is found in Appendix F for instructor reference.
Divide the students into groups of 4-5 and give each group a collection of dilemma cards. Use the Project WILD dilemmas as appropriate; as the activity progresses, you might have students write and share their own dilemmas pertaining to issues in the local area.

The first student in the group selects a dilemma card from the pile, studies the situation, decides what to do and formulates reasons for doing so. When ready (2 minutes or less), the student reads aloud the dilemma card to the group and explains what course of action he or she has chosen.

Next, group members are invited to comment on the dilemma, identify beliefs and/or values expressed by the student who responded to the dilemma, or indicate what they would do in that situation. It is not necessary (or even possible in some dilemmas) to reach consensus.

Total discussion time for each dilemma should be about 5 minutes. Continue until all students have had a turn tackling a dilemma.

7) Students now hone their skills of issue analysis on an application issue (30 minutes total: 20 minutes for group work, 10 minutes for presentations).

Working in small groups of 4-5, an environmental issue is distributed to the group for analysis. (The Beloit prairie issue or the deposit poll, Appendix G, are two options.) The procedure is excerpted from Hungerford in "A Technique for Analyzing Environmental Issues" (BR pg. 53):

"Working in small groups, the students identify and communicate the issue, name the key players, summarize the belief statements of those players, and identify the values driving those beliefs. Finally, each small group writes and presents an issue analysis report to the class. This issue analysis report summarizes the findings of that group regarding:

a) an identification of the issue itself;
b) the players;
c) the players' beliefs; and
d) the players' values."

8) Conclude by discussing how education could help resolve the environmental issue under analysis (10 minutes).

*The rule of no realm is mine, but all worthy things that are in peril as the world now stands, those are my care...for I too am a steward. Did you not know?*

J.R.R. Tolkein
Extensions:

1) Try the Dennis Weibel activity (so named until he officially names it!) Students write human activities (e.g., water skiing) on small pieces of paper and environmental issues (e.g., endangered wildlife) on another set of small pieces of paper. A student then chooses one paper from each set and draws a connection between the two (e.g., if a student selected "water-skiing" and "endangered wildlife", a connection such as "water-skiing can disrupt waterfowl from nesting" might be drawn.)

2) Visit a local site with the class that is (or could be) the focus of an environmental issue (e.g., landfill, water treatment plant, landscaped "reclaimed" area, marsh, etc.) Can students identify positive or negative human impact at the site? Can students describe the conflicting beliefs and values which make the site a real or potential issue?

Evaluation:

1) Have students choose one of the three environmental issues identified in Assignment #1. Each student should describe what characteristics make it an issue, and explain how education could play a role in resolving the issue.
Lesson Seven: 
The Method of Environmental Issue Investigation

Objectives: Students will be able to:
1) identify the components of investigation, evaluation, and action in the method of environmental issue investigation; and
2) describe at least five categories of citizen action which could be used in resolving an environmental issue.

Method: Students examine an environmental issue investigation on the topic of wolves, and identify the components of investigation, analysis of data, action, and evaluation.

Instructional Time: 1 hour

Readings:
1) "How To Help Your Elementary Students Become Issue Investigators" (BR pp. 62-65)
2) "Environmental Education and Student Behaviors" (BR pp. 66-79)
3) "Strategies" (BR pp. 80-84)
4) "You and Action: Important Ideas" (BR pp. 85-86)
5) "Sensitivity Guidelines for Students Entering a Community to Work on Local Environmental Problems" (BR pg. 87)

Background: There are an assortment of general educational methods used very effectively by both teachers and environmental educators. For example:

1. Cooperative learning
2. Dramatization
3. Writing
4. Art
5. Brainstorming
6. Music
7. Role Playing
8. Simulations
9. Problem-solving/critical thinking
10. Data gathering and analysis
11. Independent projects
12. Audio-visuals
13. Observation (field trips)

One specific method which distinguishes the instruction of EE from other disciplines is environmental issue investigation. Many of the general methods are utilized within the environmental issue investigation framework. There is limited time in one 16 hour course to thoroughly study the environmental issue investigation method.
However, teachers need a basic understanding of the sequence and skills of environmental issue investigation in order to design their curricula for achieving the goals of EE. Hungerford's *Investigating and Evaluating Environmental Issues and Actions Skill Development Modules* (1985) divides an environmental issue investigation into three broad phases.

*EE must develop problem-solvers, and thus, should itself, utilize a problem solving approach.*

Hungerford and Peyton

Trefflinger's *Creative problem solving: the Basic Course* (1984) provides an alternative model for tackling environmental issues (see Appendix H).

The following four phase approach expands Hungerford's model and incorporates parts of Trefflinger's problem-solving strategies.

**Phase I: INVESTIGATION: "Fact Finding"**

The investigation phase begins with identifying an environmental issue which you would like to investigate. Research the issue. Collect information from primary sources (people involved, resource agents) by interviewing or conducting a survey. Collect information from secondary sources (media, publications, written reports) by researching in the library or writing to organizations and agencies for information.

**Phase II: ANALYSIS OF DATA: Idea Finding and Solution Finding**

Data interpretation skills are used to analyze the information collected in Phase I. Summarize data, interpret finds, make conclusions. Generate ideas for possible actions to resolve the issue. How many ways can the issue be solved? Which solution will work best? Why? Make a final recommendation for action based on all available data.
Phase III: ACTION: Implementation of Plan

Plan and implement the chosen strategy for action. Available strategies for action include:

**Persuasion:** trying to convince others that a certain course of action is best. Examples: writing a letter to the editor; expressing your opinion at a meeting.

**Consumerism:** buying or not buying a product as a statement of one's philosophy toward the product or the maker of the product. Examples: refusing to buy soda in non-recyclable bottles; boycotts; buying products made by companies trying to reduce pollution.

**Political Action:** any action that brings pressure on political or governmental agencies in order to persuade them to take positive environmental action. Examples: writing or phoning elected officials; voting for or against certain issues or candidates; attending a public hearing.

**Legal Action:** any legal or judiciary action taken which is aimed at some aspect of environmental law enforcement. Examples: law suits, injunctions.

**Ecomanagement:** any physical action taken with respect to the environment. Examples: planting trees; building and installing birdhouses; helping a private agency raise funds to buy and preserve a piece of land.

Phase IV: EVALUATION:

The final phase of the investigation assesses the effectiveness of phases I, II, and III. What were the strengths of the investigation and action plan? What could be improved? Evaluation of action outcomes and learner outcomes is essential in designing successful issue investigations.

This model for environmental issue investigation correlates with the EE sub-goal progression of awareness to action. During the investigation phase, environmental **awareness** and **knowledge** regarding the issue are developed. **Attitudes** toward the environment, toward people involved, and toward right action emerge during this phase and are further defined in the analysis of data phase. The action phase consists of learning the **skills** for
effective action-taking on environmental issues, and ultimately taking action.

The "STS Case Study: Timber Wolf Recovery Plan" (Martha Kronholm and Mead School fifth graders from Wisconsin Rapids Public Schools, 1988-1989) will be examined as a model of environmental issue investigation. The case study was developed during a National Science Foundation Project under the supervision of Dr. Harold Hungerford, Dr. Trudi Volk and Dr. John Ramsey. The wolf study provides students an opportunity to assess ways in which the unit fulfills the concepts and components of an issue investigation, as well as the goals and sub-goals of EE.

The major purpose of this activity is for students to become familiar with the method of issue investigation and types of action for resolving environmental issues.

**Materials:**

1. overhead transparencies (3) of: phases of issue investigation; types of citizen action; 13 criteria for action
2. slides (10) of Martha Kronholm’s Timber Wolf Recovery Plan issue investigation.

**Procedure:**

1. Briefly, brainstorm a list of general educational methods which students use in their teaching and find effective (5 minutes).

2. Review from Lesson Six the distinctive characteristic of EE: issue investigation and resolution. Explain that Lesson Seven will demonstrate how general educational methods are utilized within the method of environmental issue investigation.

3. Outline the four phases of issue investigation (15 minutes):

   Phase I: investigation
   Phase II: analysis of data
   Phase III: action
   Phase IV: evaluation

Describe what occurs in each of the four phases. Also, for Phase III describe types of action. You might choose to refer students to Hungerford’s "You and Action: Important Ideas" (BR 85-86) when describing types of action.

Three overhead transparencies are provided for this section:
* Four Phases of Issue Investigation
* Methods of Citizen Action
* Citizen Action: Deciding to Act or Not to Act
4) Describe Martha Kronholm’s Timber Wolf issue investigation through slides and the following background information (15 minutes).

* Note to Instructor: the complete description by Martha of the issue investigation is included in the Book of Readings (pp. 62-65).

Martha Kronholm, a fifth grade teacher from Wisconsin Rapids, involved her students in an issue investigation during the 1988-89 school year on the topic of wolves. The research question was, "To what extent do northern Wisconsin residents feel that a timber wolf recovery plan is necessary?" Varying beliefs and values about the timber wolf were documented early in the case study when Martha had her fifth grade students write an essay on wolves. She used the story starter, "When I think of wolves..." Some excerpts of selected essays:

"Whenever I think of wolves I think of bats, snakes, and spiders. They are all mean!"

"When I think of wolves I think of stories like 'Little Red Riding Hood' and movies like 'Teen Wolf'"

The actual researching of wolves came after that first essay.

SLIDE 1
(student reading wolf book)

To develop a body of knowledge about the wolf, Martha used a variety of secondary resources (DNR publications, magazines, news clippings, books). Many students began to realize that many of their negative feelings toward the wolf were based on misconceptions.

SLIDE 2
(student reading wolf fairy tale)

Each student kept a "wolf folder" of information gathered during the investigation.

SLIDE 3
(student with wolf folder)
Research provided more accurate knowledge about the wolf, as expressed by one student project, a totem pole.

**SLIDE 4**

(student with totem pole)

During this phase of the case study, students discovered that there are many different beliefs and values concerning the timber wolf (hunters, landowners, recreationists, lumber interests). Students wondered what the latest, up-to-date feelings were on the wolf. After discussing how to obtain these feelings, Martha and her students decided it would be best to send out a questionnaire to northern Wisconsin residents. They developed a ten question survey, which included statements such as:

- *I feel the only good wolf is a dead wolf.*
- *I feel that people who kill wolves should be prosecuted.*
- *I would like to see an increase in the timber wolf population in Wisconsin.*

The survey utilized response choices of strongly agree, agree, no opinion, disagree, and strongly disagree. 350 people were selected to receive the survey, chosen randomly from northern Wisconsin telephone books.

**SLIDE 5**

(student with surveys to be mailed)

With each survey, students included a handwritten cover letter and a self-addressed, stamped envelope. Some students enclosed photos of themselves for a "personal touch".

**SLIDE 6**

(3 students with returned surveys)

Amazingly (according to Martha), 211 of the 350 surveys were returned (60% return rate). Students were thrilled at the response.

**SLIDE 7**

(student with pie chart)

Investigative skills included collapsing and interpreting the data, drawing conclusions and formulating recommendations. Overall, almost three-fourths of the respondents had positive feelings about the wolf. Students inferred that this could be the result of

*The great thing in this world is not so much where we stand, as in what direction we are moving...we must sail sometimes with the wind and sometimes against it, but we must sail, and not drift, nor lie at anchor.*

O.W. Holmes
educational and public relations efforts of the Timber Wolf Recovery Team and the Timber Wolf Alliance.

SLIDE 8
(student with TWA poster)

To assist these groups in their efforts, students took action to raise funds for the ongoing work.

SLIDE 9
(student with wolf print)

By selling student-made plaster of paris wolf prints, student-made wolf buttons, and pencils with the following message: "Ask me how I feel about timber wolves", students collected over $100 for the organizations.

SLIDE 10
(student with wolf puppet)

Other action strategies were devised by students. Reading and discussing stories such as "Little Red Riding Hood" with primary-aged youngsters in hopes of dispelling some of the misinformation found in children's story books was one; writing letters to legislators advocating stronger penalties for killing endangered species was another.

5) At the conclusion of the slides and description, divide students into four groups. Each group is to examine the environmental issue investigation conducted by Martha Kronholm and her fifth grade students (15 minutes).

Each group should answer all of the following questions and prepare a short report for the rest of the class:

a) Cite evidence, if any, of:
   1. investigation (Phase I)?
   2. analysis of data (Phase II)?
   3. action (Phase III)?
   4. evaluation (Phase IV)?

b) Identify at least five different educational methods (e.g., creative arts) which were used in the environmental issue investigation.

c) Cite at least three examples of action strategies implemented by the students, and identify which category each action represents (persuasion, consumerism, political action, legal action, ecomanagement).
6) Have groups report their findings to the rest of the class (10 minutes).

Since there will be repetition, have each group report on only one question (a, b, or c). At the conclusion of each report, other groups may contribute additional observations.

**Evaluation:**

1) Students examine their unit plan outline (Assignment #3) and identify ways in which the environmental issue investigation components are represented in the unit.

"A land ethic changes the role of *homo sapiens* from conqueror of the land community to plain member and citizen of it. It implies respect for his fellow members, and also respect for the community as such."

- Aldo Leopold
Objective: Students will be able to:
1) identify educational models of Piaget (theory of cognitive development), Kohlberg (theory of moral development), and Bloom (taxonomy of educational objectives) as contributors to EE theory; and
2) identify at least six factors which can help predict environmental sensitivity and describe one way each factor can be incorporated into environmental education.

Method: Students complete an environmental sensitivity survey, discuss factors that contribute to environmental sensitivity, and formulate ways to incorporate these factors into their teaching.

Instructional Time: 1 hour 15 minutes

Readings:
1) "Developmental Variables Affecting Environmental Sensitivity in Professional Environmental Educators: A Research Abstract" (BR pp. 88-90)

Background: Environmental education theory is based in part on the models of Piaget (theory of cognitive development), Kohlberg (theory of moral development), and Bloom (taxonomy of educational objectives). (Consult the Wisconsin DPI's "A Guide to Curriculum Planning in EE", pp. 6-11, 24-39 for further background). While establishing these educational theories as part of the foundation for EE theory, the emphasis in a short course like this is to investigate the unique characteristics of EE theory. Primarily, this involves investigating the factors which contribute to environmental sensitivity.

"If, then, a major goal of EE is the production of an active and informed citizenry, environmental educators should know the kinds of learning experiences which produce such persons." (Tanner, 1980)

Environmental sensitivity is defined as a feeling of empathy for the environment (Sivek, 1987). According to Tanner (1980), and Peterson and Hungerford (1981), factors which contribute to environmental sensitivity include:
a) **Outdoors.** Interaction with natural, rural, or other relatively pristine habitats; exploring/playing in the out-of-doors (hunting, fishing, birdwatching, camping).

b) **Habitat.** Being raised in any one particular environment (rural, suburban, urban) does not appear to be significant; however, frequent, perhaps daily contact with natural, rural, or other relatively pristine habitats is.

c) **Solitude.** Frequent contact with relatively pristine habitats, either alone of with just one or two friends.

d) **Habitat alteration.** Witnessing the commercial development of one's habitat; degradation of areas frequently visited produced a feeling of "loss of beloved open spaces".

e) **Role models.** Both family and non-family (especially teachers) role models were crucial in fostering and encouraging environmental sensitivity. "Role models appear to be equally important as outdoor experiences in developing environmental sensitivity." This has great implications for educators!

f) **Books/Reading.** Nature-oriented books were especially influential. Access to those books was key.

The average age at which a person appears to have acquired environmental sensitivity is 12.25 years. The pre-school and elementary years are critical ones for establishing environmental attitudes (Peterson and Hungerford, 1981).

The major purpose of this activity is for students to identify factors contributing to environmental sensitivity and show how these can be used to accomplish the goal of environmental education.

**Materials:**
1) overhead transparencies (4) of: Piaget; Kohlberg; Bloom; factors for environmental sensitivity
2) video of David Brower
3) one copy of the environmental sensitivity survey per student (Appendix I)

*Touch the earth, love the earth, honor the earth, her plains, her valleys, her hills and her seas; rest your spirit in her solitary places.*

Henry Beston
Procedure:

1) Briefly explain (10 minutes) that EE theory is built on the educational models of Piaget (theory of cognitive development), Kohlberg (theory of moral development), and Bloom (taxonomy of educational objectives). Overhead transparencies for each model are provided. The focus of Lesson Eight is on the unique characteristic of EE theory, environmental sensitivity.

2) Show the selected video portion of Wisconsin Public Television's biography of David Brower (10 minutes). Ask students to identify significant experiences in Brower's life which might have contributed to his environmental sensitivity (5 minutes).

3) Have each student complete an environmental sensitivity survey (10 minutes).

4) After students have finished, discuss six major factors contributing to environmental sensitivity. An overhead transparency is provided. Invite students to contribute examples of these factors from their personal experiences (15 minutes).

5) In pairs, have each student describe to the other (10 minutes):
   a) the factor that has most contributed to their environmental sensitivity;
   b) one of their current teaching strategies which is a factor in contributing to environmental sensitivity;
   c) one additional strategy which they would like to implement in their teaching to further develop environmental sensitivity in their students.

6) Application to the classroom (15 minutes): break up into groups of 4-5. Have each group develop educational strategies which incorporate factors contributing to environmental sensitivity. For example, "Books dealing with the environment (animals, landscapes, trees) should be easily accessible for students in the classroom."
Evaluation:

1) Share results from the group work session on classroom applications (step 6 above).

"We both like Weather. Not this or that kind of weather, but just Weather. It's a useful taste if one lives in England."

"How ever did you learn to do that, Mr. Denniston?" said Jane. "I don't think I should ever learn to like rain or snow."

"It's the other way round," said Denniston. "Everyone begins as a child by liking WEATHER. You learn the art of disliking it as you grow up. Haven't you ever noticed it on a snowy day? The grown-ups are all going about with long faces, but look at the children—and the dogs. THEY know what snow's for."

C.S. Lewis
Lesson Nine:
"Avoiding Infusion Confusion"

Objectives: Students will be able to:

1) summarize the three major provisions of Wisconsin's EE curriculum mandate;

2) explain at least two reasons EE is considered "multidisciplinary" in nature and state at least two implications this has for curriculum development; and

3) compare and contrast the infusion and single subject models for implementing EE, providing at least one advantage and one disadvantage for each approach.

Method: Students examine the Wisconsin EE curriculum mandate and investigate ways to infuse EE into their curriculum.

Instructional Time: 30 minutes

Readings:
1) "Two Conceptual Models of EE Curriculum" (BR pg. 91);
2) Wisconsin DPI EE curriculum mandate (BR pg. 92)

Background: The Wisconsin environmental education curriculum mandate gives teachers and administrators an important yet difficult task.

Each school district is required to:

a) develop and implement a written K-12 environmental education plan...

b) in all subject areas (with greatest emphasis placed on art, health, science, and social studies)...

c) by September 1990.

It is not enough for EE proponents to say "you must teach environmental education" without providing the resources and training on how to teach environmental education.

"Well, now that we've completely changed the curriculum, I suppose we should call in the teachers and tell them about it."
"Environmental educators have focused their attention on the development of environment-related goals and have neglected to probe deeply enough into educational implications, particularly at the level of the teacher. Environmental educators have not focused on the real-life working conditions of teachers, their perceptions about change, and the support system needed to facilitate change in teaching method demanded by these new curriculum materials." (Paul Hart, from Trends and Issues in EE: EE in School Curricula)

EE is different from most traditional subjects. The multidisciplinary nature of EE and the infusion model by which it is often implemented can be a radically new approach to teaching for many. Add to this the potential resentment of being "mandated" to teach EE and the causes for teacher frustration are evident. Teacher training in EE focuses on reducing these barriers to effective instruction of EE and on building support from within the educational ranks for EE as a key component of the total K-12 curriculum. Motivated teachers possessing the knowledge and skills to implement EE can approach the task wholeheartedly; those who feel frustrated and unprepared more likely will only dabble at EE to meet mandate requirements.

Teachers well-prepared and informed about the goals, resources and methods used in EE are the ones who will reach students. Effecting positive environmental change in Wisconsin K-12 students is, after all, the reason for the mandate. ("The goal of EE is to help students become environmentally knowledgeable, skilled, dedicated citizens who are willing to work individually and collectively toward achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment.") Teacher training is crucial as a means of successfully accomplishing this goal.

The major purpose of this activity is to understand the Wisconsin EE mandate and how the infusion model of EE instruction can help meet the mandate requirements.

Materials:
1) overhead transparency (1) of single subject and infusion models
Procedure:

1) Begin by explaining the three key points of the EE curriculum mandate (5-10 minutes).

2) Explain that the purpose of Lesson Nine is to provide students with skills and resources for meeting the mandate requirements.

3) Brainstorm a definition of "infusion". Allow 2-3 minutes for the task, emphasizing that there is no "one" correct definition.

4) Distinguish between the two conceptual models of EE curriculum described by Hungerford and Peyton (BR page 91). An overhead transparency is provided (15 minutes).

* Note to Instructor: using the terms "single subject" and "infusion" in discussing Hungerford and Peyton's models (rather than interdisciplinary and multidisciplinary) may reduce confusion. The terms interdisciplinary and multidisciplinary are often used interchangeably. However: "EE is both multidisciplinary (i.e., including EE in subjects beyond the usual science curriculum) and interdisciplinary (i.e., integrating more than one subject at a time into a single EE activity)" (Ham et al, 1988).

Compare and contrast the "single subject" model versus the "infusion" model, justifying infusion as the preferred model:

a) Weigh the **advantages** of the single subject model:

* specific courses can be taught by highly trained teachers focusing exclusively on EE

against the **disadvantages**:

* EE is compartmentalized into a single course and becomes a separate "subject";
* traditional subject areas will limit infusion of EE since it is being taught elsewhere;
* the majority of teachers will have little need to become skilled in environmental education since the "experts" are teaching EE.
b) Weigh the **advantages** of the infusion model:

* students continuously learn environmental concepts in all subject areas;
* EE is taught holistically in all areas of the school curricula;
* EE helps accomplish the goals of existing curricula;
* all teachers have reason to be involved in teaching EE against the **disadvantages**:

* difficulties in preparing all teachers to teach EE;
* infusion requires a concerted effort by the teachers and administration to implement a sequential K-12 plan.

5) Summarize by stressing that infusion of EE does not add more to an already full curriculum, but helps accomplish the goals of the existing curriculum.

**Evaluation:**

1) Have students summarize the three major provisions of the Wisconsin EE mandate.

2) Ask students to describe one learning experience they use as part of their curricula which already accomplishes the goals of EE (e.g., a social studies unit whose objectives include identifying water resources of the U.S.).

3) Have students choose one of the three environmental topics identified in Assignment #1. Ask them to describe one area of their curriculum where they could infuse environmental education about this issue (e.g., a creative writing unit whose objectives include writing haiku could meet EE objectives if haiku is written about endangered wildlife).

* Note to Instructor: remind students to bring in their curriculum (district, school, grade level, or subject area) for Lesson Ten.

As I stand and face the buttercup, I say *fellow creature, fellow creature, I won't walk on you. We are both creatures together.*

Francis Schaeffer
Lesson Ten: Designing Your EE Curriculum

Objectives: Students will be able to:

1) assess their own curriculum (district, school, grade level or subject) and identify all areas suitable for infusion of EE; and

2) identify 3 local community resources for use in environmental education.

3) elementary teachers: develop a multidisciplinary unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit is designed).

4) secondary teachers: by collaborating with a teacher from a different subject area, jointly develop a unit plan outline about a local environmental issue incorporating each of the five EE sub-goals (as appropriate for the grade level for which the unit is designed).

Method: In a guided work session, students analyze their own curriculum, choose areas for EE infusion, and develop a unit plan outline utilizing EE resources.

Instructional Time: 4 hours

Readings: none

Background: Twin barriers to environmental education often expressed by teachers are the lack of time to prepare EE lessons and the lack of resources to do so. Therefore, a major goal for inservice training of teachers in EE is to provide instruction in the use of varied resources and to provide time to use these resources in planning EE.

First, however, teachers need to be skilled in assessing their overall curricula and in selecting areas for EE infusion. By beginning with the broad view, teachers can systematically integrate EE throughout their total educational plan. This deliberate strategy reduces the temptation to piecemeal "a few neat activities" into a quasi-environmental lesson.

The major purpose of this lesson is for students to designate areas in their curricula for EE infusion; become more familiar with EE resources; and write an EE unit plan outline using those resources.

"Since the community is the student's environment, it should be a central resource in his study of environmental problems."

Mayer and McKenzie
Materials:

1) Students will need to bring their own curriculum (district, school, grade level or subject). Advance notice to students about this is necessary. Students should bring the curriculum which they actually use, or their yearly unit/lesson plans, or their textbook (last choice!) if they follow directly from a text. Students are strongly encouraged to bring curricula of Wisconsin DPI focus areas for EE infusion. Those whose schools or districts already have an EE plan should bring it as well.

2) Students should be encouraged to bring any personal EE resources which they have to this session (e.g., Project WILD, Project Learning Tree, OBIS, Naturescope).

3) UW-SP EE resource library

Procedure:

1) Review Assignment #3 (from Lesson Five).

2) Explain that students will be participating in a guided curriculum development practicum. You, as the instructor, will be circulating throughout the group to assist students in their planning. Encourage students to work individually or in a team as appropriate. Focus the unit development work session by first having students search for answers to the following three questions:

   a) "In what areas of your curriculum could you infuse environmental education?"

   b) "In what areas of your curriculum would the three issues you identified in Assignment #1 best be infused?"

   c) "In what area of your curriculum will the unit plan outline (Assignment #3) be infused?"

3) When students have completely answered these questions and demonstrated their understanding of the curriculum assessment process, guide them in their work on assignment #3 (the unit plan outline). (Students may or may not want to use one of their environmental topics researched in Assignment #1 as part of their unit.)

4) Guide students in the development of their unit plans according to the assignment criteria. Emphasize utilizing the available written resources: you don't have to reinvent the wheel! School site and community resources should be an integral component of the unit plan.

"This world, after all our science and sciences, is still a miracle; wonderful, inscrutable, magical and more, to who-soever will think of it."

Thomas Carlyle

63
Use this culminating unit project as an opportunity to build confidence in the students’ ability to teach EE.

Extensions:

1) Have students interview their district or CESA curriculum coordinator to determine the status of EE curriculum development and implementation in the district.

Evaluation:

Work on Assignment #3 until completed.

* Note to Instructor: much of the work for the unit plan outline is intended to be done under your guidance during the course. However, to allow for outside independent work, you may want to set the unit outline due date for a reasonable time after the completion of the course.
List of Appendices

Principles of Environmental Education
NR 411/611


Western Regional Environmental Education Council and Western Association of Fish and Wildlife Agencies. Project WILD. Boulder, CO. Project WILD, 1983.

"PRINCIPLES OF ENVIRONMENTAL EDUCATION"

NATURAL RESOURCES 411/611

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<td>3. &quot;Guide to EE Curriculum Materials&quot;</td>
</tr>
<tr>
<td>14</td>
<td>5. &quot;List of Agencies and Organizations&quot;, in Project WILD, Western Regional Environmental Education Council, 1985.</td>
</tr>
</tbody>
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21. Wisconsin Department of Public Instruction. "Wisconsin Environmental Education Curriculum Mandate", Wisconsin DPI.
APPENDIX L

Instructor Curriculum for the Second Course, Ecological Basis for Environmental Education, NR 412/612
Welcome to the Ecological Basis for Environmental Education, the second of four outreach courses to be offered statewide to Wisconsin K-12 teachers. This curriculum for Ecological Basis for Environmental Education is intended to provide you, the instructor, with a basic framework for teaching the course.

Instructors played a key role in developing the goals and objectives for this course during the November 1989, August and December 1990 planning sessions. The eight lessons in Ecological Basis for Environmental Education are based on those goals and objectives. While you might choose not to teach each lesson exactly as written, the overarching goals and objectives must be addressed through your instructional methods.

The format for each of the eight lessons is the same:

1. Objectives
2. Method
3. Instructional Time
4. Readings
5. Background
6. Materials
7. Procedure
8. Extensions
9. Evaluation
10. Ecosystem Investigation Task

For clarity, certain terms used throughout the curriculum are defined here:

1. Instructor: instructional academic staff selected by the University of Wisconsin-Stevens Point to teach outreach courses in environmental education to K-12 teachers in Wisconsin.

2. Student: any K-12 teacher enrolled in the outreach course.

3. Instructional Time: the approximate amount of time which instructors will need to teach a lesson. The total amount of instructional time for the entire course, Ecological Basis for Environmental Education, is 16 hours.

4. Readings: selected articles on environmental education contained in the student Book of Readings (BR).

5. Background: general information provided in each lesson for instructor reference.

6. Extensions: optional activities provided at the end of each lesson which the instructor might incorporate. The instructional time given for each lesson does not include the use of extensions.

7. Evaluation: informal activities, strategies, and questions which the instructor might use to assess student learning at the conclusion of each lesson.

8. Assignments: two specific projects which each student will complete during (or shortly after) the course. These assignments are listed in the evaluation section of lessons one and five.

9. EE Sub-goals: to be consistent with current terminology and the Wisconsin DPI Guide to Curriculum Planning in EE (draft version, 1991), the terms "citizen action skills" and "citizen action experience" replace the terms "skills" and "participation", respectively.
ACKNOWLEDGMENTS

This curriculum is a cooperative venture involving a select group of professional environmental educators throughout the state of Wisconsin. These men and women have invested four full weekends in the past year at the Central Wisconsin Environmental Station to develop and critique courses in the "Teacher Outreach in Environmental Education" Program. It is due to the creativity, energy, devotion, and skill of these people that the Ecological Basis for Environmental Education exists today. Tremendous credit and gratitude are extended to the August 3-5, 1990 team which did the "lion's share" of work developing the framework and substance of this course:

Ted May
Cindy Sanford May
Pat Marinac-Sanders
Carrie Morgan
Dean Sauers
Lori Lee Smith
Suzanne Wade

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Dolly Ledin    Bryan Pierce
Curtis Powell   Joe Smogor
Bev Southern   David Stokes
Dennis Weibel  Dr. Dennis Yockers

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Dr. Randy Champeau Dana Nelson
Dr. Dan Sivek       David Aplin
Dr. Joe Passineau   Sally Ellingboe
Dr. Mike Gross      Beverly Stencel
Jennie Lane         Ann Quale
Phyllis Peri

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<tr>
<th>TIME (hours)</th>
<th>LESSON</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>2</td>
<td>One</td>
<td>Students are introduced to the course; develop a definition of ecology; create metaphors for Barry Commoner’s Four Laws of Ecology; and distinguish between ecology, environmental education, and environmentalism. Assignment #1 given.</td>
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<tr>
<td>2</td>
<td>Two</td>
<td>Students are introduced to symbiotic relationships, habitat, and niche, and then explore a community: one exploration is using affective/sensory means, the other exploration using cognitive/knowledge-based techniques.</td>
</tr>
<tr>
<td>2</td>
<td>Three</td>
<td>Students discuss ecosystem and biome characteristics, view a video, and construct a model ecosystem.</td>
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<tr>
<td>2</td>
<td>Four</td>
<td>Students learn about the principles of photosynthesis, respiration, and energy transfer in ecosystems. They illustrate concepts in a energy pyramid simulation, and conduct further study utilizing one of three options.</td>
</tr>
<tr>
<td>2</td>
<td>Five</td>
<td>Students study five cycles (water, carbon, oxygen, nitrogen, phosphorus), utilize groundwater and greenhouse effect models, and draw “the path of X” from <em>Sand County Almanac</em>. Assignment #2 given.</td>
</tr>
<tr>
<td>2</td>
<td>Six</td>
<td>Students conduct a succession field study, learn about natural selection through a game, and identify adaptations of various organisms.</td>
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<td>2</td>
<td>Seven</td>
<td>Students analyze how limiting factors affect species population graphs, calculate doubling time, and examine human population growth scenarios.</td>
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<tr>
<td>2</td>
<td>Eight</td>
<td>Students learn about the biosphere and biodiversity, and apply these concepts in a case study of the rain forest. Students investigate how human practices impact the biosphere, and the role of environmental education in solving environmental problems.</td>
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**POSSIBLE COURSE FORMATS:**

*Ecological Basis for Environmental Education* can be taught in a variety of formats. The course requires 16 contact hours of actual instructional time. The University of Wisconsin guidelines recommend that students expect to invest double the contact hours, or 32 hours, in additional study time outside of class to adequately complete the course requirements.

Instructors are encouraged to design the 16 hour format of the course to accommodate the schedules and preferences of students enrolled. Three possible formats are suggested:

- **Four Session Format (four hours each)**
- **Six Session Format (a combination of two hour and four hour sessions)**
- **Eight Session Format (two hours each)**

### Four Session Format

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<td>Lessons One and Two</td>
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<tr>
<td>2</td>
<td>Lessons Three and Four</td>
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<td>3</td>
<td>Lessons Five and Six</td>
<td>4 hours</td>
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<td>4</td>
<td>Lessons Seven and Eight</td>
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### Six Session Format

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<td>Lessons One and Two</td>
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<tr>
<td>2:</td>
<td>Lesson Three</td>
<td>2 hours</td>
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<td>3:</td>
<td>Lesson Four</td>
<td>2 hours</td>
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<td>4:</td>
<td>Lesson Five</td>
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<tr>
<td>5:</td>
<td>Lessons Six and Seven</td>
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<td>6:</td>
<td>Lesson Eight</td>
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### Eight Session Format

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<tr>
<td>2</td>
<td>Lesson Two</td>
<td>2 hours</td>
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<tr>
<td>3</td>
<td>Lesson Three</td>
<td>2 hours</td>
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<tr>
<td>4</td>
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<td>Lesson Five</td>
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<td>6</td>
<td>Lesson Six</td>
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<tr>
<td>7</td>
<td>Lesson Seven</td>
<td>2 hours</td>
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<tr>
<td>8</td>
<td>Lesson Eight</td>
<td>2 hours</td>
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<tr>
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<td></td>
<td><strong>16 hours total</strong></td>
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</table>
Lesson One Materials:

1) optional: one assembled and one (or more) disassembled bicycle derailleurs
2) video "What About Tomorrow?" (5 minutes)
3) optional: slides of an environment
4) optional: yarn for "Webbing" activity
5) overhead transparencies (3) of Economy/Environment; Commoner's Laws; Goal and Subgoals of EE
6) a bag of items for Commoner's Laws (e.g., plastic milk jug, recycled paper, fertilizer, aluminum can, photo of a predator with prey, short chain of paper clips, lemon, candle, charcoal, lunchbox, lightbulb, newspaper)
7) optional: three hats with labels for ecology, environmental education, environmentalism

Lesson Two Materials:

1) slides (3) of pitcher plant, pitcher plant population, bog community
2) slides (5) of symbiotic relationships
3) overhead transparency (1) of Five Categories of Symbiotic Relationships
4) optional: examples of symbiotic relationships
5) optional: field study materials for community exploration

Lesson Three Materials:

1) video on Amboseli National Park ecosystem in Kenya
2) presentation materials for biomes (paper, markers, tape)
3) materials to construct an ecosystem: use either Option A or Option B:
   Option A: Bottle Biology Eco-Column materials:
   a) each student should bring in several 2 liter clear plastic soda bottles with labels removed (see BR pp. 55 for directions)
   b) scissors, felt tip marking pens, duct tape, pipe seal tape, rubber stoppers with tubes, mesh, rubber bands, sharp needles, test tubes (for making ventilation and feeding ports), heat source
   c) organisms for Eco-Columns
d) soil and water for aquatic and terrestrial environments in the Eco-
Columns

Option B: terrarium materials (see BR pp. 59-61)

a) one aquarium or other suitable container in which to construct a
terrarium

b) well-washed pebbles or sand, charcoal (briquets will do), leaf
mold and/or good topsoil

c) common woodland organisms such as ferns, mosses, lichens,
wintergreen, partridgeberry, tiny mushrooms and tiny evergreen
trees

d) possibly a salamander, small frog or toad, cricket, small snake or
turtle

Lesson Four Materials:

1) overhead transparencies (7) of Photosynthesis, Respiration, First Law of
Energy, Second Law of Energy, Grazer Food Chains, Individual Food Chain,
Pyramid of Energy

2) 25 cups with holes; one bucket of water

3) optional:
   a) For "Energy Flow in a Wetland": game board, energy loss charts, dice,
      scratch paper or calculators.
   b) For "Making A Place For Wildlife": butcher paper, markers, and tape.

Lesson Five Materials:

1) overhead transparencies (5) of Where's The Water?, Wisconsin's Water
Cycle, Carbon Cycle, Nitrogen Cycle, Phosphorus Cycle; also
Photosynthesis and Respiration overheads (2) from Lesson Four

2) water cycle: glass of water, globe or world map, one full gallon jug of water,
one empty gallon jug, five petri dishes or small jars, eyedropper, measuring
cup, food coloring (optional), Wisconsin DNR Water Cycle poster

3) groundwater model materials (instructor choice)

4) greenhouse effect: aquarium with 2" of sand or soil, cardboard,
thermometer, lamp, glass lid for aquarium

5) nitrogen and phosphorus cycles: markers or crayons, drawing paper, one
Sand County Almanac (pp. 111-114) per pair of students
Lesson Six Materials:

1) overhead transparency of succession

2) 40 feet of string, twine, or line and 4 stakes for each team in the succession study (5-7 teams per group of 25 students); pertinent field guides; one succession data sheet per team

3) various colored yarn "worms" and a large sheet of white paper

4) mounts, or live animals/plants, or photographs of several organisms for adaptation investigation (instructor choice)

5) optional: costume props for adaptation investigation

Lesson Seven Materials:

1) overhead transparencies (5) of The J-shaped Curve, The S-shaped Curve, Two Family Trees, World Population Graph, and Future Trends in World Population Growth

2) large sheet of paper and markers for graphing "Oh Deer!" data

3) reading (BR pp. 94-96) "Isle Royale: A Living Laboratory"

4) discussion sheets (one per group) for "Isle Royale: A Living Laboratory"

5) video "World Population" (5 minutes)

6) worksheet "Doubling Time" (one per person)

Lesson Eight Materials:

1) apple and knife for "Earth: The Apple of Our Eye"

2) hand-out "Ten Reasons To Save Rain Forests" (one per student)

3) overhead transparency (1) of Ten Reasons To Save Rain Forests

4) video "Rain Forest Rap" (6 minutes)

5) discussion sheets (one per group) for human practices which impact the biosphere
Summary of Assignments for
Ecological Basis for Environmental Education, NR 412/612

A letter grade will be given based on the two course assignments. These two assignments are described below, and total 100 possible points. Attendance is required at all class meetings. Grade categories are:

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<td>A-</td>
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<tr>
<td>80-82</td>
<td>B-</td>
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<tr>
<td>77-79</td>
<td>C+</td>
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Due dates for each assignment are set by the course instructor at the time each assignment is given.

**Assignment #1:**

The student will submit a handwritten notebook chronicling an ecosystem investigation. In the ecosystem investigation the student will:

1) choose one ecosystem which is readily available to him/her on an ongoing basis;

2) conduct a thorough individual investigation of this ecosystem over an extended period of time (to be specifically determined by the instructor based on the timetable of the course);

3) record in writing as experienced, observed, or researched by the student:
   a) the living and nonliving components of the ecosystem and their interrelationships, including but not limited to:
      1. individuals
      2. species populations
      3. communities
      4. ecosystems
      5. energy flow
      6. cycling of matter
      7. succession
      8. limiting factors
      9. biosphere
      10. biodiversity
   b) human impact on the ecosystem, both positive and negative;
   c) the ecosystem’s value (ecological, aesthetic, economic, recreational, spiritual); and
   d) a response to the question: "Of what value was the experience of investigating an ecosystem and keeping a notebook?"
4) Students are encouraged (but not required) to include sketches, poetry, photographs, music, or other creative portrayals of the ecosystem in addition to the written description.

Grading:

Assignment #1 is worth 50 points. Points will be assigned based on the completion of a notebook which evidences thoughtful preparation, clarity of expression, and balanced coverage of all areas as follows:

3a) 32 points (8 ecosystem tasks)
3b) 10 points (human impact on ecosystem)
3c) 5 points (ecosystem's value)
3d) 5 points (response to question)

Total = 50 points

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.

Ecosystem Investigation Task: Lesson One

1) Select and visit an ecosystem (e.g., pond, city park, field, woodlot, vacant city plot, marsh, fencerow) which is accessible to you throughout the course. Briefly describe the ecosystem in your notebook (location, type of ecosystem, special features, other notes).

2) Select one of Commoner's Four Laws of Ecology and describe in your notebook evidence of the law at work in the ecosystem which you have chosen to investigate.

Ecosystem Investigation Task: Lesson Two

1) Observe symbiotic relationships in the ecosystem which you are investigating. Describe in your notebook two different types of symbiotic relationships observed, and explain each interaction.

2) Choose one plant or animal in the ecosystem and describe its niche. The following questions can be used as a guide:

"What role do you occupy in the community?"
"Where do you live and work?"
"What plants or animals do you depend upon in the community? What depends on you?"
"With what plants or animals do you compete? cooperate?"
"What special adaptations do you have to perform your role in the community?"
Ecosystem Investigation Task: Lesson Three

1) Choose a comfortable site at the ecosystem and try to sit still for 15 minutes (on a log, on your back, against a tree). Experience the nonliving (abiotic) factors which influence the ecosystem.

2) Describe evidence of at least three abiotic factors which you observed or experienced that are at work in the ecosystem.

Ecosystem Investigation Task: Lesson Four

1) Observe the variety of producers, consumers, and decomposers in the ecosystem which you are investigating. Diagram in your notebook a pyramid of energy which could be found in the ecosystem. (The pyramid of energy found in the Book of Readings [BR pg.67] can serve as a model). Describe the organisms at each level of the pyramid. Try to identify whether the organism is a producer, primary consumer, secondary consumer, or higher level consumer. The name of the organism is not necessary; a general description (an evergreen tree with needles about 3" long) and/or a quick sketch is sufficient.

2) In one paragraph, explain from an energy standpoint why there is decrease in biomass (amount of each organism by mass) at each succeeding level of the energy pyramid.

Ecosystem Investigation Task: Lesson Five

1) Observe cycles (water, carbon, oxygen, nitrogen, phosphorus) in the ecosystem which you are investigating. Choose one cycle and describe its importance to the ecosystem in your notebook.

Ecosystem Investigation Task: Lesson Six

1) Investigate the ecosystem for evidence of past or present disturbance and/or change. Record in your notebook two types of disturbances and/or changes, citing evidence for both.

2) Choose one plant or animal of the ecosystem to closely study. Record in your notebook three specific adaptations for the organism, and the probable purpose for each.

Ecosystem Investigation Task: Lesson Seven

1) Observe and describe (by name, sketch, or written account) a population in the ecosystem which you are investigating. Identify specific examples of three biotic (living) limiting factors and three abiotic (non-living) limiting factors which determine the carrying capacity of that population.
Ecosystem Investigation Task: Lesson Eight

1) Through the course of the investigation you probably have seen evidence of human impact in the ecosystem. Describe at least two actions you could take to protect or improve the quality of the ecosystem you have investigated.

Assignment #2:

In a 3-5 page paper the student will:

Part I:

1) briefly describe a current environmental problem (5 points);

2) identify at least three ecological principles that relate to the solution or prevention of the problem, and describe the relationship (20 points).

Part II:

1) identify at least three ecological principles and describe how these can be used to guide individuals in developing ecologically sound lifestyles (25 points).

Grading:

Assignment #2 is worth 50 points. Points will be assigned based on:

a) evidence of thoughtful preparation and clarity of expression;

b) completion of a written analysis consisting of 3-5 typewritten, double-spaced pages; and

c) inclusion of a bibliography citing at least three references.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.

GRADUATE INCREMENT:

All students enrolled in NR 612 (graduate credit) should describe TWO environmental problems and three related ecological principles for each problem in Part I above. All other criteria for the assignment remain the same.
As a result of this course, students will:

1) possess knowledge of major ecological concepts, including (but not limited to):
   a) individuals
   b) species populations
   c) communities
   d) ecosystems
   e) energy flow
   f) cycles of matter
   g) succession
   h) limiting factors
   i) biosphere
   j) biodiversity

2) be able to apply knowledge of ecological concepts to the analysis of environmental problems (Marcinkowski, Volk and Hungerford, 1989);

3) be able to apply knowledge of ecological concepts in order to prevent environmental problems;

4) be able to apply knowledge of ecological concepts in predicting consequences of alternative solutions to
environmental problems (Marcinkowski, Volk and Hungerford, 1989);

5) be able to communicate and apply in an educational context the major concepts of ecology (Wilke, 1980).

OBJECTIVES FOR ECOLOGICAL BASIS FOR ENVIRONMENTAL EDUCATION NR 412/612

PART I: OBJECTIVES FOR INTRODUCTION TO ECOLOGY

During or upon completion of this course, students will relate the human factor to the study of ecology and be able to:

1) define ecology as the study of interactions of living organisms with each other and with their environment, and explain one reason why the human factor must be considered in the study of ecology.

2) provide at least one example for each of Barry Commoner's Four Laws of Ecology, and state that humans are only one member of the biotic community.

3) distinguish among ecology, environmental education, and environmentalism, stating at least one reason why ecology is considered an essential foundation for environmental education.

PART II: OBJECTIVES FOR COMMUNITIES

During or upon completion of this course, students will relate the human factor to natural communities and be able to:

1) define population as a group of individual organisms of the same species that occupy a particular area, and provide at least one example.

2) define community as all the populations of plant and animal species living and interacting in a given area, and provide at least three examples.

3) investigate a community, and identify the following symbiotic relationships within its members by locating and describing one example of each: mutualism; commensalism; predation; parasitism; and competition.
4) define habitat as the place where an organism typically lives.

5) explain the concept of "niche" as an organism's role in the community similar to the human analog of "occupation".

PART III: OBJECTIVES FOR ECOSYSTEMS

During or upon completion of this course, students will relate the human factor to ecosystems and be able to:

1) define ecosystem as a community of plants and animals interacting with each other and with their nonliving environment, and provide at least one characteristic feature which distinguishes an ecosystem from a community.

2) for each of the earth's six terrestrial biomes (arctic tundra, coniferous forest, deciduous forest, tropical forest, grassland, and desert) describe at least:
   a) one characteristic plant;
   b) one characteristic animal; and
   c) one characteristic physical or climatic condition.

3) identify the biomes found in Wisconsin as coniferous forest (along Lake Superior), deciduous forest, and grassland.

4) identify the sun as the source of all energy on earth, and how humans are dependent on this source.

5) describe photosynthesis as the process in which plants transform carbon dioxide and water by means of sunlight and chlorophyll into glucose and oxygen, and how humans are dependent on this process.

6) describe respiration as the process in which plants and animals derive usable energy from glucose by combining it with oxygen, and breaking these molecules down into carbon dioxide and water; further, describe how humans are dependent on this process.

7) state the First Law of Energy (energy can neither be created nor destroyed, only transformed from one form to another), and explain at least one ecosystem and one human implication.

8) state the Second Law of Energy (each time energy is converted to work, some of the energy is always degraded to a lower-quality, more-dispersed, less
useful form of energy), and explain at least one ecosystem and one human implication.

9) diagram a food web involving humans, comprised of at least three food chains, and label each component as producer, consumer (primary, secondary, or tertiary), or decomposer.

10) identify all the organisms of any given food web which are at the same trophic level (first, second, third, fourth, fifth).

11) trace the amount of high-quality, usable energy transferred from the first trophic level through each succeeding trophic level of an energy pyramid, and correlate this to:
   a) the First and Second Laws of Energy; and
   b) the biomass of organisms present at each trophic level in a pyramid of numbers.

12) considering world hunger, provide a rationale from an energy standpoint for a shortened food chain in the human diet.

13) diagram the quantity of earth's water found in:
   a) oceans;
   b) polar ice caps;
   c) lakes, rivers, and streams;
   d) atmosphere;
   e) groundwater; and explain how humans are dependent on these water resources.

14) diagram the water cycle labeling evaporation, transpiration, condensation, precipitation, infiltration, groundwater, and runoff; indicate how humans are dependent on these processes.

15) analyze how human intervention in the water cycle can decrease both the quality and quantity of available water through excessive water use and the influx of pollutants.

16) trace the cycles of carbon and oxygen through the processes of photosynthesis and respiration (objectives 5,6), and explain how humans are dependent on these processes.

17) analyze how human intervention in the carbon and oxygen cycles can increase the amount of carbon dioxide in the atmosphere through deforestation and the burning of fossil fuels, and state at least one human action which could reduce this buildup.
18) provide at least two examples of matter cycles (e.g., nitrogen and phosphorus), and explain how humans are dependent on these processes.

19) explain that succession is a process in which ecosystems change over time, usually becoming more complex.

20) state that fluctuation, not equilibrium, is the natural condition of ecosystems; further, identify at least three natural and/or human disturbances which cause fluctuation.

21) through direct investigation of an ecosystem, describe the process of succession by citing evidence of disturbance and change in the ecosystem.

22) explain the process of natural selection by describing two organisms and their special genetic features (adaptations) that best suit their living conditions and are passed on to their offspring.

23) identify at least five living and five nonliving limiting factors which determine the existence, abundance, or distribution of an organism; relate how the world human population is dependent on these limiting factors.

24) interpret a species population graph by distinguishing a J-shaped curve (exponential growth) from an S-shaped curve (leveled off growth) and predicting the carrying capacity; relate these concepts to the world human population graph.

25) given the annual percentage growth rate, apply "the rule of 70" to calculate doubling time for the human population in a particular region.

26) graph the human population curve to the current year; further, extrapolate the curve into three alternative future growth scenarios and provide a rationale for each.

PART IV: OBJECTIVES FOR THE BIOSPHERE

During or upon completion of this course, students will relate the human factor to the biosphere and be able to:

1) define biosphere as that part of the earth where living organisms exist, describe the extent of the biosphere, and explain how humans are dependent upon the biosphere.
2) describe three developments in human history which have significantly impacted the environment.

3) define biodiversity as the number of species and their abundance in an ecosystem, and describe the impact on an ecosystem when species are removed by human intervention.

4) given a human practice, assess its impact on the biosphere and describe at least three related actions which an individual could take to protect or improve the environment.

5) describe how environmental education can be an effective strategy in working toward solutions of environmental problems.

6) conduct a thorough individual investigation of one ecosystem, and record in writing as experienced, observed, or researched by the investigator:
   a) the living and nonliving components of the ecosystem and their interrelationships;
   b) human impact on the ecosystem, both positive and negative;
   c) the ecosystem’s value (ecological, economic, recreational, aesthetic, spiritual); and
   d) a response to the question: "Of what value was the experience of investigating an ecosystem and keeping a notebook?"

7) apply ecological concepts to the investigation of one current environmental problem by identifying at least three ecological principles that relate to the solution or prevention of the problem, and describe the relationship.

8) identify at least three ecological principles and describe how these can be used to guide individuals in developing ecologically sound lifestyles.
Lesson One:
Introducing Ecology!

Objectives: Students will relate the human factor to the study of ecology and be able to:

1) define ecology as the study of interactions of living organisms with each other and with their environment, and explain one reason why the human factor must be considered in the study of ecology.

2) provide at least one example for each of Barry Commoner's Four Laws of Ecology, and state that humans are only one member of the biotic community.

3) distinguish among ecology, environmental education, and environmentalism, stating at least one reason why ecology is considered an essential foundation for environmental education.

Method: Students are introduced to the course; develop a definition of ecology; create metaphors for Barry Commoner's Four Laws of Ecology; and distinguish between ecology, environmental education, and environmentalism.

Instructional Time: 2 hours

Readings:

1) "Confusing Ecology With Environmentalism" (BR pg. 1)
2) "Two Hats" (BR pg. 2)
3) "Commoner's Laws of Ecology" (BR pp. 3-12)
4) "Field Notebook Worksheet" (BR pg. 13)
5) "Ecology/Economy" (BR pg. 14)
6) "Goal and Subgoals of EE" (BR pg. 15)

Background: A basic understanding of ecological principles is needed to make sound decisions on
environmental issues. Ecology provides the foundation for
curriculum development in environmental education.
Ecological concepts can be complex; however, the focus
of this course is to provide a simplified, crisp presentation
of ecology for K-12 teachers. Barry Commoner's Four
Laws of Ecology are introduced in the beginning of the
course as "handholds" to grasp the major concepts of
ecology.

"In the early 1970's, ecologist Barry Commoner wrote The
Closing Circle, in which he discussed the rapid growth of
industry and technology and their persistent impact on all
forms of life. He recommends that we can lessen the
negative impact by sensitizing, informing and educating
humankind on its connection to the natural world.
Commoner introduced four laws of ecology to the scientific
community in the form of these simple statements:

1) EVERYTHING IS CONNECTED TO EVERYTHING ELSE.
2) EVERYTHING MUST GO SOMEWHERE.
3) NATURE KNOWS BEST.
4) THERE IS NO SUCH THING AS A FREE LUNCH.

These laws form the basis for studying and
understanding the relationships and interdependencies
found in communities and ecosystems. They further
explain that humankind is, in fact, only one member of
the biotic community and that people are shaped and
nurtured by characteristics of the land. These laws will
not explain everything. Mysteries will remain."

(from 4-H Earth Connections, University of Maine
Cooperative Extension Service)

Examining Commoner's Four Laws of Ecology leads into
the first assignment of the course: an individual
investigation of an ecosystem. First-hand observations of
an ecosystem over a period of time can result in pleasant
discoveries, concerns for the ecosystem's well-being as it
faces environmental stress, questions hungry for answers
("Did I just see that dragonfly grab an insect out of mid-
air?"), and a growing empathy with a small corner of the
observer's world.

The major purpose of Lesson One is to understand and
apply Commoner's Four Laws of Ecology; distinguish
between ecology, environmental education, and
environmentalism; and realize that effective environmental
education must be well-grounded ecologically.
Materials:

1) optional: one assembled and one (or more) disassembled bicycle derailleurs
2) video "What About Tomorrow?" (5 minutes)
3) optional: slides of an environment
4) optional: yarn for "Webbing" activity
5) overhead transparencies (3) of Economy/Environment; Commoner's Laws; Goal and Subgoals of EE
6) a bag of items for Commoner's Laws (e.g., plastic milk jug, recycled paper, fertilizer, aluminum can, photo of a predator with prey, short chain of paper clips, lemon, candle, charcoal, lunchbox, lightbulb, newspaper)
7) optional: three hats with labels for ecology, environmental education, environmentalism

Procedure:

1) Introductions (15 minutes):
   a) Introduce yourself to the students.
   b) Have students complete the course registration forms from UWSP's Continuing Education Office.
   c) Give a general overview to the course and its goals.
   d) Explain class meeting schedule (dates, times, location) and attendance expectations.
   e) Review with students the course grading criteria in the "Summary of Assignments"; details for completing the assignments need not be given at this time.

2) A brief (15 minute) "get acquainted" activity of the instructor's choice may be used to begin Lesson One. (Otherwise, proceed to step 3.) One "get acquainted" option, suggested by Suzanne Wade, follows: distribute to each student a part of a disassembled bicycle derailleur without disclosing that the parts are from a derailleur. (Two derailleurs might be needed depending on the number of students.) Students take turns trying to describe what they think
their part might be, or from what object their part might have come. After all descriptions have been offered, display an assembled bike derailleur. Explain that the parts, when assembled and installed, perform the important task of shifting gears on a bicycle. Guide students to infer that seemingly unimportant and unrelated parts (from a bicycle or the environment) are often highly interrelated and essential to the proper functioning of an entire system. Conclude by relating these inferences to the course focus: ecology. As Aldo Leopold wrote, "The first rule of intelligent tinkering is to save all the parts." (*Sand County Almanac*, pg. 190)

3) Show the video "What About Tomorrow?" (5 minutes).

4) Listing organisms in an environment (10 minutes): situate the students in a location where they can observe the environment (field, school playground, forest, park). This can be done by actually going outside, or sitting near the window, or viewing one of the slides provided. Have small groups of 3-4 students compile a list of the living organisms which they observe in the environment. The list can include names (black-capped chickadees), descriptions (6" tall purple flowers), or drawings; try to downplay any apprehensions students might have about not knowing all the "names" for organisms. Then, encourage the groups to infer any other living things not observed but which might be "as yet unseen" permanent residents or common visitors in that environment. Add these to the list. Some living things will be quite obvious, while others will require more thought to discover. For instance, if observing a field environment, milkweed might be readily apparent. Monarch butterflies would probably be visitors to the environment as well. Perhaps rabbits live in the thicket, hosting fleas or intestinal parasites. Hawks could fly over, searching for field mice. Have each group try to name, describe or draw at least 20 organisms which might live in the environment being observed. Emphasize that this is what ecologists do, studying organisms and their interactions with other organisms and with their environment.

5) Discuss what influence the environment has on the types of organisms present (5 minutes). Generate a list with students of environmental factors which might determine why most of plants and animals they observed in a Wisconsin environment would not be found in the Amazon rainforest or the Arctic tundra (e.g., elevation, annual rainfall, temperature, humidity, soil type, latitude, land forms). Introduce the term
abitic factors: those non-living factors which influence living organisms in an environment.

6) Have students share their list of plants and animals (10 minutes). Try to increase student awareness of how many organisms they missed. (Were humans listed?) Students should indicate any observed interactions of organisms with each other and with their environment (e.g., lichen can grow on trees or rocks, grass doesn't grow very well in sandy soil, insects were seen landing on the purple flowers).

7) Now synthesize from the three parts discussed (organisms, non-living factors, and the interactions that exist between them) the definition of ecology (5 minutes):

ECOLOGY: the study of interactions of living organisms with each other and with their environment.

(* steps 4-7 adapted from Audrey Tomera, Understanding Basic Ecological Concepts, J. Weston Walch Publishers, 1979)

8) Reinforce the concept of "interaction" from the definition of ecology by one of the following options (10 minutes):

   a) Lead students through a guided imagery (e.g., taking on the role of a hawk as it hunts, rides the thermals, builds a nest).

   b) Using yarn, construct a web of interrelationships. (The activity "Webbing" from Joseph Cornell's Sharing Nature With Children is included in Appendix A, pg. 88, for instructor reference.)

   c) "Animal Poetry" from Project WILD Elementary (Western Regional Environmental Education Council, 1986) is included in Appendix B, pp. 89-90, for instructor reference.

9) Compare and contrast the derivation of the word "ecology" with that of "economics" (5 minutes). An overhead transparency is provided. Both come from the Greek work oikos, meaning house: ecology is "the study of the house" (or place to live), and economics is "the management of the house" (or place to live). Stress the importance of the connection between the two fields; they need not be adversarial.
10) Creating Metaphors for Commoner's Four Laws of Ecology (25 minutes): Introduce the laws using the overhead transparency provided. Give a basic overview of each law. Then, have each student reach into a bag and remove one object. After a minute of "think time", have each student describe one relationship between his/her object and one of the four laws. For example, a student might describe a newspaper as an example of "there is no such thing as a free lunch" because trees were cut to make the paper, probably with a loss of wildlife habitat. Another might illustrate "everything has to go somewhere" with a lightbulb, describing how fossil fuels (from plants that "went somewhere" thousands of years ago) provide much of our energy. After all students have had the opportunity to share, discuss other relationships which could have been illustrated by various objects. Conclude the activity by summarizing Commoner's Four Laws of Ecology.

* Note to Instructor: you will need to collect a bag of items to be used in this activity. Some suggested items: plastic milk jug, recycled paper, fertilizer, aluminum can, photo of a predator with prey, short chain of paper clips, lemon, candle, charcoal, lunchbox, lightbulb, and newspaper. This activity can be done with individual students or pairs of students.

11) Discuss the question "How do ecology, environmental education, and environmentalism differ?" (10 minutes). One option is for you, the instructor, to wear hats labelled "ecologist", "environmental educator", or "environmentalist" as each is discussed. Or, recruit three student volunteers to wear the hats as distinctive characteristics of each are determined. (Thanks to Bryan Pierce for this great "hat" idea!)

a) "What is ecology?" Emphasize that ecology is a field of science which studies the interactions of living organisms with each other and with their environment. Knowledge of ecology provides the necessary foundation for environmental education.

b) "What are the goals and subgoals of environmental education?" This serves as a good time to review these major ideas from Principles of Environmental Education (NR 411/611) using the overhead transparency provided.
"The goal of EE is to help students become environmentally knowledgeable, skilled, dedicated citizens who are willing to work individually and collectively toward achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment." (Wisconsin Department of Public Instruction, 1986)

The EE subgoal progression: awareness, knowledge, values and attitudes, citizen action skills, citizen action experience.

"Who is an environmental educator?" Citing John Hug's "Two Hats" essay (BR pg. 2), an environmental educator is one who uses information and educational processes to help people analyze various viewpoints on environmental issues; an environmental educator is a developer of skills and information analyst who prepares people to participate in environmental decisionmaking.

"Who is an environmentalist?" Again citing Hug's essay, an environmentalist is one who advocates with action that wrongs against the environment must be stopped. Refer also to "Confusing Ecology With Environmentalism" (BR pg. 1).

c) Summarize by stressing the cooperative yet distinct natures of the three fields.

d) Explain Assignment #1 in the evaluation section that follows (10 minutes).

**Extensions:** A more extensive approach to distinguishing ecology, environmental education, and environmentalism is to have small groups create skits or presentations on the differences. Necessary background readings are "Confusing Ecology With Environmentalism" (BR pg. 1) and "Two Hats" (BR pg. 2).

* Note to Instructor: Depending on the timetable of your course, you might want to announce at this time the necessary preparations (designing and gathering materials) for construction of Eco-Columns in Lesson Three. Instructions are found in the students’ Book of Readings (BR pp. 53-58).
**Evaluation: Assignment #1**

The student will submit a handwritten notebook chronicling an ecosystem investigation. In the ecosystem investigation the student will:

1) choose one ecosystem which is readily available to him/her on an ongoing basis;

2) conduct a thorough individual investigation of this ecosystem over an extended period of time (to be specifically determined by the instructor based on the timetable of the course);

3) record in writing as experienced, observed, or researched by the student:
   a) the living and nonliving components of the ecosystem and their interrelationships, including but not limited to:
      1. individuals
      2. species populations
      3. communities
      4. ecosystems
      5. energy flow
      6. cycling of matter
      7. succession
      8. limiting factors
      9. biosphere
     10. biodiversity
   To accomplish the above, ecosystem investigation tasks will be given to the student at the conclusion of each of the course’s eight lessons by the instructor.

   b) human impact on the ecosystem, both positive and negative;

   c) the ecosystem’s value (ecological, aesthetic, economic, recreational, spiritual); and

   d) a response to the question: "Of what value was the experience of investigating an ecosystem and keeping a notebook?"

4) Students are encouraged (but not required) to include sketches, poetry, photographs, music, or other creative portrayals of the ecosystem in addition to the written description.
Grading:

Assignment #1 is worth 50 points. Points will be assigned based on the completion of a notebook which evidences thoughtful preparation, clarity of expression, and balanced coverage of all areas as follows:

<table>
<thead>
<tr>
<th>3a)</th>
<th>32 points</th>
<th>(8 ecosystem tasks)</th>
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<tbody>
<tr>
<td>3b)</td>
<td>10 points</td>
<td>(human impact on ecosystem)</td>
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<tr>
<td>3c)</td>
<td>5 points</td>
<td>(ecosystem's value)</td>
</tr>
<tr>
<td>3d)</td>
<td>5 points</td>
<td>(response to question)</td>
</tr>
</tbody>
</table>

**total = 50 points**

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.

**Ecosystem Investigation Task: Lesson One**

1) Select and visit an ecosystem (e.g., pond, city park, field, woodlot, vacant city plot, marsh, fencerow) which is accessible to you throughout the duration of the course. Briefly describe the ecosystem in your notebook (location, type of ecosystem, special features, other notes).

2) Select one of Commoner's Four Laws of Ecology and describe in your notebook evidence of the law at work in the ecosystem which you have chosen to investigate.
Lesson Two: Exploring Communities

Objectives: Students will relate the human factor to natural communities and be able to:

1) define population as a group of individual organisms of the same species that occupy a particular area, and provide at least one example.

2) define community as all the populations of plant and animal species living and interacting in a given area, and provide at least three examples.

3) investigate a community, and identify the following symbiotic relationships within its members by locating and describing one example of each: mutualism; commensalism; predation; parasitism; and competition.

4) define habitat as the place where an organism typically lives.

5) explain the concept of "niche" as an organism's role in the community similar to the human analog of "occupation".

Method: Students are introduced to symbiotic relationships, habitat, and niche, and then explore a community: one exploration is using affective/sensory means, the other exploration using cognitive/knowledge-based techniques.

Instructional Time: 2 hours

Readings:

1) "Five Categories of Symbiotic Relationships" (BR pp. 16-17)
2) "Water Quality Sampling Equipment" (BR pp. 18-33)
3) "Homemade Sampling Equipment" (BR pp. 34-47)
4) Miller text pp. 50-52; 67-70

Background: Scientists generally classify living organisms into five kingdoms: plant, animal, fungi, protist, and
moneran (bacteria and blue-green algae). Most of the emphasis in this course is placed on the plant and animal kingdoms, but it is important to recognize that not all living things are plants and animals.

An individual of any form of life is referred to as an organism. Organisms of the same species (such as white-tailed deer, or red pine trees) living together in a particular area are called populations. All plant and animal populations living and interacting in a particular area comprise a community. A pond, sidewalk crack, field, sedge meadow, river, forest edge, bog, or abandoned city lot are all examples of communities. Humans are integral members of communities. A woodland community could contain populations of white-tailed deer and red pine as well as black-capped chickadees, paper birch, porcupines, wintergreen, and many others. Together these living things are interrelated in multiple ways: deer browse on the pine and birch, seeds from wintergreen berries are dispersed by chickadees as they pass through the birds' digestive system, and a porcupine may find a hollow tree just the place for its daytime slumber.

Examining communities involves the study of symbiotic relationships (close living relationships) between organisms. Five main types of relationships are:

1) **mutualism** (+/+) an interaction in which both organisms benefit, and the interaction is necessary for the survival and growth of both.

   Example: lichens are composed of two plants living in very close association. Algae have chlorophyll and therefore can photosynthesize food; fungi use this food and provide water to protect the algae from drying out. Lichens can live where neither algae nor fungi could live alone. ("Alice Algae and Freddy Fungi took a 'lichen' to each other!")

2) **commensalism** (+/0): an interaction in which one organism benefits, and the other is unaffected.

   Example: a hermit crab utilizes the discarded shell of a mollusk for protection; the mollusk died before the crab came along, and therefore is neither helped nor harmed by this relationship.

3) **predation** (+/-): an interaction in which one organism (the predator) kills another organism (the prey). The predator population benefits, and the prey population is inhibited.
Example: an osprey catches a fish for food. The osprey benefits by obtaining food, but the fish dies.

4) **parasitism** (+/-): an interaction in which one organism (the parasite) nourishes itself to the detriment of the other organism (the host).

Example: humans serve as hosts for many parasites such as hookworms, tapeworms, lice, ticks, malaria, and tuberculosis microorganisms. The parasites extract nutrients from human cells; the human host is harmed through disease and malnutrition.

5) **competition** (-/-): an interaction in which one organism contends for resources (e.g., food, water, shelter, space, sunlight) with another organism. Over time, one population will predominate. In the competitive struggle, both populations are negatively impacted.

Example: in an abandoned field, aspen and conifer seedlings begin to grow. Sunlight and space is abundant for the saplings, but as the trees grow larger they must compete for these limited resources. The conifers succeed in shadowing and crowding the aspen, which is short-lived and replaced by the conifers.

Human influence in natural communities has had major impact on the relationships between organisms. Pesticides can be absorbed by predators from their prey with lethal consequences. Competition for den and nest sites between species can be aggravated by removal of dead trees during land development and logging. In many ways, interactions between plant and animal populations are intensified and sometimes disrupted by human activities.

The place where an organism typically lives is called its **habitat**. An organism's habitat in a community can be likened to its "address". An organism's **niche** is its role in the community, similar to the human analog of "occupation". The niche of a snapping turtle consists of all the factors which determine how it lives (e.g., food, shelter, temperature, reproduction, competing species). These are required for the snapping turtle to survive and reproduce in its environment. Understanding the ecological niche and habitat of an organism can be useful in managing a species. For instance, the endangered giant panda's diet is 99% bamboo; protecting stands of the bamboo from disease and destruction can assist the animal in making a comeback.
For in this forest, in this scheme of things, there are lessons to be learned. The feel of pitch on the hands and humus under the fingernails, the sound of tree limbs scraping together in the wind, of rustling leaves and falling cones, the smell of rich earth filled with life-giving decay, the appreciation of rain held in the slopes by a cover of plants and grasses, the sight of a spider's web drawn between two branches (the only straight line in nature, as Emerson said), the merry stream running quick and clear, the subtle life beneath the soil, the nobility of one fine elk, the particular grace of one tree different from all the others, the form of a fissured rock from which a struggling fir miraculously grows, the finely wrought sculpture of a dead tree without its bark, the mysteries of chlorophyll and transpiration. All this is virgin forest...

Nancy Wood

The major goal of Lesson Two is to explore populations of plants and animals which comprise local communities, investigate relationships between populations, and study the habitat and niche of several organisms.

Materials:

1) slides (3) of pitcher plant, pitcher plant population, bog community
2) slides (5) of symbiotic relationships
3) overhead transparency (1) of Five Categories of Symbiotic Relationships
4) optional: examples of symbiotic relationships
5) optional: field study materials for community exploration

Procedure:

1) Introducing terms (10 minutes):

Begin by showing the first slide of the individual pitcher plant. (You might want to briefly describe the natural history of this unique plant!) Ask questions to establish criteria for life, such as: "How do you know it's alive? grows? reproduces?" Conclude by generating a definition of organism as an individual of any form of life.

Continue with the second slide of many pitcher plants. Define organisms of the same kind living in a particular area and capable of reproducing with each other as a population (e.g., a population of pitcher plants or a population of common loons).

Finally, show the third slide of the bog community. Extend the definition process to include a community: all the populations of plant and animal species living and interacting in a given area. (If needed, clarify what is meant by species: organisms of the same kind which are capable of reproducing with each other, and usually not with organisms outside the group.) Can students give examples of populations of plant and animal species that live and interact in a bog community? (e.g., sundew, sphagnum moss, tamarack, black spruce, cranberries, bog rosemary, blueberries, labrador tea, dragonflies, arctic shrews and bog lemmings)
Solicit examples from students of communities (pond, forest, field, river) with which they are familiar. Supplement these with other communities which might be less apparent (vacant city lot, coral reef, school playground, alpine meadow, or sidewalk crack). Discuss for several of the communities what some of the populations of plants and animals might be, and some of their possible interactions.

2) Relationships in communities (10 minutes):

Illustrate five categories of **symbiotic** relationships using the set of five slides provided. (Define close living relationships between organisms as **symbiotic** relationships.) Using the overhead provided, outline the five categories and have students classify the relationships observed in the slides into the appropriate category. This overhead is reproduced in the students' Book of Readings (BR pp. 16-17).

**Five Categories of Symbiotic Relationships:**

a) **mutualism** (+/+) : an interaction in which both organisms benefit, and the interaction is necessary for the survival and growth of both.

b) **commensalism** (+/0) : an interaction in which one organism benefits, and the other is unaffected.

c) **predation** (+/-) : an interaction in which one organism (the predator) kills another organism (the prey). The predator benefits, and the prey is negatively impacted (i.e., killed).

d) **parasitism** (+/-) : an interaction in which one organism (the parasite) nourishes itself to the detriment of the other organism (the host).

e) **competition** (-/-) : an interaction in which one organism contends for resources (e.g., food, water, shelter, space, sunlight) with another organism. Over time, one population will predominate. In the competitive struggle, both populations are negatively impacted.

* Note to Instructor: Any actual examples which you could bring to class illustrating these interactions would be very useful. (Possibilities: lichen, owl pellets, carnivore skull, hermit crab, tree portion with woodpecker hole, ticks, milkweed and monarch butterfly.)
3) Significance of habitat and ecological niche (10 minutes): describe habitat as an organism’s "address" in the community, and an organism’s niche as its role in the community, similar to the human analog of "occupation". Emphasize that niche includes all the factors (e.g., food, shelter, temperature, reproduction, competing species) which determine how an organism survives and reproduces in its environment.

Personal analogy: have each student assume a role (e.g., beaver, muskellunge, mosquito). In that role, the student tries to answer the following questions silently and individually as the instructor reads them aloud:

"What role do you occupy in the community?"
"Where do you live and work?"
"What plants or animals do you depend upon in the community? What depends on you?"
"With what plants or animals do you compete? cooperate?"
"What special adaptations do you have to perform your role in the community?"

(adapted from "Which Niche?, Project WILD Secondary, Western Regional Environmental Education Council, 1986.)

4) Community exploration (1.5 hours total): visit one community with your students and investigate it using both affective/sensory and cognitive/knowledge-based techniques. Keep in mind the objectives for Lesson Two while exploring: focus on the concepts of populations, communities, symbiotic relationships, habitat and niche throughout the community exploration.

* Note to Instructor: None of the following activities are reproduced in the curriculum. Refer to the cited resource.

Affective/sensory (45 minutes): emphasize environmental sensitivity using an activity appropriate for the community being explored, possibly including but not limited to the following:

Naming is often both an asset and an obstacle to the study of natural systems. When students go to a community, they want to know the names of the organisms they encounter. This is a good time to learn to recognize some plants and animals. But often it is enough to appreciate differences and similarities, and even for students to assign names of their own making to the things they see. Do not let a lack of detailed knowledge of names discourage study. Instead, use this as an opportunity to pose the “How can we find out?” questions. Emphasize the characteristics of plants and animals and their interactions, rather than losing sight of those attributes in a quest to label the parts.

Project WILD Aquatic

Cognitive/knowledge-based (45 minutes): emphasize ecological concepts using an activity appropriate for the community being explored, possibly including but not limited to the following:

a) Project WILD Elementary (Western Regional Environmental Education Council, 1986.)


b) Project WILD Secondary (Western Regional Environmental Education Council, 1986.)

"Grasshopper Gravity", pp. 59-61

c) Project WILD Aquatic (Western Regional Environmental Education Council, 1987.)

"Water Canaries", pp. 35-39
d) "Sampling A River" (from *Conserving America: River Resource Guide*, National Wildlife Federation and WQED/Pittsburgh, 1988) This river field study is included in Appendix C, pp. 91-93, for instructor reference. Information on specific functions of water sampling equipment is included in the Book of Readings (BR pp. 18-33); instructions for constructing low cost sampling equipment is included in the students’ Book of Readings (BR pp. 34-47).

e) Many fine field studies are available to guide an exploration of ponds, forests, fields, and other communities. Feel free to use these resources and to recommend their inclusion in the instructor manual for this course.

* Note to Instructor: You may choose to have students collect organisms during the community study for Eco-Columns in Lesson Three.

**Extensions:**

1) "Good Buddies", *Project Wild* Secondary pp. 89-90 (Western Regional Environmental Education Council, 1986) is a card game involving research on animals exhibiting commensalism, mutualism, or parasitism.

2) Many portions of this course in ecology are well-suited and enhanced by outdoor instruction. Return to the community explored in this lesson whenever appropriate during future lessons to further investigate the community.

**Evaluation:**

1) During the community exploration, have students identify at least one observed interaction demonstrating mutualism, commensalism, predation, parasitism, and competition.

2) Have small groups of students (3-4) select an organism from the community just explored and try to establish its ecological niche by "interviewing" it with the following questions:

"What role do you occupy in the community?"
"Where do you live and work?"
"What plants or animals do you depend upon in the community? What depends on you?"
"With what plants or animals do you compete? cooperate?"
"What special adaptations do you have to perform your role in the community?"

**Ecosystem Investigation Task**: Lesson Two

1) Observe symbiotic relationships in the ecosystem which you are investigating. Describe in your notebook two different types of symbiotic relationships observed, and explain each interaction.

2) Choose one plant or animal in the ecosystem and describe its niche. The following questions can be used as a guide:

"What role do you occupy in the community?"
"Where do you live and work?"
"What plants or animals do you depend upon in the community? What depends on you?"
"With what plants or animals do you compete? cooperate?"
"What special adaptations do you have to perform your role in the community?"

The thin snow now driving from the north and lodging on my coat consists of those beautiful star crystals... How full of creative genius is the air in which these are generated! I should hardly admire more if real stars fell and lodged on my coat. Nature is full of genius, full of divinity. Nothing is cheap and coarse, neither dewdrops nor snowflakes.

*Henry David Thoreau*
Lesson Three:
The Ecosystem Concept

Objectives: Students will relate the human factor to ecosystems and be able to:

1) define ecosystem as a community of plants and animals interacting with each other and with their nonliving environment, and provide at least one characteristic feature which distinguishes an ecosystem from a community.

2) for each of the earth's six terrestrial biomes (arctic tundra, coniferous forest, deciduous forest, tropical forest, grassland, and desert) describe at least:
   a) one characteristic plant;
   b) one characteristic animal; and
   c) one characteristic physical or climatic condition.

3) identify the biomes found in Wisconsin as coniferous forest (along Lake Superior), deciduous forest, and grassland.

Method: Students discuss ecosystem and biome characteristics, view a video, and construct a model ecosystem.

Instructional Time: 2 hours

Readings:

1) "A Guide to the Ecosystem Concept" (BR pp. 48-52)
2) "Bottle Biology: Eco-Columns" (BR pp. 53-58)
3) "Constructing Terrariums" (BR pp. 59-61)
4) Miller text pp. 74-76

Background: So far in this course, only the biotic (living) components of communities have been studied. Now abiotic (nonliving) factors will be examined as well. A community of living things interacting with each other and with their nonliving environment is called an ecosystem. Some abiotic factors which influence ecosystems are temperature, light, soil, humidity, pollutants, elevation,
nutrients, and precipitation. Six major land ecosystems, called biomes, are identified: arctic tundra, coniferous forest, deciduous forest, tropical forest, grassland, and desert. There is only one aquatic biome: the ocean. (Freshwater ecosystems are neither extensive enough nor stable enough to be considered biomes.) Each biome is distinguished by characteristic plants, animals, and physical and climatic conditions.

By designing and constructing a self-contained ecosystem, students must balance the needs of living organisms with the capacity of the nonliving environment to sustain them.

The major purpose of Lesson Three is for students to acquire an understanding of the biotic and abiotic components in ecosystems and to begin studying them experientially.

Materials:

1) video/slide show on ecosystems
2) presentation materials for biomes (paper, markers, tape)
3) materials to construct an ecosystem: use either Option A or Option B:

Option A: Bottle Biology Eco-Column materials:

a) each student should bring in several 2 liter clear plastic soda bottles with labels removed (see BR pp. 55 for directions)

b) scissors, felt tip marking pens, duct tape, pipe seal tape, rubber stoppers with tubes, mesh, rubber bands, sharp needles, test tubes (for making ventilation and feeding ports), heat source

c) organisms for Eco-Columns

d) soil and water for aquatic and terrestrial environments in the Eco-Columns

Option B: terrarium materials (see BR pp. 59-61)

a) one aquarium or other suitable container in which to construct a terrarium

b) well-washed pebbles or sand, charcoal (briquets will do), leaf mold and/or good topsoil

It comes about that most people simply don’t know how beautiful the world is and how much splendor is revealed in the smallest things, in a common flower, in a stone, in the bark of a tree or the leaf of a birch. Grown-up people who have occupations and cares and who worry themselves about mere trifles, gradually lose the eye for these riches which children, if they are observant and good, quickly notice and love with their whole heart.

Rainer Maria Rilke
c) common woodland organisms such as ferns, mosses, lichens, wintergreen, partridgeberry, tiny mushrooms and tiny evergreen trees

Procedure:

1) The Ecosystem Concept (15 minutes): review with students what their community study involved: investigating plant and animal populations living and interacting in a particular area. Refer back to the definition of ecology which students generated in Lesson One. ("Ecology is the study of interactions of living organisms with each other and with their environment.") Ask students if their community study fits the definition of ecology. (Interactions between organisms were investigated, but not interactions between organisms and their environment.) To more fully comprehend the interactions observed in their community study, abiotic (nonliving) factors must be considered. Review, as needed, examples of abiotic factors.

Introduce the term ecosystem: a community of plants and animals interacting with each other and with their nonliving environment.

Compare and contrast communities with ecosystems. Emphasize that the remainder of the course will focus on the ecosystem concept: living organisms interacting with each other and with their nonliving environment.

2) Show the video about the Amboseli National Park ecosystem in Kenya (11 minutes). After the video, discuss (9 minutes) how abiotic factors impact the ecosystem. How do various human activities (Maasai tribe, tourists, poachers, park managers) impact the ecosystem?

3) Biomes (25 minutes):
   a) Define biome as a large, extensive ecosystem.
   b) Identify six terrestrial biomes (arctic tundra, coniferous forest, deciduous forest, tropical forest, grassland, desert) and one aquatic biome (ocean).
   c) Divide students into small groups of 3-4. Refer them to the information on biomes in Miller's text pp. 74-76. Have each group research and
present to the class information on one biome, including at least:
* one characteristic plant;
* one characteristic animal (if possible: Miller's text is slim on animals); and
* one characteristic physical or climatic condition.
(Drawings, skits, poems, short interviews, or other types of presentations could be made.)

* Note to Instructor: In the Miller text, the arctic tundra biome is referred to as the "polar grassland". Although grasslands and deserts can be further subdivided by type (page 75, Miller text), for NR 412/612 use the six biome categories listed above.

d) Students should determine which biomes are found in Wisconsin. (The three biomes in Wisconsin are the coniferous forest, deciduous forest, and grasslands).

4) Using either Option A or Option B, students construct an ecosystem (60 minutes):

a) Option A: Construction of Bottle Biology Eco-Columns. A prepared Eco-Column made by the instructor would be helpful to introduce this part of the Lesson. Then, following the instructional materials from Bottle Biology (BR pp. 53-58), each student is to design and construct an Eco-Column. During the remainder of the course, students should observe the interactions between the living and nonliving components in their Eco-Column.

* Note to Instructor: Advance preparations by the student (designing the Eco-Column and gathering materials) are needed before Lesson Three. Also, you may choose to have students collect during the community study in Lesson Two for the Eco-Column or the terrarium (topsoil, water, dragonfly naiads, mosquito larvae, aquatic plants, spiders, minnows, small frogs).

b) Option B: Construction of a Terrarium. Construct a terrarium as a group project. Refer to the instructional materials (BR pp. 59-61) as needed. Ideally, the terrarium would remain in
the classroom for the duration of this course for observation, questions, and trouble-shooting.

**Extensions:** Try some of the interesting *Bottle Biology* "Explorations" (BR page 58). Also, have students report informally on developments in their Eco-Columns. If a terrarium is constructed, encourage student reports of interactions observed. (This might be a nice "opener" to a class session.)

**Evaluation:** Have students provide a rationale for the ratio of biotic/abiotic components in the constructed ecosystem.

**Ecosystem Investigation Task:** Lesson Three

1) Choose a comfortable site at the ecosystem and try to sit still for 15 minutes (on a log, on your back, against a tree). Experience the nonliving (abiotic) factors which influence the ecosystem.

2) Describe evidence of at least three abiotic factors which you observed or experienced that are at work in the ecosystem.
Lesson Four:
It All Starts With Sunshine... (ENERGY)

Objectives: Students will relate the human factor to ecosystems and be able to:

1) identify the sun as the source of all energy on earth, and how humans are dependent on this source.

2) describe photosynthesis as the process in which plants transform carbon dioxide and water by means of sunlight and chlorophyll into glucose and oxygen, and how humans are dependent on this process.

3) describe respiration as the process in which plants and animals derive usable energy from glucose by combining it with oxygen, and breaking these molecules down into carbon dioxide and water; further, describe how humans are dependent on this process.

4) state the First Law of Energy (energy can neither be created nor destroyed, only transformed from one form to another), and explain at least one ecosystem and one human implication.

5) state the Second Law of Energy (each time energy is converted to work, some of the energy is always degraded to a lower-quality, more-dispersed, less useful form of energy), and explain at least one ecosystem and one human implication.

6) diagram a food web involving humans, comprised of at least three food chains, and label each component as producer, consumer (primary, secondary, or tertiary), or decomposer.

7) identify all the organisms of any given food web which are at the same trophic level (first, second, third, fourth, fifth).

8) trace the amount of high-quality, usable energy transferred from the first trophic level through each succeeding trophic level of an energy pyramid, and correlate this to:
   a) the First and Second Laws of Energy; and
   b) the biomass of organisms present at each trophic level in a pyramid of numbers.
considering world hunger, provide a rationale from an energy standpoint for a shortened food chain in the human diet.

**Method:** Students learn about the principles of photosynthesis, respiration, and energy transfer in ecosystems. They illustrate concepts in an energy pyramid simulation, and conduct further study utilizing one of three options.

**Instructional Time:** 2 hours

**Readings:**

1. "Photosynthesis and Respiration" (BR pg. 62)
2. "First and Second Laws of Energy" (BR pg. 63)
3. "Energy Flow Chart" (BR pg. 64)
4. "Grazer Food Chains" (BR pg. 65)
5. "Individual Food Chains" (BR pg. 66)
6. "Pyramid of Energy" (BR pg. 67)
7. "Earth Day Diet" (BR pg. 68)
8. "In My Opinion: Agriculture and the Environment" (BR pg. 69)
9. Miller text pp. 38-41; 57; 61-67

**Background:** "Earth's energy? Why, from the sun of course!" Most people could tell you where energy originates; however, the processes which transform sunlight to usable energy for life on earth are not always clearly understood. Therefore, we will begin at the beginning, tracing energy pathways and examining laws which regulate energy transfer.

All of earth's energy comes to us in the form of sunlight. Plants utilize this solar energy to transform carbon dioxide and water into glucose and oxygen through the process of photosynthesis. Plants and animals then are able to use this stored chemical energy by combining food molecules such as glucose with oxygen ("burning calories"). This process is called respiration: its by-products are carbon dioxide and water.
Because plants contain chlorophyll, they are able to photosynthesize using solar energy and produce stored chemical energy: plants are therefore called **producers**. Animals are unable to gain energy directly from the sun, but must consume plants (or other animals which have consumed plants) to obtain energy: animals are therefore called **consumers**. Some organisms obtain their energy from breaking down dead plants and animals: these organisms are called **decomposers**. Producers, consumers, and decomposers are interconnected by **food chains** and **food webs** to utilize the sun’s energy. All organisms which share the same category of food in a food chain are said to be at the same **trophic level**. Plants are at the first trophic level; animals which eat plants are at the second trophic level; animals which eat other plant-eating animals are at the third trophic level, and so forth. Usually there are no more than five or six trophic levels in a food chain due to the relative inefficiency of energy transfer.

Two laws of energy govern its flow: the **First and Second Laws of Energy** (or the First and Second Laws of Thermodynamics, if you prefer). The First Law of Energy can be paraphrased "you can't get something for nothing". It states that energy can neither be created nor destroyed, but only transformed from one form to another.

Because of this, the First Law is often called the Law of Conservation of Energy. Energy which travels from the sun to earth (sunlight) is transformed to chemical energy (glucose and other high-energy molecules) through photosynthesis; this stored chemical energy is utilized through respiration and released as usable energy (heat) needed for an organism’s life functions; the heat is then radiated into space. The total amount of energy in the universe is constant; energy has not been created or destroyed, but has passed through the earth’s system in various forms (sunlight, glucose, and heat).

The Second Law of Energy can be paraphrased "you can’t break even". According to the Second Law, each time energy is converted to work, some of the energy is always degraded to a lower-quality, more-dispersed, less useful form. Although the amount of energy is constant (the First Law), the quality of that energy is being depleted (the Second Law). Energy transfer is not a highly efficient process; therefore, whenever high-quality energy is used it is not possible to "break even" and obtain a high-quality energy output. Instead, a lower-quality form of energy results. Energy transfer at each trophic level in a food chain exemplifies this. At each transfer, work is done, heat is released to the environment, and the amount of high-quality energy available to organisms at the next trophic level is reduced. Only about 10% of the high-quality chemical energy available at one trophic level is transferred.
to the next trophic level, with the remaining 90% being released as heat into the environment. An energy pyramid graphically depicts the degradation of high-quality to low-quality energy as it moves through a food chain. The pyramid of numbers shows that the number of organisms which can be supported at higher trophic levels is only a small percentage of those at lower trophic levels. Considering these energy "taxes" and world hunger, we would do well to reconsider shortening the length of the food chain in the human diet.

The major goal of Lesson Four is for students to understand the role of energy in an ecosystem, the two laws which govern its flow, and the ecological implications as energy is transferred and used.

**Materials:**


2) 25 cups with holes; one bucket of water

3) optional:
   a) For "Energy Flow in a Wetland": game board, energy loss charts, dice, scratch paper or calculators.
   b) For "Making A Place For Wildlife": butcher paper, markers, and tape.

**Procedure:**

1) Introduction (10 minutes): ask students where the energy they used today (food, gasoline for auto, heat, electricity, and more) came from. Trace their answers back to the sun. Can the sun be generalized as the source of energy for all forms of life on earth? Where does the energy go after we’re through with it? (It is radiated into space as heat.) Announce that this Lesson will focus on energy and the principles that govern its flow through ecosystems.

2) Photosynthesis (10 minutes): introduce photosynthesis as the LINK between the sun and the earth’s food/energy/life system using the overhead transparency provided.
a) All of earth’s energy comes to us in the form of sunlight.

b) Chlorophyll utilizes this light as energy to make glucose from carbon dioxide and water. Oxygen is also produced in the process. Plants are called producers because of their ability to transform solar energy into chemical energy (glucose). Explain the chemical formula for photosynthesis:

\[
\text{PHOTOSYNTHE\$IS:} \\
\text{light energy} \\
6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \\
\text{chlorophyll}
\]

c) Explaining the etymology of the term might be useful: photo is derived from a Greek word meaning "light", and synthesis from another Greek word meaning "to put together".

3) Respiration (10 minutes): ask students "What does the plant do with the glucose which it has just synthesized?" Plants utilize glucose in two ways:

* The plant stores some as chemical energy in the form of organic matter (plant tissue).
* The plant uses some for growth, reproduction, and other life functions. The process of deriving energy from glucose is called respiration.

a) Explain that the process of respiration is essentially the reverse of photosynthesis. Glucose is combined with oxygen (the "burning of calories") to release energy for the organism: by-products are carbon dioxide and water.

\[
\text{RESPIRA\$ION:} \\
\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}
\]
b) Discuss how animals must obtain their energy needs from plants through the process of respiration. By consuming the stored chemical energy (C\(_6\)H\(_{12}\)O\(_6\)) found in plant tissue and combining it with oxygen, energy is produced for the animal's life functions. Because animals are not able to obtain their energy needs directly from the sun but must obtain them from consuming plants they are called consumers. (And of course, some animals eat other animals to obtain energy; although indirectly, the C\(_6\)H\(_{12}\)O\(_6\) obtained was still produced by plants. Decomposers also utilize the C\(_6\)H\(_{12}\)O\(_6\) produced initially by plants when degrading waste and dead organisms.)

c) Trace the cycles of CO\(_2\) and O\(_2\) through photosynthesis and respiration: the products of photosynthesis are the essential components of respiration, and vice versa.

* Note to Instructor: Although C\(_6\)H\(_{12}\)O\(_6\) is actually a carbohydrate occurring in several forms, it is referred to as glucose (a familiar example of a carbohydrate) to simplify the discussion.

4) The First Law of Energy (5 minutes):

   a) Review the transformations of energy: solar energy (sunlight) to chemical energy (glucose) to heat (which is radiated into space). You might diagram this:

   b) Introduce the First Law of Energy (or Thermodynamics). An overhead transparency is provided.

   THE FIRST LAW OF ENERGY:

   *Energy can neither be created nor destroyed, only transformed from one form to another.*
Use the review of energy transformations to illustrate this. Stress that the total amount of energy in the universe is constant; energy has not been created nor destroyed, but has passed through the earth's system in various forms (sunlight, glucose, and heat). This is a good opportunity to explain why photosynthesis and respiration equations are "balanced" (i.e., the number of carbon atoms \([6]\) is the same on both sides of the equation, as well as hydrogen atoms \([12]\) and oxygen atoms \([18]\)).

c) Ask students if they can explain why the First Law of Energy is sometimes called the Law of Conservation of Energy and can be paraphrased "you can't get something for nothing".

5) The Second Law of Energy (5 minutes):

a) According to the First Law of Energy, we will never run out of energy because energy can neither be created nor destroyed. How can it be that the world is experiencing an "energy crisis"? Have students offer explanations which account for the First Law of Energy. (The amount of energy is constant but energy occurs in different forms, some more useful than others.) Use this as a lead-in to the Second Law of Energy (or Thermodynamics). An overhead transparency is provided.

THE SECOND LAW OF ENERGY:

*Each time energy is converted to work, some of the energy is always degraded to a lower-quality, more-dispersed, less useful form.*

Although the amount of energy is constant (the First Law), the quality of that energy is being depleted (the Second Law).

b) Generate a list of examples of high-quality energy (electricity, gasoline, coal, oil, sunlight, wind, Uranium-235). Generate a list of examples of low-quality energy (primarily low temperature heat... not much of a list!) Illustrate the Second Law of Energy, perhaps by reading Miller's quote in the box found earlier in this Lesson.
The earth's vegetation is part of a web of life in which there are intimate and essential relations between plants and the earth, between plants and other plants, and between plants and animals. Sometimes we have no choice but to disturb these relationships, but we should do so thoughtfully, with full awareness that what we do may have consequences remote in time and place.

Rachel Carson
Silent Spring

6) Demonstrate the flow of energy through an ecosystem using the activity, "Sun's Bucket Brigade" (25 minutes), developed and contributed by Suzanne Wade from Riveredge Nature Center. Water will spill, so travel to an outside area for this activity!

a) Divide the students into the following trophic levels of appropriate size (numbers given are for a group of 25 students; adjust as necessary):

- producers (11)
- herbivores (7)
- first level carnivores (3)
- decomposers (3)
- top level carnivore (1)

b) Arrange the students in lines to form a pyramid, with the producers on the bottom, then the herbivores and two decomposers, then the first level carnivores and one decomposer, and finally the top level carnivore:

```
Top
CCCD
DHHHHHHHH
PPPPPPPPPPP
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c) Hand out cups which have six or more holes punched in the sides and bottom, except for the top carnivore's cup which has only one hole. The "sun" rises (YOU!) and pours its "energy" (5 quart pail of water) in a line along the producers' cups with much of it pouring out between plants. The plants pour their "energy" into the herbivores' cups who in turn pour their "energy" into the first level carnivores' cups who then pour their "energy" into the top carnivore's cup. (Decomposers are involved as well.) Because of the holes, very little of the "energy" gets to the top carnivore. You might choose to repeat the
activity more than once to see if the results differ significantly.

d) Have students describe in what ways the demonstration illustrates the First and Second Laws of Energy. (The quantity of water remained the same [First Law], but the quality of the water was degraded and made less useful [Second Law] since most spilled on the ground as "heat"). Discuss the numbers of producers in an ecosystem relative to the number of herbivores, first level carnivores, second level carnivores, and top carnivores. Use this as a "lead in" to the topic of trophic levels and the shape of a biomass pyramid.

7) Energy Transfer in Ecosystems (15 minutes):

a) Explain to students that the First and Second Laws of Energy have important implications to ecosystems. Energy transfers occur at each link in a food chain. (An overhead transparency of grazer food chains is provided.) Review the energy transfers from sun to producer to first consumer to second consumer to third consumer. Introduce the concept of trophic level: all organisms which share the same category of food in a food chain are said to be at the same trophic level. Identify the various trophic levels in the individual food chain of the grizzly bear. (An overhead transparency is provided.) At each trophic level:

* energy is transferred;
* work is done;
* heat is released to the environment; and
* the amount of high-quality energy available to organisms at the next trophic level is reduced.

b) Only about 10% of the high-quality chemical energy available at one trophic level is transferred to the next trophic level, with the remaining 90% being released as heat into the environment. Using the pyramid of energy overhead transparency, trace the 10,000 parts of usable energy through the energy pyramid. How much heat energy is released into the environment at each trophic level? (90%) Correlate this to the decreasing biomass of organisms present at each succeeding level in the pyramid.

All are needed by each one,
Nothing is fair or good alone.

Wordsworth
8) Food Webs and Energy Transfer (40 minutes): select from the following activities based on student background and experience to complete Lesson Four. Offer one, two, or all three options to students for their participation.

a) Intermediate/Advanced: "Food Chain in a Wetland" (from the National Science Teachers' Association, 1983). Game rules are included in Appendix D, pg. 94, for instructor reference. Students move "up" through a wetland food chain on a playing board by rolling a die. Calories are surrendered along the way! (very good for math buffs)

b) Intermediate/Advanced: "Making A Place For Wildlife" (from The CLASS Project, National Wildlife Federation, 1982). The activity is included in Appendix E, pp. 95-98, for instructor reference. Small groups of students (3-4) are given information on ten animals, for whom they design a suitable habitat. Students also construct food pyramids and food webs for the ten animals (raccoon, mayfly, carpenter ant, trout, cougar, flying squirrel, white-tailed deer, bald eagle, and pileated woodpecker).

* Note to Instructor: The topics of limiting factors and carrying capacity are introduced later this course; "Making A Place For Wildlife" addresses these topics briefly. Concentrate on energy, habitat, food pyramids, and food webs in this activity; wait till later in the course to introduce limiting factors and carrying capacity.

c) Advanced: "Energy, Food Chains, and the Human Diet." Using the background readings listed in the Evaluation section (below), structure a modified debate. Students read and discuss the pro and con positions presented in light of the ecological principles learned in Lesson Four.

* Note to Instructor: Ask students to bring a copy of Sand County Almanac to Lesson Five (to trace "the path of X").

Extensions: Utilize other options in step 8 of the Procedure (above) for additional study.
Evaluation: Have each student provide a rationale from an energy standpoint for a shortened food chain in the human diet. You might introduce this by asking, "What would be more efficient from an energy standpoint, to use a 100 acre field to grow grains for human consumption, or to feed the grains to cattle and then to eat the cattle?" This topic needs to be handled carefully and sensitively; however, ecological implications for the human diet learned in Lesson Four should not be overlooked. Readings from EE News serve as references for this task:

1) "Earth Day Diet" (pro-low food chain); and
2) "In My Opinion: Agriculture and the Environment" (pro-beef).

These articles are found in the Book of Readings (BR pp. 68-69).

Ecosystem Investigation Task: Lesson Four

1) Observe the variety of producers, consumers, and decomposers in the ecosystem which you are investigating. Diagram in your notebook a pyramid of energy which could be found in the ecosystem. (The pyramid of energy found in the Book of Readings [BR pg. 67] can serve as a model). Describe the organisms at each level of the pyramid. Focus on whether the organism is a producer, primary consumer, secondary consumer, or higher level consumer. The name of the organism is not necessary; a general description (an evergreen tree with needles about 3" long) and/or a quick sketch is sufficient.

2) In one paragraph, explain from an energy standpoint why there is decrease in biomass (amount of each organism by mass) at each succeeding level of the energy pyramid.

Water, soil, and the earth's green mantle of plants make up the world that supports the annual life of the earth. Although modern man seldom remembers the fact, he could not exist without the plants that harness the sun's energy and manufacture the basic foodstuffs he depends on for life. Our attitude toward plants is a singularly narrow one. If we see any immediate utility in a plant we foster it. If for any reason we find its presence undesirable, we may condemn it to destruction forthwith.

Rachel Carson
Silent Spring
Lesson Five:
What Goes Around Comes Around (Cycles)

Objectives: Students will relate the human factor to ecosystems and be able to:

1) diagram the quantity of earth's water found in:
   a) oceans;
   b) polar ice caps;
   c) lakes, rivers, and streams;
   d) atmosphere;
   e) groundwater; and explain how humans are dependent on these water resources.

2) diagram the water cycle labeling evaporation, transpiration, condensation, precipitation, infiltration, groundwater, and runoff; indicate how humans are dependent on these processes.

3) analyze how human intervention in the water cycle can decrease both the quality and quantity of available water through excessive water use and the influx of pollutants.

4) trace the cycles of carbon and oxygen through the processes of photosynthesis and respiration (objectives 5,6), and explain how humans are dependent on these processes.

5) analyze how human intervention in the carbon and oxygen cycles can increase the amount of carbon dioxide in the atmosphere through deforestation and the burning of fossil fuels, and state at least one human action which could reduce this buildup.

6) provide at least two examples of matter cycles (e.g., nitrogen and phosphorus), and explain how humans are dependent on these processes.

Method: Students study five cycles (water, carbon, oxygen, nitrogen, phosphorus), utilize groundwater and greenhouse effect models, and draw "the path of X" from Sand County Almanac. Assignment #2 given.

Instructional Time: 2 hours
**Readings:**

1) "Water: a drop of life" (BR pp.70-71)

2) "Does Your Cup of Coffee Cause Forest Fires?" (BR pp. 72-76)

3) "The Two Ozones: Up There vs. Down Here" (BR pg. 77)

4) "Where's The Water?" (BR pg. 78)

5) "Wisconsin's Water Cycle" (BR pg. 79)

6) "Carbon Cycle" (BR pg. 80)

7) "Nitrogen Cycle" (BR pg. 81)

8) "Phosphorus Cycle" (BR pg. 82)

9) Miller text pp. 55-61

**Background:** Water and nutrients pass through ecosystems in a cyclical manner, unlike energy which travels the path of a straight line without a return trip. In this Lesson five different cycles are examined: water, carbon, oxygen, nitrogen, and phosphorus. While understanding each cycle's basic pathway is important, emphasis is given to the impact of human intervention on each cycle.

The water cycle is probably the most familiar cycle, and usually there is little difficulty involved in identifying evaporation, transpiration, condensation, precipitation, infiltration, groundwater, and runoff. Although water cycles and can therefore appear "limitless", the quantity of water available for human use is actually very limited. Humans have a vast responsibility to protect and conserve both the quality and the quantity of water for all forms of life on the planet.

The processes of photosynthesis and respiration demonstrate the interconnection between the carbon and oxygen cycles. Plants (utilizing CO₂ and generating O₂) and animals (utilizing O₂ and generating CO₂) are integral parts of both cycles. Deforestation and the burning of fossil fuels can impact the delicate atmospheric balance of carbon and oxygen. These activities can increase carbon dioxide levels in the atmosphere and produce a phenomenon known as the greenhouse effect. Carbon dioxide and other air pollutants (e.g., methane, nitrous oxides, chlorofluorocarbons, lower atmosphere ozone) act much like the panes of glass in a greenhouse, allowing...
sunlight to pass through the atmosphere but trapping the radiated heat within. Scientific models predict that the greenhouse effect could raise the earth's surface temperatures up to seven degrees Fahrenheit.

Ozone (O$_3$) is an oxygen compound occurring in the atmosphere. In the upper atmosphere (10-35 miles above the earth), ozone forms a valuable protective layer which filters out 99% of the sun's ultraviolet radiation. Chlorofluorocarbons (CFCs) deplete the protective layer by transforming ozone molecules (O$_3$) to oxygen molecules (O$_2$). CFCs are used in refrigerants, propellants, and some foam products. Ozone in the lower atmosphere (0-1 miles above the earth) is a dangerous air pollutant. Plant and animal tissues are especially susceptible to lower ozone damage. Lower atmosphere ozone is produced when sunlight strikes air pollutants (primarily hydrocarbons and nitrogen oxides) and a chemical change results. (This information is taken from "The Two Ozones: Up There vs. Down Here" [BR pg. 77]. This reading accompanies Lesson Five and describes the differences quite extensively.)

The nutrient cycles of nitrogen and phosphorus show the conversion of non-useable forms of the elements into usable forms and their return to the cycle. These two cycles are susceptible to disruption through human activities such as burning of fossil fuels, sewage treatment discharge, and use of commercial fertilizers and detergents.

The major purpose of Lesson Five is for students to develop a basic understanding of five cycles (water, carbon, oxygen, nitrogen, and phosphorus) and the impact which human intervention can cause to each one.

**Materials:**

1) overhead transparencies (5) of Where's The Water?, Wisconsin's Water Cycle, Carbon Cycle, Nitrogen Cycle, Phosphorus Cycle; also Photosynthesis and Respiration overheads (2) from Lesson Four

2) water cycle: glass of water, globe or world map, one full gallon jug of water, one empty gallon jug, five petri dishes or small jars, eyedropper, measuring cup, food coloring (optional), Wisconsin DNR Water Cycle poster

3) groundwater model materials (instructor choice)

4) greenhouse effect: aquarium with 2" of sand or soil, cardboard, thermometer, lamp, glass lid for aquarium
5) nitrogen and phosphorus cycles: markers or crayons, drawing paper, one *Sand County Almanac* (pp. 111-114) per pair of students

**Procedure:**

1) Introduce *(5 minutes)* the topic of cycles by contrasting it with energy, which travels through an ecosystem in a straight line with no return trip. Identify the five cycles which will be investigated in the Lesson (water, carbon, oxygen, nitrogen, phosphorus). Emphasize that energy drives these cycles.

2) Water Cycle:

   a) Demonstrate the amount of water found on earth by using one gallon of water in a milk jug *(10 minutes)*:

   Tell students that the gallon of water (16 cups) represents all the water on earth. (You can dramatically "squeeze" the globe to "fill" the gallon jug!) For better visibility, the water can be tinted appropriately. Pour 15 ½ cups of the original gallon of water into another gallon jug to represent the amount of water found...WHERE? (Hopefully, most students will be able to hypothesize that the 15 ½ cups represents the amount of water found in the oceans. To stimulate the thinking process, you might have one student drink a glass of water: then ask the class "Where was the water yesterday? Where will it be tomorrow? Next week?")

   Students should also attempt to predict the following five sources of water and the relative amounts of water found in each. From the remaining ½ cup of water in the original gallon, remove the following amounts to petri dishes, clear cups or jars:

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>icecaps and glaciers</td>
<td>16 ½ drops</td>
</tr>
<tr>
<td>groundwater</td>
<td>5 drops</td>
</tr>
<tr>
<td>freshwater lakes</td>
<td>1 ½ drops</td>
</tr>
<tr>
<td>atmosphere</td>
<td>1 drop</td>
</tr>
</tbody>
</table>
   | rivers           | "part of a drop"

(adapted from "What The Dinosaurs Drank", in *Water We Doing With Water?*, UWSP Extension, 1991)
b) Summarize students’ hypotheses and the demonstration with this table, provided on an overhead transparency (5 minutes):

WHERE'S THE WATER?

1) oceans 97.2%
2) icecaps and glaciers 2.0%
3) groundwater 0.62%
4) atmosphere 0.001%
5) freshwater lakes 0.0009%
6) rivers 0.0001%

TOTAL = 99.822%

Students should predict what percentage of the water on earth is available for direct human use such as drinking, cooking, irrigation, bathing, and other uses. (Less than 1%; over 99% of the earth’s water is unavailable for human use, although it certainly has great value besides being of direct usefulness to humans.)

Using the "Where’s The Water?” table, students should identify the largest source of available water for human use as groundwater. Lakes, rivers, and the atmosphere also provide usable water for human consumption.

Emphasize that although water is a renewable resource, the amount available for human use is very limited. Humans have an important responsibility to protect the quality and quantity of water for all forms of life.

c) Guided imagery (5 minutes) "Alice in Waterland" (from Project WILD Aquatic, Western Regional Environmental Education Council, 1987) Ask students to sit quietly, close their eyes, and imagine that they are able to shrink down to a size that would let them travel up though their faucet and into their water pipes to explore the world of water used by humans. Ask students to visualize in their minds what you will describe to them in the following words:

"Imagine that you are small enough to climb into the faucet in your kitchen... Pretend you have magic powers that allow you to travel through the water that comes from the faucet to its origins... You will be able to pass through all the pipes, valves, and other barriers along the way... The first part of the journey takes you through..."
the pipes in your house to where it connects to your water source... If you live on a farm or ranch the source would probably be a well or perhaps a spring. In the city, the water source for your home would probably be far away...

First you get into a water main... Then you come to a pumping plant where water pressure is maintained... Past the pumping plant is a place where the water is purified... This may be very complex --- a place with filters, chemical tanks, and treatment equipment... Beyond the purification plant, the water may be in an aqueduct or open channels coming from a reservoir... The reservoir is a huge lake where water is stored... There are often trees and bushes on its edges... Wildlife is common, fish are usually abundant, and people often use the site for recreation... Natural streams usually flow into the reservoir... They drain large areas of the land's surface which are called watersheds... A watershed is the land area that catches and transports water through streams, underground flow, and rivers... The water in a watershed contains all the water that is naturally available for use by all living things in that area... If you want, stay in the watershed. Try to see the plants and animals that live in the area. Or, follow your route all the way back through the reservoir and channels and treatment plant and pumping plant to the water main and the pipes in from your house and out your faucet. Then, open your eyes."

d) Using the overhead transparency from Miller's text (page 61) and/or the Wisconsin DNR poster "Groundwater and Land Use in the Water Cycle", review the processes of the water cycle (10 minutes):

1. evaporation
2. transpiration
3. condensation
4. precipitation
5. infiltration
6. groundwater
7. runoff

"Wisconsin's Water Cycle" is provided on an overhead transparency, summarizing annual average amounts:

Average precipitation: 32.0 inches/year
Average runoff: 3.0 inches/year
Evaporation and transpiration: 22.0 inches/year
Becomes groundwater: 7.0 inches/year

e) Demonstrate the flow of groundwater using a groundwater model (15 minutes). Discuss:

* how excessive water demands deplete groundwater supplies; and

* how the influx of pollutants impacts water quantity and quality.

* Note to Instructor: Preparation of the groundwater model needs to be done before the lesson. The groundwater model developed by the University of Wisconsin is an effective method for demonstrating groundwater flow. If the district in which you are teaching this course has access to this groundwater model, use the district's model for this lesson. If the district does not have access, then you are asked to demonstrate one of the three simpler groundwater models (information is included in appendices F, G, and H on their assembly and use.) The rationale for this request is that the groundwater model demonstrated in your NR 412/612 course should definitely be one which can be easily reproduced by the students for their own classroom use.

Three simple groundwater models which could be used are:

1. "There is No Away" (from Living Lightly On The Planet, Vol. I), Appendix F, pp. 99-102;

2. "A Water Quality Weekend" (4-H Extension, Delaware), Appendix G, pg. 103; or


3) Carbon and Oxygen Cycles:

a) Review (2 minutes) the processes of photosynthesis and respiration using overhead transparencies from the previous lesson:

Highlight the interrelationship between:

* plant uptake of CO₂ in photosynthesis and the release of O₂ and
animal (and plant!) uptake of O₂ in respiration and the release of CO₂.

**PHOTOSYNTHESIS:**

\[
\text{light energy} \quad 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{chlorophyll} \quad 6\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

**RESPIRATION:**

\[
\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}
\]

b) Discuss the major aspects of the carbon and oxygen cycles (8 minutes). An overhead transparency of the carbon cycle is provided. Some questions which might aid in discussion follow.

"Why is carbon an important element to consider?" (It is a basic building block for all life, found in sugars, carbohydrates, fats, proteins, and genetic molecules such as DNA.)

"Where do plants get their carbon (in the form of CO₂)?" (absorbed from the atmosphere through leaves)

Through photosynthesis, CO₂ is combined with H₂O to form glucose (C₆H₁₂O₆) and oxygen gas. The plants then convert glucose into plant tissue for storage.

"Where do animals get their carbon?" (from eating plants)

"When plants and animals derive energy from the carbon-containing glucose through respiration, what results?" (CO₂ and H₂O) This carbon, in the form of CO₂, returns to the atmosphere.

"What happens to plants and animals when they die, particularly their carbon-containing tissues?"
Decomposers also respire, releasing CO₂ into the atmosphere. Sometimes decay is very slow, and carbon compounds become tied up over thousands of years in fossil fuels.

"What is released to the atmosphere when fossil fuels are burned?" (CO₂) An increase in carbon dioxide levels in the atmosphere can produce a phenomenon known as the greenhouse effect. "In addition to the burning of fossil fuels, what else contributes to increased atmospheric CO₂?" (primarily deforestation)

c) Demonstrate the greenhouse effect (20 minutes).

This is an excellent opportunity for using the scientific method. One strategy is "PHEOC": Problem; Hypothesis; Experiment; Observation; Conclusion. In the following demonstration, students should predict what will happen and why.

Place in a glass aquarium a layer of sand or soil an inch or two deep. Dampen the sand or soil using a spray bottle. Using a piece of cardboard, make a support for a thermometer to be placed upright in the aquarium. (These three steps can be done by the instructor ahead of time.) Have a student read the thermometer to obtain room temperature. Now cover the aquarium with a glass lid. Mount a lamp directly above the aquarium (within 12" of the top) so that the light shines directly on the thermometer bulb. Have students made their predictions yet of what will happen and why? (They should have.) Have a student, or team of students, record the temperature of the thermometer every two minutes for 20 minutes. Remove the glass lid and continue to record the temperature for another 10 minutes. Proceed with the Lesson as temperature readings are being taken. (adapted from Environmental Science Laboratory Manual, Harley and Nebel, 1990.)

d) As temperature changes in the aquarium are read and recorded, have students share their predictions. Probably many students will be able to predict "what will happen" (the temperature inside the aquarium will rise); can students predict "why?" Allow for student predictions and discussion on this important
aspect of the experiment. Some questions which might aid in discussion follow.

"How do CO₂ and other greenhouse gases act like the glass cover on the aquarium?" (Carbon dioxide and other air pollutants [e.g., methane, nitrous oxides, chlorofluorocarbons, lower atmosphere ozone] act much like the panes of glass in a greenhouse, allowing sunlight to pass through the atmosphere but trapping the radiated heat within.)

"What important function do normal amounts of atmospheric CO₂ and other greenhouse gases provide?" (They warm the earth’s lower atmosphere; without this, the earth would be a cold and lifeless planet with an atmospheric temperature of zero degrees Fahrenheit.)

"What is the danger of increased atmospheric CO₂?" (Buildup of the greenhouse gases, especially CO₂, trap even more heat and contribute to global warming. Since preindustrial 1860 to 1986, levels of CO₂ have risen 26% [275 ppm to 346 ppm].)

"To what can this rise in CO₂ be attributed?" (burning of fossil fuels; deforestation, especially in the tropics, significantly reduces the number of trees removing CO₂ during photosynthesis)

"What might be some climatic effects if the latest climate models are accurate, which predict a seven degree Fahrenheit rise of the earth’s surface temperature in the 21st century?" (coastal flooding; decreased precipitation in some areas causing drought and desertification; increased precipitation in some areas causing erosion and flooding; widespread loss of marine life)

"What actions can you take to reduce CO₂ buildup?" (Motor vehicles and power plants account for 75% of CO₂ emissions in industrialized nations. Drive my car less; instead, carpool, use mass transit, or bicycle. Install efficient furnaces, water heaters, fluorescent light bulbs. Conserve energy. Plant trees. Be a wise consumer: don’t buy products made from tropical rainforest wood.)

And here, too, one learns that the world, though made, is yet being made; that this is still the morning of creation.

John Muir
(in Alaska)
4) Nitrogen and Phosphorus Cycles (10 minutes)

a) Using the overhead transparency provided, briefly outline the steps of the nitrogen cycle, a gaseous nutrient cycle:

All life forms need nitrogen to make proteins. The major reservoir of nitrogen is the atmosphere. Nitrogen enters the soil from the air through a complex process called "fixation." Plant roots take up nitrogen from the soil; animals obtain nitrogen from consuming plants. Nitrogen is returned to the soil when animals give off waste or when plants and animals die. Decomposers break down nitrogen-containing waste and return most of it to the atmosphere, continuing the cycle.

b) Using the overhead transparency provided, briefly outline the steps of the phosphorus cycle, a sedimentary nutrient cycle:

Phosphorus is essential to all life. It is necessary for bones and teeth, genetic material (DNA, RNA), and energy molecules (ATP, ADP). The primary reservoir of phosphorus is sedimentary rock. Through weathering, phosphorus is released and taken up by plant roots. Animals obtain phosphorus from consuming plants. Phosphorus is returned to the soil when animals give off waste or when plants and animals die. Decomposers break down the waste releasing the phosphorus to the soil; it is eventually formed once again into sedimentary rock, continuing the cycle.

5) Sand County Almanac and "The Odyssey of X" (20 minutes).

Begin by having students read individually and silently pp. 111-114 in Sand County Almanac. Then, have students work in pairs (one reading aloud, the other drawing) to trace the path of "X", an atom of nitrogen, as described by Aldo Leopold. (This activity was developed by Dean Sauers. He recommends asking the pair which one is the better artist... then assigning the other person to do the drawing! Thank you, Dean, for contributing this activity!)

6) Explain Assignment #2 in the evaluation section (10 minutes).
Extensions:

1) Study trees (or houseplants in winter) to observe transpiration. Students fasten a clear sandwich bag securely around a leaf or several leaves and tape the baggie securely shut at the bottom. (Putting a small stone in the baggie helps the water stay in the bottom of the baggie rather than running out the taped end.) Compare rates of transpiration on sunny and cloudy days. Do evergreen needles transpire? (For further information, see "Nature’s Air Conditioners", Project Learning Tree Secondary, pg. 17 (American Forest Institute and Western Regional Environmental Education Council, 1977).

2) Have students continue in Sand County Almanac (Procedure, step 6 above) tracing the path of Y (pp. 114-115). Switch roles, so that the reader draws and the artist reads. Compare the difference between the paths of X and Y.

Evaluation: Assignment #2:

In a 3-5 page paper the student will:

Part I:

1) briefly describe a current environmental problem (5 points);

2) identify at least three ecological principles that relate to the solution or prevention of the problem, and describe the relationship (20 points).

Part II:

1) identify at least three ecological principles and describe how these can be used to guide individuals in developing ecologically sound lifestyles (25 points).

Grading:

Assignment #2 is worth 50 points. Points will be assigned based on:

a) evidence of thoughtful preparation and clarity of expression;

b) completion of a written analysis consisting of 3-5 typewritten, double-spaced pages; and

c) inclusion of a bibliography citing at least three references.
Due Date:
To be determined by the course instructor.

Late Assignments:
An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.

GRADUATE INCREMENT:
All students enrolled in NR 612 (graduate credit) should describe TWO environmental problems and three related ecological principles for each problem in Part I above. All other criteria for the assignment remain the same.

Ecosystem Investigation Task: Lesson Five

1) Observe cycles (water, carbon, oxygen, nitrogen, phosphorus) in the ecosystem which you are investigating. Choose one cycle and describe its importance to the ecosystem in your notebook.
Lesson Six:
The Process and Pattern of Change
(Succession and Natural Selection)

Objectives: Students will relate the human factor to ecosystems and be able to:

1) explain that succession is a process in which ecosystems change over time, usually becoming more complex.

2) state that fluctuation, not equilibrium, is the natural condition of ecosystems; further, identify at least three natural and/or human disturbances which cause fluctuation.

3) through direct investigation of an ecosystem, describe the process of succession by citing evidence of disturbance and change in the ecosystem.

4) explain the process of natural selection by describing two organisms and their special genetic features (adaptations) that best suit their living conditions and are passed on to their offspring.

Method: Students conduct a succession field study, learn about natural selection through a game, and identify adaptations of various organisms.

Instructional Time: 2 hours

Readings:

1) "New Eye on Nature: The Real Constant Is Eternal Turmoil" (BR pp. 83-86)

2) "The Man Who Planted Hope and Grew Happiness" (BR pp. 87-92)

3) "Succession" (BR pg. 93)

4) Miller text pp. 85-91
Background:

"The balance-of-nature concept makes nice poetry, but it's not such great science."

(Dr. Steward T. A. Pickett, plant ecologist, Institute of Ecosystem Studies of the New York Botanical Garden)

"We can say that's dead [the balance-of-nature concept] for most people in the scientific community."

(Dr. Peter L. Chesson, theoretical ecologist, Ohio State University)

"There will always be people who will cling to old ideas. But certainly the center of mass of thinking [has shifted away from equilibrium] toward the fluctuating nature of natural systems."

(Dr. Simon A. Levin, ecologist, Cornell University; 1990-91 president, the Ecological Society)

What is constant in ecosystems? Change. In recent years the scientific community has rejected one of the long-held tenets of ecology: the balance of nature. Scientists now say that "nature is actually in a continuing state of disturbance and fluctuation. Change and turmoil, more than constancy and balance, is the rule." The idea that ecosystems would progress to a stable and balanced condition has long been a basic premise of ecology and decades of resource management. This theory now appears to have proven untrue, although ecologists admit that a adequate new theory has not yet fully replaced it.

Succession is a process in which ecosystems change over time. Usually the ecosystem becomes more complex: plant and animal communities become more numerous and diverse, food webs become more extensive and niches more abundant. Multiple factors are simultaneously disrupting the system, however: climatic change, annual variations in weather, fires, windstorms, hurricanes, disease. Because of this, the ecosystem rarely attains the highly touted "balance of nature" or permanently stable condition.

"Humans are emerging as just one of many sources of ecological disturbance that keep nature in a perpetual state of uproar." (William Stevens) Since it is already a "given" that humans will have an impact on natural systems, ecologists believe that the question to ask about human intervention is which sort should be promoted and which
opposed. In the latter category, two types of human intervention in natural systems causing grave concern are loss of habitat diversity (and thus, species diversity) and increasing CO₂ levels in the atmosphere contributing to global warming.

(from "New Eye on Nature: The Real Constant Is Turmoil", included in the Book of Readings [BR pp. 83-86].)

**Natural selection** is the process by which organisms whose genetic traits do not allow them to cope with environmental stress die off, and those whose traits do allow them to cope survive and reproduce. Those organisms which survive and reproduce pass on to their offspring special genetic traits, or **adaptations**, which best suit their living conditions. Many species can adapt to ecosystem changes which occur over hundreds and thousands of years. Accelerated rates of change in ecosystems, often caused by catastrophic events or human intervention, can severely stress populations. Unable to adapt to environmental change at such a rapid pace, entire species can become endangered or even extinct.

The major purpose of Lesson Six is to investigate evidence of succession, identify disruption and change in natural systems as the prevalent condition, and identify adaptation advantages of selected organisms.

**Materials:**

1) overhead transparency of succession

2) 40 feet of string, twine, or line and 4 stakes for each team in the succession study (5-7 teams per group of 25 students); pertinent field guides; one succession data sheet per team

3) various colored yarn "worms" and a large sheet of white paper

4) mounts, or live animals/plants, or photographs of several organisms for adaptation investigation (instructor choice)

5) optional: costume props for adaptation investigation

**Procedure:**

1) Introduce the topic of **succession (10 minutes)**: an overhead transparency is provided. Succession is a process in which plant and animal communities are
usually replaced over time by different and usually more complex communities. Contrast the pioneer (immature) community, containing fewer species and simpler food webs, with the climax (mature) community, containing a greater number of species and more complex food webs. Point out that succession is a slow, gradual process containing many intermediate steps between pioneer and climax stages. (In view of recent research, the climax stage is a transient one at best.)

2) Disruptions to succession (5 minutes): have students predict what factors are simultaneously disrupting the process of succession (e.g., climatic change, annual variations in weather, fires, windstorms, hurricanes, disease, human activity). These factors rarely allow an ecosystem to attain the highly touted "balance of nature" or permanently stable condition. Instead, ecosystems constantly vary within certain boundaries: although there may be a tendency toward a "perfect" stable state, the ecosystem usually never gets there.

3) Succession Field Study (1 hour 15 minutes): take students to a nearby site to study succession. (Preferably, the study is conducted on a school site or adjacent location.) Possible study sites:

- a pond, lake, marsh, meadow, or wetland community;
- the transitional margin between two communities (e.g., a field and forest);
- two wooded areas of different ages;
- an area logged, burned, or "developed" in recent years;
- two vacant city lots of different ages; or
- a fence row between cultivated farm fields.

Break students into teams of 4-5. Give each team a succession data sheet (Appendix I, pp. 108), a 40 foot section of string and 4 stakes. Explain two options for sampling:

- the team may form a 10 foot square quadrat with their string, studying three different quadrats along the path of succession;
- the team may position their string in a straight 40 foot transect line, studying several feet on either side of the transect. The line may need to be extended (to 60 or 80 feet) to fully span the succession study area.
As the instructor, you may want to increase or reduce the transect line or quadrat size as necessary.

Each team should:

a) observe, quantify, and identify (if possible) the dominant plant species either within the three quadrats or along the transect line;

b) describe any apparent changes in the type or amount of plant species found in the three quadrats or along the transect line;

c) hypothesize what are the pioneer, intermediate, and climax plant species (all three might not be present), and what animal species might be found with the different plant types;

d) cite evidence of change and disruption occurring in the ecosystem which might prevent it from "arriving" at a stable, balanced state;

e) predict what the ecosystem might look like in 10, 50, and 200 years; and

f) determine whether or not the area studied was an example of the processes of succession at work. Why or why not?

While still at the site, gather all students into a large group and discuss the results of each team’s investigation. Summarize the findings and emphasize that although the ecosystem may not appear to be changing, it is undergoing continual change, fluctuation, disturbance, and stress.

Continue in this outdoor setting with step 4 of the Procedure which follows, or return inside.

* Note to Instructor: there is an indoor alternative to the outdoor Succession Field Study. If it is impossible to conduct the Succession Field Study, use the activity "Pond Succession" (Project WILD Secondary, pp. 95-96, Western Regional Environmental Education Council, 1986). In this activity, small groups of 3-5 students construct a series of three murals depicting the successional changes in a pond ecosystem over a 1300 year time span.

Basic research is what I'm doing when I don't know what I'm doing.

Werner Von Braun
4) Natural Selection and Adaptation:

a) "Bird 'n' Worms" (10 minutes) (Project Learning Tree, American Forest Institute and Western Regional Environmental Education Council, 1977): The complete activity is included in Appendix J, pp. 109-110, for instructor reference.

After explaining how to play "Bird 'n' Worms", have students predict what color "worms" will be picked up first and last. (Substitute yarn for pipe cleaners in the activity.) Green "worms" in the summer, white in the winter, and brown in the autumn and spring should demonstrate protective coloration and provide a lead-in to the concept of natural selection.

b) Introduce the concepts of natural selection and adaptation (15 minutes):

Natural selection is the process by which organisms whose genetic traits do not allow them to cope with environmental stress die off, and those whose traits do allow them to cope survive and reproduce. Those organisms which survive and reproduce pass on to their offspring special genetic traits, or adaptations, which best suit their living conditions.

Using mounts, live animals or plants, or photographs, have students examine organisms and identify adaptations. Then, have students state the advantage each adaptation provides to the organism for surviving in its habitat. (An alternative would be to dress a student volunteer as a beaver or other animal. Ask what types of adaptations beavers have, and as examples are given, dress the "beaver". Possible costume items: fins, oil can, paper "teeth", paddle, fur, goggles, rain hat.)

c) Human intervention in ecosystem processes (5 minutes):

Humans intervene in the ongoing processes occurring in ecosystems. Encourage students to read "The Man Who Planted Trees and Grew Hope" (BR pp. 87-92) as an example of positive human intervention. Conclude the lesson by reading the following excerpt to students as another example of what can come from humans intervening in an ecosystem:

When the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can begin again.

William Beebe
Malaria and the Borneo Episode

Malaria once infected nine out of ten people on the island of North Borneo, now known as Brunei. In 1955 the World Health Organization (WHO) began spraying dieldrin (a pesticide similar to DDT) to kill malaria-carrying mosquitoes. The program was so successful that the dreaded disease was almost eliminated from the island. But other, unexpected things happened. The dieldrin killed other insects, including flies and cockroaches inhabiting the houses. The islanders applauded. But then small lizards that also lived in the houses died after gorging themselves on dead insects. Then cats began dying after feeding on the dead lizards. Without cats, rats flourished and began overrunning the villages. Now people were threatened by sylvatic plague carried by the fleas on the rats. The situation was brought under control when WHO parachuted healthy cats onto the island.

On top of everything else, roofs began to fall in. The dieldrin had killed wasps and other insects that fed on a type of caterpillar that either avoided or was not affected by the insecticide. With most of its predators eliminated, the caterpillar population exploded. The larvae munched their way through one of their favorite foods, the leaves used in thatching roofs. In the end, the Borneo episode was a success story; both malaria and the unexpected effects of the spraying were brought under control. But it shows the unpredictable result of interfering in an ecosystem.

(from Living In The Environment, G. Tyler Miller, 1988)

Extensions:

1) "Fashion A Fish" (from Project WILD Aquatic, pp. 81-85, Western Regional Environmental Education Council, 1987). In this activity, students design various fish adapted for various aquatic habitats.

2) "Adaptation Artistry" (from Project WILD Secondary, pp. 91-92, Western Regional Environmental Education Council, 1985). In this activity, students design birds based on adaptations necessary for their habitat.

Evaluation: Have each student make a list of positive ways in which humans can intervene in ecosystem processes (e.g., develop backyard habitat, recycle, install nesting boxes, bicycle or walk instead of drive a car, plant trees). Then have the student circle two of those ways and attempt to do them in the next month.
Ecosystem Investigation Task: Lesson Six

1) Investigate the ecosystem for evidence of past or present disturbance and/or change. Record in your notebook two types of disturbances and/or changes, citing evidence for both.

2) Choose one plant or animal of the ecosystem to closely study. Record in your notebook three specific adaptations for the organism, and the probable purpose for each.

I remembered one morning when I discovered a cocoon in the bark of a tree, just as a butterfly was making a hole in its case and preparing to come out. I waited a while, but it was too long appearing and I was impatient. I bent over it and breathed on it to warm it. I warmed it as quickly as I could and the miracle began to happen before my eyes, faster than life. The case opened, the butterfly started slowly crawling out and I shall never forget my horror when I saw how its wings were folded back and crumpled; the wretched butterfly tried with its whole trembling body to unfold them. Bending over it, I tried to help it with my breath. In vain.

It needed to be hatched out patiently and the unfolding of the wings should be a gradual process in the sun. Now it was too late. My breath had forced the butterfly to appear, all crumpled, before its time. It struggled desperately and, a few seconds later, died in the palm of my hand.

That little body is, I do believe, the greatest weight I have on my conscience. For I realize today that it is a mortal sin to violate the great laws of nature. We should not hurry, we should not be impatient, but we should confidently obey the eternal rhythm.

Kazantzakis
Zorba the Greek
Lesson Seven: 
Limits To Growth

Objectives: Students will relate the human factor to ecosystems and be able to:

1) identify at least five living and five nonliving limiting factors which determine the existence, abundance, or distribution of an organism; relate how the world human population is dependent on these limiting factors.

2) interpret a species population graph by distinguishing a J-shaped curve (exponential growth) from an S-shaped curve (levelled off growth) and predicting the carrying capacity; relate these concepts to the world human population graph.

3) given the annual percentage growth rate, apply "the rule of 70" to calculate doubling time for the human population in a particular region.

4) graph the human population curve to the current year; further, extrapolate the curve into three alternative future growth scenarios and provide a rationale for each.

Method: Students analyze how limiting factors affect species population graphs, calculate doubling time, and examine human population growth scenarios.

Instructional Time: 2 hours

Readings:

1) "Isle Royale: A Living Laboratory" (BR pp. 94-96)
2) "World Population: Fundamentals of Growth" (BR pp. 97-102)
3) "J-shaped and S-shaped curves" (BR pg. 103)
4) "Two Family Trees" (BR pg. 104)
5) Miller text pp. 1-6, 71-73, 83-84
Background: A species population introduced into a favorable environment with adequate resources will usually increase until it reaches an upper limit. Thereafter, population numbers generally fluctuate between a lower limit and an upper limit. A population's lower limit could be zero (extinction), but usually does not fall to such a level. Factors which determine the upper limit are called **limiting factors**. The existence, abundance, or distribution of an organism is influenced by both living and nonliving limiting factors. Examples of biotic limiting factors include: parasites, population pressures, disease, suitable habitat, predators, and food supply. Examples of abiotic limiting factors include: shelter, nutrients, light, environmental pollution, water, temperature, and weather.

The greatest population size of a species which a certain area can support indefinitely with its resources is called the **carrying capacity**. When graphed, the response of a species population to resource availability is usually either a **J-shaped or S-shaped curve**. The J-shaped curve represents exponential growth (1, 2, 4, 8, 16, 32...), a rapidly accelerating growth rate which occurs as a series of doublings. The S-shaped curve represents the leveling off of the exponential growth phase. A J-shaped curve is converted into an S-shaped curve when the growing population exceeds one or more of the limiting factors, the exponential growth is slowed, and the population reaches its carrying capacity.

**Doubling time** for a population can be calculated using "the rule of 70". According to the rule, doubling time can be determined by dividing the annual percentage growth rate into the number 70. A population with a 2% annual growth rate will double in 35 years; a population with a 7% annual growth rate will double in 10 years.

Human population growth currently exhibits an exponential pattern of growth, which gravely concerns many who study population trends and their implications. World population reached the 5 billion mark in the late 1980's, and according to United Nations predictions, will double again to 10 billion before leveling off in the year 2100. The principles of limiting factors, carrying capacity, and doubling time all have direct application to human population growth.

The major purpose of Lesson Seven is to understand factors which influence species population growth and to apply them to the study of human population growth.

Materials:

1) overhead transparencies (5) of The J-shaped Curve, The S-shaped Curve, Two Family Trees, World
Population Graph, and Future Trends in World Population Growth

2) large sheet of paper and markers for graphing "Oh Deer!" data

3) reading (BR pp. 94-96) "Isle Royale: A Living Laboratory"

4) discussion sheets (one per group) for "Isle Royale: A Living Laboratory"

5) video "World Population" (5 minutes)

6) worksheet "Doubling Time" (one per student)

Procedure:

1) Limiting factors and carrying capacity:

a) "Oh Deer" (20 minutes) (from Project WILD Secondary, Western Régional Environmental Education Council, 1986). The complete activity is found in Appendix K, pp. 111-114 for instructor reference.

Play enough rounds to generate data for a graph depicting at least four peaks and subsequent declines. Graph the results and discuss the concepts of limiting factors and carrying capacity with students. Reemphasize from the previous lesson that natural systems fluctuate (thus the oscillations in the graph, not a straight line.)

b) Moose and wolf interactions: have students read (5 minutes) "Isle Royale: A Living Laboratory" (BR pp. 94-96). Divide students into small groups of 3-4 and distribute to each group the discussion sheet containing the following four questions (10 minutes):

1. List at least two living and two nonliving limiting factors for both the moose and the wolf populations.

2. Explain the change in the wolf population after the 1969-1972 moose population crash due to starvation.

3. What was the wolf population in 1980? 1981? 1982? Correlate this to the moose population during the same years.

It levelled every bush and tree and levelled every hill, and hung the moles for traitors — though the brook is running still, it runs a naked stream, cold and chill.

John Clare
4. If a disease killed most of the beavers on Isle Royale, how would the moose population be affected? the wolf population?

Discuss group results with the entire class (5 minutes).

2) Reading population graphs (10 minutes): using the two overhead transparencies provided, compare and contrast J-shaped and S-shaped curves.

Explain that when graphed, the response of a species population to resource availability is usually either a J-shaped or S-shaped curve.

* The J-shaped curve represents exponential growth (1, 2, 4, 8, 16, 32...), a rapidly accelerating growth rate which occurs as a series of doublings.

* The S-shaped curve represents the leveling off of the exponential growth phase.

* The J-shaped curve is converted into an S-shaped curve when the growing population exceeds one or more of the limiting factors. This curtails exponential growth, and the population decreases (through a crash, dieoff, or emigration) until the population reaches its carrying capacity.

3) Doubling Time (15 minutes):

a) Pose the following problem to the students:

At 10:00 am bacteria are placed into a sealed bottle with food and water. Every minute the number of bacteria in the bottle doubles. At 11:00 am, the bottle is full. At what time was the bottle half full? (Answer: 10:59 am)

If you were a bacteria in the bottle, at what time might you become aware that space was becoming limited? (Answers will vary: maybe when the bottle was ¼ full at 10:58 am or ½ full at 10:59 am)

Imagine some enterprising bacteria realize that space in the bottle is becoming limited, so they escape to search for additional bottles. They locate an empty bottle ("WOW! Another whole bottle!") and retrieve it for the growing colony.
At what time will the second bottle be filled? (Answer: 11:01 am)

Emphasize that population size increases so rapidly in a population growing exponentially (doubling) that it can seem out of control. To demonstrate this, ask students to predict the thickness of a piece of paper if it was folded in half (doubled in thickness) twenty times. (Answer: over 340 feet high! Based on an initial paper thickness of 1/256", after 8 doublings the paper would be 1" thick; after 12 doublings the paper would be 16" thick; after 17 doublings the paper would be over 42 feet high.)

b) Explain that doubling time for a population can be calculated using "the rule of 70". Dividing the annual percentage growth rate into the number 70 yields the doubling time. Have students calculate the following problems:

1. In how many years will a population of mice double if the population is growing at a 10% annual growth rate? (Answer: 70 ÷ 10 = 7 years)
2. In how many years will a population of deer double if the population is growing at a 2% annual growth rate? (Answer: 70 ÷ 2 = 35 years)

* Note to Instructor: Students might be interested to know that "the law of 70" also applies to their bank balance. $1000 invested at a 7% annual interest rate will double in 10 years to $2000!! (70 ÷ 7 = 10 years)

4) Patterns of Human Population Growth:

a) Show the video "World Population" (5 minutes).

b) Using "Doubling Time" (35 minutes) (from Living Lightly On The Planet, Vol. 1, Maura O'Connor, 1989), follow steps 1-4 (omit step 5) of the activity procedure. Overhead transparencies of the two family trees and the world population graph are provided. The complete activity is provided in Appendix L, pp. 115-118, for instructor reference.
The most common misperception of the population problem is that it's a problem of poor Indians who don't know how to use condoms. Actually, the problem in the world is that there are too many rich people.

Paul Ehrlich (explaining that one American is likely to do 20 to 100 times more damage to the Earth than an inhabitant of Bangladesh or Venezuela)

c) After completing the world population graph in step 4 of "Doubling Time", use the overhead transparency "Future Trends in World Population Growth" to depict three projections of world’s population in the year 2100. Discuss the following (15 minutes):

* Trace the three fertility rates (3.8, 3, 2 children) to the year 2100 and contrast the resulting population (51, 22, 6 billion).

* What are limiting factors for human population growth? Can we predict the earth’s carrying capacity for humans?

* Review the relationship between population growth and world resource consumption (food, water, land, fuel, minerals). Paul Ehrlich’s quote (box) might be appropriate to discuss here.

It was the best of times,
   it was the worst of times.
It was the age of wisdom,
   it was the age of foolishness.
It was the epoch of belief,
   it was the epoch of incredulity.
It was the season of light,
   it was the season of darkness.
It was the spring of hope,
   it was the winter of despair.
We had nothing before us,
   we had everything before us.

Charles Dickens

Extensions: Contrast population growth in developed and developing countries. (See "World Population: Fundamentals of Growth" BR pp. 97-102)

Evaluation: Divide students into three groups. Each group should assess the feasibility of a different projection of world population in the year 2100. Each group then presents their assessment to the other two groups.
Ecosystem Investigation Task: Lesson Seven

1) Observe and describe (by name, sketch, or written account) a population in the ecosystem which you are investigating. Identify specific examples of three biotic (living) limiting factors and three abiotic (non-living) limiting factors which determine the carrying capacity of that population.

* Note to Instructor: It will greatly enhance Lesson Eight if students complete the readings (BR pp. 105-113) prior to the Lesson. You might assign these readings as homework.
Lesson Eight:
The Biosphere and Global Human Impact

Objectives: Students will relate the human factor to the biosphere and be able to:

1) define biosphere as that part of the earth where living organisms exist, describe the extent of the biosphere, and explain how humans are dependent upon the biosphere.

2) describe three developments in human history which have significantly impacted the environment.

3) define biodiversity as the number of species and their abundance in an ecosystem, and describe the impact on an ecosystem when species are removed by human intervention.

4) given a human practice, assess its impact on the biosphere and describe at least three related actions which an individual could take to protect or improve the environment.

5) describe how environmental education can be an effective strategy in working toward solutions of environmental problems.

6) conduct a thorough individual investigation of one ecosystem, and record in writing as experienced, observed, or researched by the investigator:
   a) the living and nonliving components of the ecosystem and their interrelationships;
   b) human impact on the ecosystem, both positive and negative;
   c) the ecosystem's value (ecological, economic, recreational, aesthetic, spiritual); and
   d) a response to the question: "Of what value was the experience of investigating an ecosystem and keeping a notebook?"

7) apply ecological concepts to the investigation of one current environmental problem by identifying at least three ecological principles that relate to the solution or prevention of the problem, and describe the relationship.
8) identify at least three ecological principles and describe how these can be used to guide individuals in developing ecologically sound lifestyles.

Method: Students learn about the biosphere and biodiversity, and apply these concepts in a case study of the rain forest. Students investigate how human practices impact the biosphere, and the role of environmental education in solving environmental problems.

Instructional Time: 2 hours

Readings:
1) "Tropical Rain Forest Information Sheet" (BR pg. 105)
2) "Problems and Solutions" (BR pp. 106-109)
3) "You Can Help!" (BR pp. 110-113)
4) Miller text pp. 16-19, 91-92

Background: The scope of "Ecological Basis For Environmental Education" starts with a narrow focus and enlarges gradually to end with the broad perspective. Beginning with individual organisms and species populations, this course expands to encompass concepts of communities and ecosystems, and concludes with a global view of the biosphere. The biosphere is that part of the earth where living organisms exist. (If the earth were an apple, the biosphere would be as thick as the apple's skin.) The goal of ecology, in essence, to find out how everything in the biosphere is related. One measure of the health and vigor of the biosphere is the abundance of plant and animal species present in an ecosystem. The greater the number of species, the higher the biodiversity (or biological diversity). An ecosystem with high biodiversity is usually more resilient when confronted with small or moderate environmental stress than one with lower biodiversity. With so many different species, niches, and interrelationships the stress can be more widely distributed. The ecosystem that does not "put all its eggs in one basket" has more strategies available for responding to many environmental disturbances. An economic analogy could be drawn of a city with a diverse economy versus a city relying on only one or two primary businesses: the more diversified economy can usually survive and adapt to most changing economic pressures better than the single-economy city.

*Ecology's message is not to avoid growing food, building cities, and making other changes that affect the earth's plant and animal communities, but to recognize that such human-induced changes have far-reaching and unpredictable consequences. Ecology is a call for wisdom, care, and restraint as we alter the biosphere.*

G. Tyler Miller
However, current ecological research does not always support the "diversity means stability" model. Continual change, disturbance, and fluctuation are characteristic of most ecosystems, not "stability". Another difficulty is defining "stability": is it the capacity to withstand disturbance, or the capacity to recover from disturbance? For example, California redwood forests and tropical rain forests have high biodiversity and are hard to destroy through natural processes. Once these forests are cleared, however, it is almost impossible to reestablish them. Grasslands, by contrast, have a lower biodiversity and are more susceptible to disruption, especially through burning. Yet, grasslands are highly resilient and able to recover quickly. They suffer total destruction only if the roots of grassland plants are plowed up and other crops are sown.

These examples demonstrate why ecologists are not certain that high biodiversity is always essential to an ecosystem's resilience and capacity to mitigate stress. However, evidence does indicate that simplifying ecosystems by the removal of species can have damaging and disruptive effects. Humans can cause global impact on the biosphere by simplifying ecosystems, sometimes deliberately and sometimes unknowingly.

To understand this global human impact on the biosphere, ecologists must try to understand the species *Homo sapiens*. Humans in some ways are typical animals, carrying on basic life functions like other organisms. Unlike typical animals, however, the human brain has made possible three major developments in the history of mankind. The ability to make and use tools, the domestication of plants and animals, and the technological developments of the Industrial Revolution have each had a dramatic effect on the environment. These three developments, along with political institutions, social structures, and religions, comprise human culture. Culture enables humans to become highly adaptable within the environment and tends to separate humans from the environment. Cultured humans are no longer mere members of ecosystems but are also *changers* and *makers* of ecosystems. (adapted from *Understanding Basic Ecological Concepts*, by Audrey Tomera, J. Weston Walch Publishing, 1979)

Evidence of humans as agents of environmental change can be seen in many human activities which simplify ecosystems and reduce biodiversity. **Monoculture**, the practice of growing only one crop, is an energy-intensive form of agriculture which removes the natural checks and balances found in a multiple species ecosystem of the grassland. **Forest management practices** which replace the mixed-age/mixed-species forest with a single-age/single species forest create a simplified ecosystem.
more susceptible to environmental stress and disease. Another disadvantage of the single-age/single-species forest is that it will support a less diverse wildlife population than would the mixed forest. **Draining and filling of wetlands**, especially of coastal and prairie pothole wetlands, significantly decrease habitat essential for many birds and aquatic animals. **Ranching practices** often eliminate competitors and predators of livestock, converting grasslands to simpler ecosystems. **Overhunting** and **overfishing** diminish species diversity. The biodiversity of the rainforest ecosystem, containing over half of the world's plant and animal species, is being annihilated through **rainforest deforestation**. At the current rate of destruction, the rainforests and the biological richness within them will vanish early in the next century. The burning of fossil fuels create atmospheric pollutants that contribute to **acid rain**, which simplify forest ecosystems by killing trees and aquatic ecosystems by killing fish. **Atmospheric change** is another indicator of global human impact which threatens ecosystem integrity. Both the **greenhouse effect** and the **depletion of the ozone layer** are directly related to human activities.

In summary, evidence of humans as changers and makers of ecosystems is abundant. Often human intervention simplifies an ecosystem through removal of species. This resulting loss of biodiversity can damage the vigor and resiliency of the biosphere. Human activity should be promoted which "tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise." (Aldo Leopold) Those activities which "tend to do otherwise" should be opposed.

The major purpose of Lesson Eight is to culminate the study of ecology with a global biosphere perspective, investigate the actions of humans as changers and makers of ecosystems, and understand how environmental education can motivate and equip citizens to improve and protect the environment.

Materials:

1) apple and knife for "Earth: The Apple of Our Eye"

2) hand-out "Ten Reasons To Save Rain Forests" (one per student)

3) overhead transparency (1) of Ten Reasons To Save Rain Forests

4) video "Rain Forest Rap" (6 minutes)
5) Discussion sheets (one per group) for human practices which impact the biosphere

**Procedure:**

1) **Review (5 minutes)** the progression of concepts (from simple to complex) in the course:

   organisms
   populations
   communities
   ecosystems
   **biosphere**

   Introduce the concept of the **biosphere** as that part of the earth where living organisms exist.

   What is the goal of ecology? To find out how everything in the biosphere is related.

2) Illustrate the extent of the biosphere using an apple (**5 minutes**). The instructions are in "Earth: The Apple of Our Eye" (Appendix M, page 119).

3) **Predicting biosphere health (10 minutes):**

   a) Ask students to predict which of two cities would be better able to survive and adapt to changing economic pressures: a city with a diverse economy or a city relying on only one or two primary businesses. Discuss reasons why the city with a diversified economy is usually more resilient than the single-economy city. (The Irish Potato Famine could be used as an example: caused by a fungal blight in the mid-1800's, half of Ireland's 8 million people had either starved to death or emigrated by 1900.)

   b) Explain that one measure of the health and vigor of the biosphere is **biodiversity** (or **biological diversity**): the number of species and their abundance in an ecosystem. Again, have students predict which of two ecosystems would be better able to survive and adapt to small or moderate environmental stress: an ecosystem with high biodiversity or an ecosystem with low biodiversity. Challenge students to support their predictions based on their knowledge of species, niches, and interrelationships.

4) **The Human Factor (5 minutes):**
To understand global human impact on the biosphere, ecologists must try to understand the species *Homo sapiens*.

* Humans in some ways are typical animals, carrying on basic life functions like other organisms.

* Humans are unlike typical animals, because the human brain has made possible three major developments in the history of mankind. Can students identify these?

  a) the ability to make and use tools;

  b) the domestication of plants and animals; and

  c) the technological developments of the Industrial Revolution.

Humans are no longer mere members of ecosystems but are also *changers* and *makers* of ecosystems.

5) "Why Save Rain Forests?" *(1 hour TOTAL)*
(from *Naturescope "Rain Forests: Tropical Treasures", National Wildlife Federation, 1989*):

The complete activity is found in Appendix N, pp. 120-122, for instructor reference. An *abbreviated synopsis* of the activity follows:

* Note to Instructor: Students should prepare for this activity by reading the relevant articles in the Book of Readings (BR pp. 105-113) prior to Lesson Eight. Be sure to assign these readings.

a) In groups of 4-5, have students make a list of reasons why they think the rain forest should be protected *(10 minutes)*.

b) Compile a master list of reasons as each group reports its ideas. Then distribute copies of the handout "Ten Reasons To Save Rain Forests". Have students compare the ten reasons to the master list and make any additions or clarifications to the master list desired *(15 minutes)*.
c) Using the master list, have each group try to reach consensus about the two most important reasons to save the rain forest. Have each group then report their two reasons to the class. (10 minutes)

d) Next, discuss (10 minutes) some of the reasons that rain forests are being destroyed.

e) Finally, have students evaluate which reasons from the master list would best convince other people — especially those who don’t know much about rain forests or show much interest in protecting them — that saving the rain forest is important. Are the reasons the same as what students thought individually? (5-10 minutes)

f) Conclude by showing the World Wildlife Fund video "Rain Forest Rap" (6 minutes), showing problems of the rain forest and how people can help. (Or, you can use the video to introduce this activity.)

6) Human impact on the biosphere (25 minutes):

a) Divide the students into five groups. Assign each group a different one of the following human practices:

* Modern agriculture
* Forest management (non-tropical)
* Ranch/livestock management
* Wetland use
* Fossil fuel use

Distribute the discussion sheet to the group which describes the following task:

"Based on your knowledge of the practice and your knowledge of ecology gained from this course, try to assess the following:

1. Which aspects of the practice are ecologically beneficial to the biosphere and which aspects are ecologically harmful? Why?

2. What effect does the practice have on the biodiversity of the ecosystem?

3. Describe at least three positive environmental actions an individual could
take to solve or prevent any problems caused by this practice.

b) Have each group share its assessment with the class. The following information might be useful to the discussion.

**Modern agriculture** practices often involve monoculture, the growing only one crop. It is an energy-intensive form of agriculture which removes the natural checks and balances found in a multiple species ecosystem of the grassland.

**Forest management** practices which replace the mixed-age/mixed-species forest with a single-age/single species forest create a simplified ecosystem more susceptible to environmental stress and disease. Another disadvantage of the single-age/single-species forest is that it will support a less diverse wildlife population than would the mixed forest.

**Ranching practices** often eliminate competitors and predators of livestock, converting grasslands to simpler ecosystems.

**Draining and filling of wetlands**, especially of coastal and prairie pothole wetlands, significantly decrease habitat essential for many birds and aquatic animals.

**The burning of fossil fuels** create atmospheric pollutants that contribute to acid rain, which simplify forest ecosystems by killing trees and aquatic ecosystems by killing fish. Atmospheric change is another indicator of global human impact which threatens ecosystem integrity. Both the greenhouse effect and the depletion of the ozone layer are directly related to human activities.

7) **The Role of Environmental Education (10 minutes):**

a) Use student suggestions of individual actions in the previous activity as a lead-in to discussing the role of environmental education.

b) Acknowledge that global environmental problems can seem overwhelming without strategies for effectively working toward their solution. In light of this, involve students in a discussion reviewing how environmental

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When some thinker does come forth to provide us with a rationale for conduct, he will have to consider not only the problems of man's conduct with his fellowmen, but also of man's conduct toward nature. Life is a unity; the biosphere is a complex network of interrelations among all the host of living things. The questions of the nature of his relationship with the birds and the beasts, with the trees of the forests and the fish of the seas, become ethical questions; questions of what is good and right not only for man himself, but for the living world as a whole. In the words of Aldo Leopold, we need to develop an ecological conscience.

Marston Bates
education can be an effective strategy in working toward solutions of environmental problems:

"What is the goal of environmental education?"

...not only to develop citizens knowledgeable about the environment, but also citizens who are equipped with the necessary skills and motivation to take positive environmental action.

("The goal of EE is to help students become environmentally knowledgeable, skilled, dedicated citizens who are willing to work individually and collectively toward achieving and maintaining a dynamic equilibrium between the quality of life and the quality of the environment.")

"How can we as educators attain the goal of environmental education?"

Through a balanced K-12, multidisciplinary learning progression which includes:
- Awareness
- Knowledge
- Values and Attitudes
- Citizen Action Skills
- Citizen Action Experience

"What should be the role of environmental education in the future?"

"What challenges will teaching environmental education present to classroom teachers like me?"

"In what ways has this course enabled me to meet these challenges?"

8) Conclusion of course.

Extensions: As an opportunity for further study, have students research examples of endangered species and identify loss of habitat as one of the primary causes for their threatened or actual extinction.

Evaluation: Read the following quote to students and have them write a one or two paragraph reaction to it:
"Ecology's message is not to avoid growing food, building cities, and making other changes that affect the earth's plant and animal communities, but to recognize that such human-induced changes have far-reaching and unpredictable consequences. Ecology is a call for wisdom, care, and restraint as we alter the biosphere." (G. Tyler Miller)

Ecosystem Investigation Task: Lesson Eight

1) Through the course of the investigation you probably have seen evidence of human impact in the ecosystem. Describe at least two actions you could take to protect or improve the quality of the ecosystem you have investigated.

To accomplish great things we must not only act but also dream, not only plan but also believe.

Anatole France
List of Appendices.

Ecological Basis for Environmental Education
NR 412/612


Appendix I: Succession Data Sheet, University of Wisconsin-Stevens Point. Stevens Point, WI, 1991.


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ECOLOGICAL BASIS
FOR
ENVIRONMENTAL
EDUCATION

NATURAL RESOURCES
412/612

A BOOK OF READINGS
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APPENDIX M

Instructor Curriculum for the Fourth Course, Environmental Education Teaching Strategies, NR 414/614
Teacher Outreach
In
Environmental Education:

Course Four:

Environmental Education
Teaching Strategies

Natural Resources 414/614

A Project Of
The Wisconsin Center for Environmental Education,
The College of Natural Resources
and
The Office of Continuing Education
The University of Wisconsin-Stevens Point

1991

Written By Nancy H. Cripe

Teacher Outreach Program Coordinator:
Dr. Dan Šivek

100% Recycled Paper
Welcome to *Environmental Education Teaching Strategies*, the final outreach course in a series of four to be offered statewide to Wisconsin K-12 teachers. This curriculum for *Environmental Education Teaching Strategies* is intended to provide you, the instructor, with a basic framework for teaching the course.

Instructors played a key role in developing the goals and objectives for this course during the November 1989, August and December 1990 planning sessions. The eight lessons in *Environmental Education Teaching Strategies* are based on those goals and objectives. While you might choose not to teach each lesson exactly as written, the overarching goals and objectives must be addressed through your instructional methods.

The format for each of the eight lessons is the same:

1. Objectives
2. Method
3. Instructional Time
4. Readings
5. Background
6. Materials
7. Procedure
8. Extensions
9. Evaluation

For clarity, certain terms used throughout the curriculum are defined here:

1. **Instructor**: instructional academic staff selected by the University of Wisconsin-Stevens Point to teach outreach courses in environmental education to K-12 teachers in Wisconsin.

2. **Student**: any K-12 teacher enrolled in the outreach course.

3. **Instructional Time**: the approximate amount of time which instructors will need to teach a lesson. The total amount of instructional time for the entire course, *Environmental Education Teaching Strategies*, is 16 hours.

4. **Readings**: selected articles on environmental education contained in the student Book of Readings (BR).

5. **Background**: general information provided in each lesson for instructor reference.

6. **Extensions**: optional activities provided at the end of each lesson which the instructor might incorporate. The instructional time given for each lesson does not include the use of extensions.

7. **Evaluation**: informal activities, strategies, and questions which the instructor might use to assess student learning at the conclusion of each lesson.

8. **Assignments**: specific projects which each student will complete during (or shortly after) the course. These assignments are listed in the evaluation section of lessons one, two, five and seven.

9. **EE Sub-goals**: to be consistent with current terminology and the Wisconsin DPI *Guide to Curriculum Planning in EE* (draft version, 1991), the terms "citizen action skills" and "citizen action experience" replace the terms "skills" and "participation", respectively.
ACKNOWLEDGMENTS

This curriculum is a cooperative venture involving a select group of professional environmental educators throughout the state of Wisconsin. These men and women have invested four full weekends in the past year at the Central Wisconsin Environmental Station to develop and critique courses in the "Teacher Outreach in Environmental Education" Program. It is due to the creativity, energy, devotion, and skill of these people that the Environmental Education Teaching Strategies exists today. Tremendous credit and gratitude are extended to the August 3-5, 1990 team which did the "lion's share" of work developing the framework and substance of this course:

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Harvey Hayden
Judy Klippel
Bev Southern
David Stokes
Dennis Weibel
Dennis Yockers

Many thanks to the following instructional academic staff for their valuable contributions:

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Dolly Ledin
Cindy Sanford May
Bryan Pierce
Pat Marinac-Sanders
Lori Lee Smith
Suzanne Wade

And finally, sincere appreciation is due to the UW-SP steering committee members who initiated the process of turning the vision of statewide teacher training in EE into a reality:

Dr. Richard Wilke
Dr. Randy Champeau
Dr. Dan Sivek
Dr. Joe Passineau
Dr. Mike Gross
Jennie Lane

Dr. Mike Offerman
Dana Nelson
David Aplin
Sally Ellingboe
Beverly Stencel
Ann Quale
Phyllis Peri

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## LESSON SYNOPSIS AND TIMELINE

<table>
<thead>
<tr>
<th>TIME (hours)</th>
<th>LESSON</th>
<th>DESCRIPTION</th>
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<tr>
<td>2</td>
<td>One</td>
<td>Students are familiarized with the course, complete a preassessment form, and review the goal and subgoals of EE through investigation of sample units. Major and minor emphases for EE subgoals at grade level groups are studied. Assignment #1, the status of EE in the local school district, is given.</td>
</tr>
<tr>
<td>2</td>
<td>Two</td>
<td>Students review Assignment #1. A group challenge activity is used to demonstrate the infusion model. Students participate in an EE activity and evaluate its infusion potential into various subject areas. Assignment #2, developing an instructional plan for infusing supplemental EE curriculum activities, is given.</td>
</tr>
<tr>
<td>2</td>
<td>Three</td>
<td>Students participate in an EE activity, evaluate methods used in it, and brainstorm a list of possible methods effective for accomplishing EE subgoals. Students are then introduced to &quot;Goals for Curriculum Development in EE&quot;, correlate these four goal levels to the five EE subgoals, and discuss recommended methods for each goal level. Finally, students work in teams to prepare EE activities which they instruct during Lessons Four and Five.</td>
</tr>
<tr>
<td>2</td>
<td>Four</td>
<td>Three teams of students each teach an EE activity to the class. The class critiques the effectiveness of the instructional method(s) used in each activity.</td>
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<tr>
<td>2</td>
<td>Five</td>
<td>Three teams of students each teach an EE activity to the class. The class critiques the effectiveness of the instructional method(s) used in each activity. Assignment #3, reviewing EE curriculum resources, is given.</td>
</tr>
<tr>
<td>2</td>
<td>Six</td>
<td>In small groups, students compare their reviews of an EE resource from Assignment #3; groups present findings to the class. All resources are then made available for student investigation in a &quot;curriculum fair&quot;. The Lesson concludes with a &quot;resource bowl&quot; to summarize resource highlights.</td>
</tr>
<tr>
<td>2</td>
<td>Seven</td>
<td>Students investigate school site resources for EE, and learn strategies for inventoring and using environmentally-related community resources. Assignment #4, inventoring community resources, is given to those students enrolled for graduate credit.</td>
</tr>
<tr>
<td>2</td>
<td>Eight</td>
<td>In a guided work session, students continue their progress on Assignment #2: designing an instructional plan for infusing EE into their curricula.</td>
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</table>
POSSIBLE COURSE FORMATS:

*Environmental Education Teaching Strategies* can be taught in a variety of formats. The course requires 16 contact hours of actual instructional time. The University of Wisconsin guidelines recommend that students expect to invest double the contact hours, or 32 hours, in additional study time outside of class to adequately complete the course requirements.

Instructors are encouraged to design the 16 hour format of the course to accommodate the schedules and preferences of students enrolled. Three possible formats are suggested:

- **Five Session Format** (a combination of two hour and four hour sessions)
- **Six Session Format** (a combination of two hour and four hour sessions)
- **Eight Session Format** (two hours each)

### Five Session Format

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<tr>
<td>Lesson One</td>
<td>Lessons Two and Three</td>
<td>Lessons Four and Five</td>
<td>Lessons Six and Seven</td>
<td>Lesson Eight</td>
</tr>
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<td>4 hours</td>
<td>4 hours</td>
<td>4 hours</td>
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### Six Session Format

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<tr>
<td>Lesson One</td>
<td>Lessons Two and Three</td>
<td>Lesson Four</td>
<td>Lesson Five</td>
<td>Lessons Six and Seven</td>
<td>Lesson Eight</td>
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<tr>
<td>2 hours</td>
<td>4 hours</td>
<td>2 hours</td>
<td>2 hours</td>
<td>4 hours</td>
<td>2 hours</td>
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<tr>
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### Eight Session Format

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<td>Lesson Two</td>
<td>Lesson Three</td>
<td>Lesson Four</td>
<td>Lesson Five</td>
<td>Lesson Six</td>
<td>Lesson Seven</td>
<td>Lesson Eight</td>
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<tr>
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Lesson One Materials:
1) preassessment forms (one per student)
2) water unit or acid rain unit synopses (one per student) for EE subgoal review
3) discussion sheets (one per group) for EE subgoal review
4) overhead transparency (1) of "Grade Level Major and Minor Emphases"

Lesson Two Materials:
1) carpet squares (or tape, chalk, or string)
2) materials for EE infusion activity (instructor choice)
3) DPI eight step infusion worksheets (page 36): five per student for Assignment #2

Lesson Three Materials:
1) 4-8 pictures from magazines or newspapers depicting environmental topics (e.g., pollution, natural disasters, hunger, depletion of natural resources, or other forms of environmental degradation. Pictures depicting local issues would be especially appropriate.)
2) butcher paper and markers
3) overhead transparencies (8 total) of "Goal Levels in EE" (2); "A Goal-Oriented Framework for Organizing Instructional Methods and Resources" (3); "Dale's Cone of Experience" (3)
4) books from resource library containing EE activities for team teaching assignment (or one copy per student of a selected EE activity contained in instructor appendices)
5) materials, as needed, for EE activities in team teaching assignment
6) critique forms for team teaching assignments (6 per student)

Lesson Four Materials:
1) as needed for activities selected by teams
2) critique forms (3 per student), distributed at the end of Lesson Three

Lesson Five Materials:
1) as needed for activities selected by teams
2) critique forms (3 per student), distributed at the end of Lesson Three

3) EE curriculum resources and review forms (one per student) for Assignment #3

**Lesson Six Materials:**

1) EE curriculum resources from resource library, and other sources as available

2) resource review forms (one per student)

3) "resource bowl" prizes (optional)... pine cones, environmental buttons, wildlife stamps...

**Lesson Seven Materials:**

1) school site investigation materials (instructor's choice)

2) overhead transparency (1) of "Resource Inventory Worksheet of Kincaid Wildlife Refuge"

3) resource inventory worksheets (one per student)

**Lesson Eight Materials:**

1) EE curriculum resources from resource library, and other sources as available

2) Assignment #2 materials

---

*COMMON POLYPHYLY FERN*
A letter grade will be given based on the course assignments. These assignments are described below, and total 100 possible points. Attendance is required at all class meetings. Grade categories are:

<table>
<thead>
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<th>Score Range</th>
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<tr>
<td>93-100</td>
<td>A</td>
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<tr>
<td>90-92</td>
<td>A-</td>
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<tr>
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<tr>
<td>57-59</td>
<td>D-</td>
</tr>
<tr>
<td>50-56</td>
<td>F</td>
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</tbody>
</table>

Due dates for each assignment are set by the course instructor at the time each assignment is given.

### Assignment #1:

**Evaluating Environmental Education in Your School District**

The student will:

1) meet with a local district curriculum coordinator to discuss and evaluate the present and future status of EE in the district.

2) complete and return the accompanying form to the course instructor describing the district and the status of EE in district. (Signature of district curriculum coordinator required.)

**Grading:**

Assignment #1 is worth 25 points. Points will be assigned based on:

- a) evidence of thoughtful preparation and clarity of expression in completing the form;
- b) balanced coverage and completion of all questions in the form.

**Due Date:**

To be determined by the course instructor.

**Late Assignments:**

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.
Evaluating Environmental Education in Your School District

Assignment #1: Natural Resources 414/614 EE Teaching Strategies

Your Name: 
Name of the District: 
Major Town and County: 
CESA: 

Size of District:
  Number of Students 
  Number of Teachers: 
  Number of Administrators: 
  Number of Schools in each grade range: 

Provide a brief outline of the general process used for developing any (not just EE) K-12 curriculum within the district. Who works on it? What is their timeline? How is the final product implemented?

Given that the Wisconsin state legislature mandated the infusion of EE into K-12 education by September 1990, how is the school district responding? What is the status of EE (in terms of curriculum guidelines, teacher awareness, teacher implementation) at present? What changes are anticipated in the future?
List the names and titles of key people in the EE curriculum development process in the district.

Identify the role of CESA in the EE curriculum development process in the district.

Identify any concerns which you, teachers, or administrators have regarding the infusion of EE in the district.

Identify any needs this district has with respect to beginning, continuing, or improving its EE curriculum implementation process.

Signature of Administrator: ________________________________
Position/Title: ________________________________
Address/Phone: ________________________________
Assignment #2:

An Instructional Plan for Infusing Supplemental EE Curriculum Activities

The student will:

1) select a subject area(s). Further,
   a) identify the basic content and skills to be taught in the area(s);
   b) analyze those contents and skills for their infusion potential; and
   c) design an instructional plan for infusion opportunities identified.

In designing the instructional plan, the student will:

1) write three behavioral objectives for each major emphasis EE subgoal for the appropriate grade level in the selected subject area(s).

2) write two behavioral objectives for each minor emphasis EE subgoal for the appropriate grade level in the selected subject area(s).

3) identify or develop one supplemental EE curriculum activity to help teach at least one of the objectives written for each of the five EE subgoals (both major and minor emphasis). In at least one of the activities, utilize a school site or community resource.

4) complete the DPI eight step infusion worksheet for each of the five supplemental EE curriculum activities identified or developed.

Grading:

Assignment #2 is worth 50 points. Point distribution is as follows:

a) behavioral objectives for major and minor emphasis EE subgoals: 10 points total. Objectives should be typed and submitted separately from the DPI infusion worksheets. Behavioral objectives are to be precise statements of learning outcomes. Refer to the Book of Readings, pp. 5-15 for guidelines on writing behavioral objectives.

b) DPI eight step infusion worksheets: 8 points per worksheet X 5 worksheets = 40 points total. Worksheets should evidence thoughtful preparation and should adequately cover each of the eight steps.

Due Date:

To be determined by the course instructor.
Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.

Assignment #3:

Environmental Education Curriculum Resources Review

The student will:

1) review one environmental education curriculum resource.

2) complete and return the accompanying form to the course instructor describing the resource.

3) as a member of a team, present the results of the review to the class.

Grading:

Assignment #3 is worth 25 points. Points will be assigned based on:

a) evidence of a careful review of one curriculum, demonstrated by the thoughtful and concise completion of the form.

b) balanced coverage and completion of all questions in the form.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.
ENVIROMMENTAL EDUCATION CURRICULUM RESOURCES REVIEW

Select a set of resource materials with which you are not familiar and complete the following information:

Your name: ____________________________

Name of resource: ____________________________

Who developed the resource: ____________________________

Appropriate grade level(s): K-3___ 3-6___ 6-9___ 9-12___

Subject areas into which the resource could be infused (check all that apply):
Science___ Social Studies___ Health___ Art___ Math___ Language Arts___
Physical Education___ Other:__________________________

Approximate percentage (%) of activities conducted: outdoors___ % indoors___ %

Are the activities organized sequentially in the resource? yes___ no___
If yes, how are the activities sequenced?

Rank order from 1 to 5 (1 = greatest emphasis; 5 = least emphasis) the Wisconsin DPI
EE subgoals as emphasized in the resource:

Awareness___ Knowledge___ Values and Attitudes____
Citizen Action SKILLS___ Citizen Action EXPERIENCE___

What are the predominant instructional methods used in the resource?

Describe at least three strengths of the resource:

Describe at least one drawback/weakness of the resource:

Describe how this resource might be useful for infusion into YOUR curriculum?

Cost and ordering information (if available):

Other comments:
Assignment #4:

ONLY FOR STUDENTS ENROLLED FOR GRADUATE CREDIT

Inventorying Community Resources

The student will:

1) inventory one environmentally-related community resource.

2) complete and return the resource inventory worksheet to the course instructor describing the resource.

3) duplicate the resource inventory worksheet for distribution to the class (one copy per student).

Grading:

Assignment #4 is graded Pass/Fail. Students enrolled in NR 614 must complete Assignment #4 with a passing grade in order to receive graduate credit for the course. Assignments receiving a failing grade are to be reworked and resubmitted until a passing grade is awarded. Assignments will be evaluated based on:

   a) evidence of a careful inventory of one community resource, demonstrated by the thoughtful and concise completion of the worksheet.

   b) balanced coverage and completion of all inventory criteria in the worksheet.

   c) successful distribution of the worksheet to all students in the class.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due receives a failing grade, and the student will receive an incomplete for the NR 414/614 course grade. The student will be required to complete assignment #4 with a passing grade in order to receive credit for the course.
The Resource Inventory Worksheet

Name of the Resource: __________________________________________

Appropriate Content Area Usage: __________________________________

Appropriate for the Following: Field Trip __; In Class Use __; Investigation
by Students __; Other __ (Please Explain) ____________________________

Address/Location: ______________________________________________

Contact Person and Address: _______________________________________

_________________________________________________________________

Telephone: ______________________________________________________

Suggestions for Use: _____________________________________________

Use Limitations/Restrictions: _______________________________________

Check which of the following EE subgoals can be taught using the resource:

awareness __; knowledge __; values and attitudes __;
citizen action SKILLS __; citizen action EXPERIENCE __
ENVIRONMENTAL EDUCATION TEACHING STRATEGIES
NR 414/614

Course Outline

I. Introduction
   A. Review of EE Goal and Subgoals

II. Grade-Level Emphases of EE Subgoals
   A. Major
   B. Minor

III. Status of the District EE Plan

IV. Strategies for Infusion
   A. Identifying Areas for Infusion
   B. Designing an Instructional Plan

V. Correlating Methods to EE Goals
   A. Methods at Each EE Goal Level
   B. Team Teaching of EE Activities

VI. EE Curriculum Resources

VII. School Site and Community Resources

VIII. Designing an Instructional Plan

ENVIRONMENTAL EDUCATION TEACHING STRATEGIES
NR 414/614

Goals:

As a result of this course, students will:

1) understand and be able to apply the awareness, knowledge, attitudes and values, and action skills inherent in environmental education.

2) demonstrate the ability to effectively implement instructional methods and materials designed to assist the development of environmentally literate students.

3) experience and utilize a variety of instructional methods and resources (i.e., curricular, school site, and community).

4) develop motivation to teach environmental education at all grade levels and in all subject areas.
ENVIRONMENTAL EDUCATION TEACHING STRATEGIES
NR 414/614

Objectives:

As a result of this course, students will:

1) analyze a sample environmental education unit and identify the five subgoals of EE in the unit (awareness, knowledge, values and attitudes, citizen action skills, and citizen action experience).

2) distinguish between major and minor emphases for environmental education subgoals at each of four grade level groups.

3) assess the present and future status of environmental education in a local school district by meeting with the district curriculum coordinator.

4) provide a rationale for the infusion model as one way of integrating environmental education into the K-12 curricula.

5) generate a list of content matter and process skills emphasized in an environmental education activity.

6) categorize content matter and process skills emphasized in an environmental education activity into one or more subject areas.

7) evaluate subject area content and skills for environmental education infusion opportunities.

8) develop an instructional plan for infusing at least five supplemental environmental education curriculum activities into selected subject area curricula.

9) identify at least three instructional methods recommended for each EE goal level to accomplish learner objectives.

10) identify methods recommended for teaching the major EE emphasis areas at the student's grade level grouping.

11) prepare and teach, as a member of a team, a specific EE activity which emphasizes a particular instructional method.
12) demonstrate the ability, as a member of a team, to organize and instruct an EE activity which utilizes method(s) recommended for accomplishing EE goals.

13) evaluate an EE activity for effective use of instructional methods by means of a written and verbal critique.

14) determine at which EE goal level(s) a specific instructional method would be effective.

15) review one environmental education curriculum resource and assess the instructional methods, EE goal levels, grade levels, and subject areas addressed.

16) identify environmental education curriculum resources available for specific grade levels and subject areas.

17) demonstrate the ability to utilize school site and community resources in environmental education instructional planning.

18) describe at least five community resources which could be included in an environmentally-related resource inventory.
Lesson One: Getting Underway...

Objectives: Students will be able to:

1) analyze a sample environmental education unit and identify the five subgoals of EE in the unit (awareness, knowledge, values and attitudes, citizen action skills, and citizen action experience).

2) distinguish between major and minor emphases for environmental education subgoals at each of four grade level groups.

3) assess the present and future status of environmental education in a local school district by meeting with the district curriculum coordinator.

Method: Students are familiarized with the course, complete a preassessment form, and review the goal and subgoals of EE through investigation of sample units. Major and minor emphases for EE subgoals at grade level groups are studied. Assignment #1, the status of EE in the local school district, is given.

Instructional Time: 2 hours

Readings:

1) "Goal and Objectives of EE" (BR pg. 1)

2) "Grade-Level Emphases of EE" (BR pg. 2)

3) "Wisconsin EE Curriculum Mandate" (BR pp. 3-4)

Background: A brief review of the goals and subgoals of environmental education is needed as a starting point for this course in EE teaching strategies. After becoming reacquainted with awareness, knowledge, values and attitudes, citizen action skills, and citizen action experience, the next step is the concept of major and minor emphases of subgoals. Based on the contemporary learning theories of Piaget and others, different subgoals are stressed at different grade levels. These varying emphases are crucial in the process of effective EE curriculum development, from the classroom to the district level. Quality classroom
instruction of EE is tied to the local school district’s careful
development and implementation of a cohesive EE plan at
all grade levels and in all subject areas. Because of this,
the course’s first assignment is to assess the status of EE
in the local school district. Proceeding from that
assessment, strategies for implementing EE at the
classroom level becomes the focus of this course.

The major purpose of Lesson One is for students to review
the goal and subgoals of EE, to examine grade level
emphases of the subgoals, and to investigate the status of
their district’s EE plan.

Materials:

1) preassessment forms (one per student)
2) water unit or acid rain unit synopses (one per student)
   for EE subgoal review
3) discussion sheets (one per group) for EE subgoal
   review
4) overhead transparency (1) of "Grade Level Major and
   Minor Emphases"

Procedure:

1) Introductions (15 minutes):
   a) Introduce yourself to the students.
   b) Have students complete the course registration
      forms from UW-SP’s Continuing Education
      Office if they have not done so already.
   c) Give a general overview to the course and its
      goals.
   d) Explain class meeting schedule (dates, times,
      location) and attendance expectations.

* Note to Instructor: Students will need to bring their
  subject area and/or grade level curricula (district,
  CESA, or school) for use throughout the course.
  Textbooks might also be useful. Ask students to
  bring these to all future class meetings.
e) Review with students the course grading criteria in the "Summary of Assignments"; details for completing the assignments need not be given at this time.

2) A brief (20 minute) "get acquainted" activity of the instructor's choice may be used to begin Lesson One. (Otherwise, proceed to step 3.)

One possible activity is to ask students to reflect quietly for 1-2 minutes on an "environmental memory", on memorable outdoor places and environments from their childhood. Have students share their memory with a partner or in a small group. Conclude by encouraging students to be "gatekeepers to the door of nature for children."

3) Preassessment (20 minutes):

a) Distribute a preassessment form (pages 24-25) to each student and explain the instructions for completing it.

b) When students have completed the form, you might invite students to share some of their responses with the class (for instance, question #1, "Why I teach...")

c) Collect the preassessment forms and review them outside of class. Responses may have bearing on how you structure the course. Return the forms to students during the next class period. (Forms can be collected without names, should you wish to preserve confidentiality. Number them instead.)

4) Reviewing the Goals of EE (30 minutes):

a) To review the goal and subgoals of EE studied in NR 411/611, divide students according to their teaching assignments into two groups, K-6 or 7-12. Then subdivide each group into smaller work groups of 3-5 students. To each student in the K-6 work groups distribute a synopsis of the "Water" unit (page 26); to each student in the 7-12 work groups distribute a synopsis of the "Acid Rain" unit (pages 27-28).

b) Provide each group with a discussion sheet to facilitate their task. (K-6 and 7-12 groups receive the same discussion sheet.) The following questions are listed on the discussion sheet:
1. Individually, read the synopsis of the EE unit provided. Complete the task explained on the worksheet. (Refer to the Book of Readings, page 1, for review as needed.)

2. As a group, discuss task results. Do you think some EE subgoals are emphasized more than others? If so, which ones?

3. For which grade levels would this unit be appropriate? For which subject areas? Could you use or adapt this unit for your curriculum? Would you want to?

c) Gather all the K-6 work groups together for a combined discussion of their assessment. Likewise, gather all the 7-12 work groups together for their assessment. Circulate between the two groups and facilitate as needed.

d) In one large group, highlight the findings of both the K-6 and 7-12 groups, emphasizing the five EE subgoals as seen in the units.

5) Major and Minor Emphases of EE Subgoals for Grade Levels (15 minutes):

a) Introduce the concept that various subgoals are emphasized at various grade levels. You might ask students to hypothesize which of the four grade level groups (K-3, 3-6, 6-9, 9-12) would focus on awareness as a major emphasis. (Yes, at the K-3 level.) What about citizen action? (the 9-12 level) Other major and minor emphases aren't always as "intuitively" obvious, so use the overhead transparency provided on Grade Level Emphases to further develop the concept. (Students can refer to this chart in their Book of Readings, page 2.)

b) Refer to the units which the students have just examined. Can students cite examples of major and minor grade level emphases in the units?

c) Have each student identify the major emphases for his or her grade level group. While the minor emphases will not be overlooked, the focus of this course will be to enable students to explore and practice teaching methods within their major emphases.
6) Introduce Assignment #1: Status of the District EE Plan (20 minutes)

a) Review with students the Wisconsin EE curriculum mandate (BR pages 3-4).

b) Introduce the assignment described in the evaluation section of this Lesson. Students are to meet with a local district curriculum coordinator to discuss the present and future status of EE in the district. Review the form accompanying Assignment #1 which the students are to complete with information gathered during their meeting.

* Note to Instructor: One possibility for expediting Assignment #1 is to arrange for the district curriculum coordinator to meet with students before or after class. Students unable to attend this meeting would arrange their own meeting time with the coordinator.

The due date for Assignment #1 should be the next class meeting (ideally). Lesson Two addresses EE at the district level; the remainder of the course focuses on EE at the classroom level.

Extensions: Further discussion using questions from the preassessment questionnaire and/or the form for Assignment #1 might be useful.

Evaluation: Assignment #1:

Evaluating Environmental Education in Your School District

The student will:

1) meet with a local district curriculum coordinator to discuss and evaluate the present and future status of EE in the district.

2) complete and return the accompanying form to the course instructor describing the district and the status of EE in district. (Signature of district curriculum coordinator required.)
Grading:

Assignment #1 is worth 25 points. Points will be assigned based on:

a) evidence of thoughtful preparation and clarity of expression in completing the form;

b) balanced coverage and completion of all questions in the form.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.
Evaluating Environmental Education in Your School District
Assignment #1:
Natural Resources 414/614 EE Teaching Strategies

Your Name: ________________________________
Name of the District: _______________________
Major Town and County: ____________________
CESA: ________

Size of District:
Number of Students: __________
Number of Teachers: __________
Number of Administrators: ______
Number of Schools in each grade range:


Provide a brief outline of the general process used for developing any (not just EE) K-12 curriculum within the district. Who works on it? What is their timeline? How is the final product implemented?

Given that the Wisconsin state legislature mandated the infusion of EE into K-12 education by September 1990, how is the school district responding? What is the status of EE (in terms of curriculum guidelines, teacher awareness, teacher implementation) at present? What changes are anticipated in the future?
List the names and titles of key people in the EE curriculum development process in the district.

Identify the role of CESA in the EE curriculum development process in the district.

Identify any concerns which you, teachers, or administrators have regarding the infusion of EE in the district.

Identify any needs this district has with respect to beginning, continuing, or improving its EE curriculum implementation process.

Signature of Administrator: ____________________________

Position/Title: _______________________________________

Address/Phone: ______________________________________
ENVIRONMENTAL EDUCATION TEACHING STRATEGIES

UNIVERSITY OF WISCONSIN-STEVEN'S POINT
NATURAL RESOURCES 414/614

PREASSESSMENT

Please answer the following 7 questions. Your responses will help the instructor(s) determine the background of class participants and design the course as much as possible to accommodate participant desires and needs.

1. Please describe yourself as a teaching professional: how many years you have taught, which grades and subjects, and why you teach.

2. Check which of the following methods apply to your teaching style. Then circle the three methods in which you feel most proficient and which you primarily use in your teaching.

   - lecture & discussion
   - a/v & discussion
   - demonstrations
   - role playing
   - concept mapping
   - cooperative learning
   - storytelling
   - art, music, theater
   - teaching outdoors
   - case studies
   - community resource use
   - inquiry
   - reading & discussion
   - experiments
   - simulations, models
   - debates, panels
   - brainstorming
   - computer simulations
   - guided imagery
   - field trips
   - issue analysis
   - projects
   - problem-solving
   - values and moral education strategies

   other (please describe):

3. Circle the number which best describes how comfortable you feel teaching about environmental topics:

   very unsure  unsure  ok  confident  very confident
   1  2  3  4  5

24
4. Check any of the following environmental education teaching resources which you are currently using:

___ Project Learning Tree  ___ Project WILD
___ Project WILD Aquatic   ___ Naturescope series
___ Living Lightly series   ___ CLASS Project
___ Audubon Adventures      ___ OBIS

___ Wisconsin DNR publications (specify which ones):

___ Other materials (specify materials and source):

5. Describe any courses, workshops, conferences, or experiences which you have had that have prepared you to teach about the environment.

6. Do you have district environmental education objectives as part of your curriculum plan for your grade/subject? (If "yes", describe how useful these objectives are to you.)

7. Complete this sentence: "When the course is over, the most important thing I want to have learned is......"
YOUR TASK: Order the five lessons of this water unit into a progression (1st lesson, 2nd lesson, 3rd lesson...) using the five subgoals of environmental education as a framework. Identify the subgoal on which each lesson is based. Refer to the Book of Readings, page 1, for review.

<table>
<thead>
<tr>
<th>Lesson #</th>
<th>Subgoal</th>
<th>Lesson Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Students develop an understanding of the relative distribution of water resources on Earth, learn the steps of the water cycle, and realize the limited renewable nature of water as a resource.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students track down sources of water pollution in hypothetical &quot;Crystal River&quot; by investigating the amount of pollutants in water samples and using sleuthing clues.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students take an artistic approach to understanding the importance of water to all living things and learn how humans can impact this resource.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students calculate the gallons of water used in their homes daily and make &quot;Water Deputy&quot; badges and pledges to help their families conserve water.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students take roles in a story dealing with the negative ways of thinking about water, identify those viewpoints, and suggest positive ways of thinking about water.</td>
</tr>
</tbody>
</table>

* Note: this synopsis is based on the UW-SP curriculum, 'Water' We Doing With Water?, 1991.
YOUR TASK: Order the five lessons of this acid rain unit into a progression (1st lesson, 2nd lesson, 3rd lesson...) using the five subgoals of environmental education as a framework. Identify the subgoal on which each lesson is based. Refer to the Book of Readings, page 1, for review.

<table>
<thead>
<tr>
<th>Lesson #</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Students investigate the acid rain issue by designing a survey to collect data. Students organize the data, interpret and communicate their findings (including any conclusions or recommendations.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students read various articles which present diverse perspectives on acid rain issues. In small groups, students identify positions, points of view, and potential consequences of those views ecologically, socially, economically, and politically.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students learn about properties of acids using limestone and dilute hydrochloric acid. A media presentation, guest speaker, or field trip to a coal-fired power plant helps students become familiar with the process of generating electricity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students work in small groups to propose solutions to the acid rain issue. Each group devises a plan to implement the proposed solutions. The plan is evaluated with the teacher, and students are given the opportunity to implement their plan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students view the video tape &quot;Acid Rain: New Bad News&quot;, which presents two major sources of acid rain and three main theories about its effects. Students prepare and interpret posters which display the cause-and-effect relationships involved in acid rain.</td>
</tr>
</tbody>
</table>

* Note: this synopsis is based on a case study in the UNESCO-UNEP document, *An Environmental Education Approach to the Training of Teachers*, environmental education series #27, 1988.
Lesson Two: Strategies for Infusion

Objectives: Students will be able to:

1) provide a rationale for the infusion model as one way of integrating environmental education into the K-12 curricula.

2) generate a list of content matter and process skills emphasized in an environmental education activity.

3) categorize content matter and process skills emphasized in an environmental education activity into one or more subject areas.

4) evaluate subject area content and skills for environmental education infusion opportunities.

5) develop an instructional plan for infusing at least five supplemental environmental education curriculum activities into selected subject area curricula.

Method: Students review Assignment #1. A group challenge activity is used to demonstrate the infusion model. Students participate in an EE activity and evaluate its infusion potential into various subject areas. Assignment #2, developing an instructional plan for infusing supplemental EE curriculum activities, is given.

Instructional Time: 2 hours

Readings:

1) "How to Organize a Lesson Plan" (BR pp. 5-15)

2) "Sample Infused Units" (BR pp. 16-24)

Background: The task of formulating and implementing a cohesive EE curriculum plan, whether in a school district or in an individual classroom, can seem colossal. In Lesson Two, students become acquainted with the rationale and strategies for EE infusion in order to put this task in its proper perspective. The process is in three simplified steps:
1) Students identify the basic content matter and skills in a selected subject area (using their curricula and texts as guides).

2) Students analyze those contents and skills for potential areas for EE infusion.

3) Students design an instructional plan for infusion opportunities which they identified.

This process, outlined in An EE Approach to the Training of Middle Level Teachers: A Prototype Programme (UNESCO, 1990), can be adapted for a single lesson or for an entire district K-12 plan.

The major purpose of Lesson Two is for students to gain experience using the basic strategies in planning and implementing EE infusion.

Materials:

1) carpet squares (or tape, chalk, or string)
2) materials for EE infusion activity (instructor choice)
3) DPI eight step infusion worksheets (page 36): five per student for Assignment #2

Procedure:

1) District Status of EE (20 minutes):
   a) As a class, review student findings from Assignment #1 about the current status of EE in the local school district. Compare this with the requirements of the Wisconsin EE curriculum mandate. Discuss the school district’s progress toward fulfilling mandate requirements:

   "What IS happening in your school district in environmental education?"

   "What SHOULD BE happening in your school district in environmental education?"

   "What are you PROUD OF or DISAPPOINTED ABOUT in your school district’s efforts in environmental education?"

   b) Emphasize the integral and essential role the school district plays in the sequential implementation of EE across the K-12 curricula.

Learning science is not just knowing from others what is already known.

UNESCO, 1986
Yet, even if a school district’s EE plan is lacking, there are many ways the individual classroom teacher can make EE a consistent focus of student learning. Having looked at the role of the school district in the implementation of EE, inform students that the remainder of the course will emphasize EE at the classroom level... what the teacher can do.

2) What is infusion? (15 minutes):

In education, infusion refers to the integration of certain content with existing courses in a manner as to focus on that content without jeopardizing the integrity of the courses themselves. In the case of EE, the professional educator carefully analyzes traditional courses for content and/or skills which could be "environmentalized". Finding such, the educator adapts that content/skills component so that environmental goals can be facilitated.

(From An EE Approach to the Training of Elementary Teachers: A Teacher Education Program. UNESCO, 1988.)

a) Demonstrate the single subject approach ("add-on") vs. the infusion model of EE using a human body/group challenge activity.

Try to fit 3/4 of the class --- representing the existing curricula --- on several carpet squares (or a limited area marked by tape, chalk, or whatever else works.) Then try to "add on" the remaining 1/4 of the class --- representing EE --- to this already limited space. Get ready for some contortions and wild balancing acts!

Next, illustrate the infusion model by having the 1/4 of the class (EE) join hands around the balancing 3/4 (the existing curricula) to act as a support.

b) Debrief the exercise by drawing analogies between the activity and the task of implementing EE in the school curricula. Discuss the pros and cons of the single subject ("add-on") approach and infusion model. Stress that infusion is a way of supporting the existing curricula. To see how this can actually work, students will now participate in an EE activity and analyze its infusion potential.
3) Experiencing an EE infusion activity (30 minutes):

The EE activity to be taught is determined by you, the course instructor. Suggested activities are:

"Deadly Links" from Project WILD Secondary, pp. 123-126. (Students become hawks, shrews, and grasshoppers to demonstrate pesticides in a food chain.)

"Adopt-A-Tree" from Project Learning Tree K-6, pp. 4-6. (Students select and investigate numerous aspects of a tree.)

"Hooks and Ladders" from Project WILD Aquatic, pp. 69-73. (Students simulate salmon in an activity portraying their life cycle and hazards faced by salmon.)

4) Evaluating an EE infusion activity (30 minutes):

* Note to Instructor: Students will need their subject area and/or grade level curricula (district, CESA, or school) for the remainder of Lesson Two. If students do not have curricula and/or texts, remind students to bring these to all future class meetings.

a) After completing the EE activity, have students brainstorm a list of specific content matter or skills addressed in the lesson. (For example, in "Deadly Links", content matter could include food chains, pesticides, and nutrition. Skills covered could include computation, classification, and psychomotor development.) Next, have students categorize the content and skills into subject areas (e.g., computation; math). There will be, and should be, overlap between some subject areas!

* Note to Instructor: You might wish to make a chart for the above brainstorming session, with content and skills on the left, and correlated subject areas on the right.

b) Next, divide students into groups of 3-5 by their subject area teaching assignments (e.g., social studies, art, science) and grade level groupings (K-3, 3-6, 6-9, or 9-12). Each group should
describe where the EE activity in which they have just participated could be infused into their group's subject area curriculum at the appropriate grade level. For example, a group focusing on social studies in grades 3-6 would identify all possible areas/topics/units of the social studies curriculum which could be targeted for infusion of the EE activity.

c) Reconvene the class and have each group briefly report their targeted areas for infusion.

5) Introduce Assignment #2: An Instructional Plan for Infusing Supplemental EE Curriculum Activities (25 minutes)

a) Introduce the assignment described in the evaluation section of this Lesson. This assignment is intended to help students better understand the basic strategies and skills needed to accomplish the infusion of EE. (Lessons 3-8 will further equip students to complete Assignment #2.)

* Note to Instructor: The preliminary selection of a subject area(s) by the student and the analysis of its content and skills for infusion potential is not graded as part of Assignment #2. However, the instructional plan results from these essential preliminaries.

b) There are several helpful resources included in the students' Book of Readings for developing the instructional plan. Review these resources with the students.

"How to Organize a Lesson Plan" (BR pp. 5-15) provides useful information on writing behavioral objectives.

"Sample Infused Units" (BR pp. 16-24) provides four units using the eight step infusion worksheet. These are good samples to guide students in completing the Assignment #2 worksheets. These sample units are reproduced from the Wisconsin DPI's A Guide to Curriculum Planning in EE (1986).
Extensions:

1) Select one of the sample infused units (BR pp. 16-24) and highlight the eight step infusion process.

2) Demonstrate how to use Avoiding Infusion Confusion guides to identify activities for specific content areas.

Evaluation: Assignment #2

An Instructional Plan for Infusing Supplemental EE Curriculum Activities

The student will:

1) select a subject area(s). Further,
   a) identify the basic content and skills to be taught in the area(s);
   b) analyze those contents and skills for their infusion potential; and
   c) design an instructional plan for infusion opportunities identified.

In designing the instructional plan, the student will:

1) write three behavioral objectives for each major emphasis EE subgoal for the appropriate grade level in the selected subject area(s).

2) write two behavioral objectives for each minor emphasis EE subgoal for the appropriate grade level in the selected subject area(s).

3) identify or develop one supplemental EE curriculum activity to help teach at least one of the objectives written for each of the five EE subgoals (both major and minor emphasis). In at least one of the activities, utilize a school site or community resource.

4) complete the DPI eight step infusion worksheet for each of the five supplemental EE curriculum activities identified or developed.

Grading:

Assignment #2 is worth 50 points. Point distribution is as follows:
a) behavioral objectives for major and minor emphasis EE subgoals: 10 points total. Objectives should be typed and submitted separately from the DPI infusion worksheets. Behavioral objectives are to be precise statements of learning outcomes. Refer to the Book of Readings, pp. 5-15 for guidelines on writing behavioral objectives.

b) DPI eight step infusion worksheets: 8 points per worksheet X 5 worksheets = 40 points total. Worksheets should evidence thoughtful preparation and should adequately cover each of the eight steps.

Due Date:
To be determined by the course instructor.

Late Assignments:
An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.
### EE Infusion Lesson

<table>
<thead>
<tr>
<th>Process Steps</th>
<th>Existing Unit Characteristics</th>
<th>Added Environmental Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Select environmental topic to be infused.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Identify subject area targeted for infusion.</td>
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<td></td>
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<tr>
<td>3. Develop environmental objectives for the subject area unit.</td>
<td></td>
<td></td>
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<tr>
<td>4. Specify environmental content to be added to the unit.</td>
<td></td>
<td></td>
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<tr>
<td>5. Develop new instructional procedures if they are needed.</td>
<td></td>
<td></td>
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<tr>
<td>6. Identify new process skills to be developed.</td>
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<td></td>
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<tr>
<td>7. Identify new resources.</td>
<td></td>
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<tr>
<td>8. Identify related activities and suggested new topics for investigation.</td>
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</tr>
</tbody>
</table>
Lesson Three: Which Methods For Which Goals???

Objectives: Students will be able to:

1) identify at least three instructional methods recommended for each EE goal level to accomplish learner objectives.

2) identify methods recommended for teaching the major EE emphasis areas at the student's grade level grouping.

3) prepare and teach, as a member of a team, a specific EE activity which emphasizes a particular instructional method.

Method: Students participate in an EE activity, evaluate methods used in it, and brainstorm a list of possible methods effective for accomplishing EE subgoals. Students are then introduced to "Goals for Curriculum Development in EE", correlate these four goal levels to the five EE subgoals, and discuss recommended methods for each goal level. Finally, students work in teams to prepare EE activities which they instruct during Lessons Four and Five.

Instructional Time: 2 hours

Readings:

1) "Goal Levels in EE" (BR pp. 25-26)

2) "A Goal-Oriented Framework for Organizing Instructional Methods and Resources" (BR pp. 27-29)

3) "Dale’s Cone of Experience" (BR pp. 30-32)

3) "Teaching Methodologies in EE" (BR pp. 33-49)

4) "Strategies for Dealing with Controversial Issues in the Classroom" (BR pp. 50-54)

5) "Concept Mapping with Earthwatching III" (BR pp. 55-59)
Background: There are many possible instructional methods which could be used to accomplish the five EE subgoals. Teachers need to develop experience and confidence with these instructional methods and be prepared to use them in their own classrooms. "Teachers cannot be expected to become effective environmental educators (i.e., change students' behavior) if they are prepared to use only lecture and discussion approaches in the teaching-learning process." (UNESCO, 1990)

Lesson Three aims to answer one major question: "Which methods would be particularly effective in helping to accomplish each EE subgoal?"

At this point in the course, a transition is made from the Tbilisi Declaration's five subgoals to the four goal levels in "Goals for Curriculum Development in Environmental Education" proposed by Hungerford, Peyton, and Wilke (1980). The rationale for making this transition is that curriculum developers have struggled with translating Tbilisi's general goal and subgoals of EE into manageable instructional objectives for program and classroom curricula. An intermediate set of subgoals was needed to bridge the gap between the general goal of EE as set forth by the Tbilisi Declaration, and manageable instructional objectives needed by EE practitioners. The four goal levels in "Goals for Curriculum Development in Environmental Education" have proved to be very successful in bridging the gap.

Using these four goal levels, a framework for organizing recommended methods around the goals of EE can be used as a tool in developing instructional plans. This allows environmental educators to select methods to accomplish EE goals based on accepted educational theories, models, and research.

The major purpose of Lesson Three is for students to understand the relationship between methods and EE goals, and to gain practical experience with a number of methods effective in EE.
Materials:

1) 4-8 pictures from magazines or newspapers depicting environmental topics (e.g., pollution, natural disasters, hunger, depletion of natural resources, or other forms of environmental degradation. Pictures depicting local issues would be especially appropriate.)

2) butcher paper and markers

3) overhead transparencies (8 total) of "Goal Levels in EE" (2); "A Goal-Oriented Framework for Organizing Instructional Methods and Resources" (3); "Dale’s Cone of Experience" (3)

4) books from resource library containing EE activities for team teaching assignment (or one copy per student of a selected EE activity contained in instructor appendices)

5) materials, as needed, for EE activities in team teaching assignment

6) critique forms for team teaching assignments (6 per student)

Procedure:

1) Environmental Problem-solving (15 minutes):

   a) Begin Lesson Three by posting 4-8 pictures around the classroom which depict pollution, natural disasters, hunger, depletion of natural resources, or other forms of environmental degradation. (Pictures depicting local issues would be especially appropriate.) Pictures could be photographs from magazines, newspapers, or other sources. Each picture should be clearly numbered (#1, #2, #3...). Each student numbers a piece of paper to correspond to the numbers on the pictures. While viewing the pictures, students answer the following questions:

      1. What problem does the picture suggest to you?

      2. What are several solutions or ways to prevent this problem?

   b) When students have finished viewing the pictures and answering questions, have them

   In EE it is necessary to adopt the problem-oriented and action-oriented methodologies, which require more learner involvement if we intend to achieve the goals of EE. Emphasis must be on students investigating the events and conditions of their immediate environments and working out solutions to its problems.

   UNESCO, 1986
discuss and compare their findings (in small groups or as a class).

Discussion questions:

1. Could there be any other environmental problems suggested by these pictures?
2. What are possible causes of these problems?
3. Would other environmental problems could be caused by the solutions suggested?
4. Are there actions you would be willing to take to help solve these problems?

(activity adapted from EE: Module for In-Service Training of Social Science Teachers and Supervisors for Secondary Schools, UNESCO, 1985.)

2) Organizing Instructional Methods Around EE Goals:

a) Have students brainstorm a list of methods which were used in the environmental problem-solving activity. Do the methods utilized in this activity effectively address any of the five EE subgoals? If so, which one(s) and how? (5 minutes)

b) Divide students into five groups. Provide each group with butcher paper and markers. Each group has the same task: to list as many possible instructional methods which could be used to accomplish the five EE subgoals. After groups have made their lists, assign each group a different subgoal. Each group should then evaluate its list and identify which methods would be particularly effective in helping to accomplish that subgoal. Have each group briefly share its work with the class. (20 minutes)

* Note to Instructor: what follows is a list --- though certainly not exhaustive --- of possible instructional methods.

Inquiry
Presentations and Demonstrations
Simulations and Models
Role Playing
Panel Discussions and Debates
3) **Goals for Curriculum Development in EE:**

**a)** It is important for students to understand the relationship between instructional methods and EE goals.

Explain to students that up to this point in the course, the framework used for EE goals has been the five subgoals set forth in the Tbilisi Declaration (1977) and the Wisconsin DPI's *Guide to Curriculum Planning in EE* (1986). Because curriculum developers have struggled with translating these five subgoals of EE into manageable classroom objectives and curricula, an intermediate set of goals was needed to bridge the gap. Thus, the "Goals for Curriculum Development in Environmental Education" were proposed by Hungerford, Peyton, and Wilke (1980). These four goal levels for EE will now be used as the framework for the course when relating methods and EE goals. *(5 minutes)*

**b)** Using the overhead transparency "Goal Levels in EE", highlight major components of each of the four goal levels. *(The transparency is included in the students’ Book of Readings, pp. 25-26.)* Develop the transition from the Tbilisi Declaration's five subgoals to the four
There are a variety of methods and resources available... and there is no "one best method" of instruction for addressing each goal level. Planners should utilize a combination of methods and resources which are available and which have been found to be effective.

UNESCO, 1990

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c) Using the overhead transparency "A Goal-Oriented Framework for Organizing Instructional Methods and Resources", compare the methods described at each goal level with those identified by students working in small groups (step 2b above). (The transparency is included in the students' Book of Readings, pp. 27-29.) Because different objectives are emphasized at each goal level, methods should be carefully selected in order to attain those objectives. The most effective methods will therefore vary from goal level to goal level.

Have students use this chart to identify methods recommended for teaching the major EE emphasis areas in their grade level grouping. (Refer to Lesson Two as needed to review major emphasis areas.)  

4) Dale's Cone of Experience: Approaches to Teaching and Learning (10 minutes)

Use "Dale's Cone of Experience" to further reinforce the concept that different instructional methods are needed at different age levels to accomplish various cognitive and affective goals. Three overhead transparencies are provided for presenting "Dale's Cone of Experience":

"Approaches to Teaching and Learning"
"Cognitive Domain: Selecting Experiences for EE"
"Affective Domain: Selecting Experiences for EE"

(The transparencies are included in the students' Book of Readings, pp. 30-32.)

5) Preparation for Team Teaching of Selected EE Activities (45 minutes):

a) Students should form six different teaching teams. Each team should be comprised of students from similar subject area(s), grade levels, and major EE emphasis areas. Each team will prepare and teach to the entire class a specific EE activity which emphasizes at least one particular instructional method. Schedule three teaching teams to instruct their EE activities during Lesson Four; schedule three teams to instruct their EE activities during

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Lesson Five. Each team will be given 30 minutes to instruct their activity.

b) Explain that a 10 minute critique by all students of the activity will follow each team's presentation. Distribute the critique forms at this time so that students can become familiar with the criteria. The purpose of the critique is to provide the members of the teaching team primarily with positive feedback on their instructional methods (and perhaps one or two suggestions for improvement.)

* Note to Instructor: If a team is able to teach its activity to actual K-12 students and videotape the lesson, the tape could be viewed by the class during the team's 30 minute slot in Lesson Four or Five.

Assist each teaching team in selecting an appropriate activity based on team needs and interests. (Make sure each team is instructing a different activity.) Provide guidance as necessary during this 45 minute planning session as teams prepare their activities.

Recommended EE activities for emphasizing at least one specific instructional method are:


   "Are There Any Clearcut Answers?", from *The CLASS Project*, pp. 53-57.

   (Refer students also to BR pp. 43, 50-51.)

3. **Role Playing**: "To Zone or Not To Zone", from *Project WILD Secondary*, pp. 177-180.

   "To Dam or Not To Dam", from *Project WILD Aquatic*, pp. 125-128.

   (Refer students also to BR pp. 44-45, 50-51.)

"Pro and Con: Consumptive and Non-Consumptive Uses of Wildlife", from *Project WILD Secondary*, pp. 33-34.

(Refer students also to BR pp. 51-54.)


7. Creative Arts - Art: "Fashion A Fish", from *Project WILD Aquatic*, pp. 81-85.


(Refer students also to BR pp. 70-78.)


(Refer students also to BR pp. 48-49, 60-62.)


11. Experimental Research: "How Birds Make A Living", from *Central Wisconsin*
Environmental Station Activity Manual.
Included for instructor reference in Appendix F: pp. 89-100.

"No Water Off A Duck’s Back", from Project WILD Secondary, pp. 119-120.

* Note to Instructor: Community resource use is covered later in the course and is not addressed specifically in this Lesson. Also, since the methods of EE issue investigation and case study are covered extensively in NR 413/613, Citizen Action in EE, they are not emphasized in this Lesson.

Extensions: Encourage students to prepare and teach an EE activity which has great potential of being infused into their own curricula... then infuse it and use it!

Evaluation: Team teaching of EE activities, and critiquing of instructional methods, will occur in Lessons Four and Five.
Lesson Four: Team Teaching
Practicum I

Objectives: Students will be able to:

1) demonstrate the ability, as a member of a team, to organize and instruct an EE activity which utilizes method(s) recommended for accomplishing EE goals.

2) evaluate an EE activity for effective use of instructional methods by means of a written and verbal critique.

3) determine at which EE goal level(s) a specific instructional method would be effective.

Method: Three teams of students each teach an EE activity to the class. The class critiques the effectiveness of the instructional method(s) used in each activity.

Instructional Time: 2 hours

Team 1: 30 minutes to teach activity; 10 minutes for critique by class

Team 2: 30 minutes to teach activity; 10 minutes for critique by class

Team 3: 30 minutes to teach activity; 10 minutes for critique by class

Total Time: 120 minutes (2 hours)

Readings: None

Background: To become effective environmental educators, many teachers need guided practice with some of the less-familiar instructional methods used in EE. Having gained direct experience with these strategies, teachers are better prepared to design EE instructional plans utilizing a variety of methods for their students in the classroom.
The major purpose of Lesson Four is for students to acquire practical, guided experience with a variety of instructional methods effective in the field of EE.

**Materials:**

1) as needed for activities selected by teams

2) critique forms (3 per student), distributed at the end of Lesson Three

**Procedure:**

1) The first teaching team instructs its EE activity, involving all students in the course as active participants. The team is allowed 30 minutes to teach the activity. As the course instructor, your primary responsibility is to keep the team on schedule ("You have 2 minutes remaining in which to conclude your activity...") At the end of 30 minutes, have all students complete an "Instructional Methods Critique" form. Allow 5 minutes for students to write their comments on the critique form. Then, invite students to verbally share their comments for 5 minutes with the teaching team. Focus on the importance of processing an activity, not merely "doing it".

Conclude by discussing the relationship between the instructional method(s) demonstrated in the activity and the EE goal levels which could be met with these methods. Collect the critique forms and deliver them to the team for further review.

* Note to Instructor: Throughout the activities in Lesson Four, continue to emphasize the relationship between methods and goals. These are more than just "neat" activities, these are important instructional methods designed to achieve specific EE goal levels in learners.

2) Follow the same procedure for the second and third teaching teams.

**Extensions:** If time allows, resume any EE activities that students would like to continue which concluded after the initial 30 minute period.
**Evaluation:** The "Instructional Methods Critique" form is used after each teaching team's presentation for evaluation in Lesson Four.
Instructional Methods Critique: Name of Activity

Please briefly answer the questions on this critique for the benefit of the teaching team.

1. I believe the teaching team effectively taught the activity and accomplished the activity's goal(s) through the use of the selected instructional method. (Circle the number which best represents your assessment.)

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Comments:

2. Describe the best aspect of the teaching team's instructional methods. If possible, describe one area where the teaching team could improve its instructional methods.

3. Which one of the five EE subgoals was PRIMARILY addressed in the activity?
Lesson Five: Team Teaching
Practicum II

* Note to Instructor: Reserve 5 minutes to introduce Assignment #3 at the end of Lesson Five. Otherwise, Lesson Five is identical to Lesson Four.

Objectives: Students will be able to:

1) demonstrate the ability, as a member of a team, to organize and instruct an EE activity which utilizes method(s) recommended for accomplishing EE goals.

2) evaluate an EE activity for effective use of instructional methods by means of a written and verbal critique.

3) determine at which EE goal level(s) a specific instructional method would be effective.

Method: Three teams of students each teach an EE activity to the class. The class critiques the effectiveness of the instructional method(s) used in each activity. Assignment #3, reviewing EE curriculum resources, is given.

Instructional Time: 2 hours

Team 1: 30 minutes to teach activity; 10 minutes for critique by class

Team 2: 30 minutes to teach activity; 10 minutes for critique by class

Team 3: 30 minutes to teach activity; 10 minutes for critique by class

Total Time: 120 minutes (2 hours)

Readings: None
**Background:** To become effective environmental educators, many teachers need guided practice with some of the less-familiar instructional methods used in EE. Having gained direct experience with these strategies, teachers are better prepared to design EE instructional plans utilizing a variety of methods for their students in the classroom.

The major purpose of Lesson Five is for students to acquire practical, guided experience with a variety of instructional methods effective in the field of EE.

**Materials:**

1) as needed for activities selected by teams
2) critique forms (3 per student), distributed at the end of Lesson Three
3) EE curriculum resources and review forms (one per student) for Assignment #3

**Procedure:**

1) The first teaching team instructs its EE activity, involving all students in the course as active participants. The team is allowed 30 minutes to teach the activity. As the course instructor, your primary responsibility is to keep the team on schedule ("You have 2 minutes remaining in which to conclude your activity...") At the end of 30 minutes, distribute to all students an "Instructional Methods Critique" form. Allow 5 minutes for students to write their comments on the critique form. Then, invite students to verbally share their comments for 5 minutes with the teaching team. Focus on the importance of processing an activity, not merely "doing it".

Conclude by discussing the relationship between the instructional method(s) demonstrated in the activity and the EE goal levels which could be met with these methods. Collect the critique forms and deliver them to the team for further review.

2) Follow the same procedure for the second and third teaching teams.
* Note to Instructor: Throughout the activities in Lesson Five, continue to emphasize the relationship between methods and goals. These are more than just "neat" activities, these are important instructional methods designed to achieve specific EE goal levels in learners.

3) Introduce Assignment #3: EE Curriculum Resources Review (5 minutes)
   
a) Introduce the assignment described in the evaluation section of this Lesson. Each student will need to select a curriculum resource with which he or she is not familiar, review it, and complete a review form before the next class meeting (Lesson Six). The same resources will be reviewed by several students, working individually. Distribute the "EE Curriculum Resources Review" worksheet (one per student).

* Note to Instructor: Insure that a wide variety of curricula are selected for review, not just a few "popular" ones.

**Extensions:** If time allows, resume any EE activities that students would like to continue which concluded after the initial 30 minute period.

**Evaluation: Assignment #3**

Environmental Education Curriculum Resources Review

The student will:

1) Review one environmental education curriculum resource.

2) Complete and return the accompanying form to the course instructor describing the resource.

3) As a member of a team, present the results of the review to the class.
Grading:

Assignment #3 is worth 25 points. Points will be assigned based on:

   a) evidence of a careful review of one curriculum, demonstrated by the thoughtful and concise completion of the form.
   b) balanced coverage and completion of all questions in the form.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due is penalized 10% of the final score earned.
ENVIRONMENTAL EDUCATION CURRICULUM RESOURCES REVIEW

Select a set of resource materials with which you are not familiar and complete the following information:

Your name: __________________________________________________________

Name of resource: _____________________________________________________

Who developed the resource: ___________________________________________

Appropriate grade level(s): K-3   3-6   6-9   9-12

Subject areas into which the resource could be infused (check all that apply):
Science  Social Studies  Health  Art  Math  Language Arts  Physical Education  Other

Approximate percentage (%) of activities conducted: outdoors  %  indoors  %

Are the activities organized sequentially in the resource? yes  no
If yes, how are the activities sequenced?

Rank order from 1 to 5 (1 = greatest emphasis; 5 = least emphasis) the Wisconsin DPI EE subgoals as emphasized in the resource:

Awareness  Knowledge  Values and Attitudes  Citizen Action SKILLS  Citizen Action EXPERIENCE

What are the predominant instructional methods used in the resource?

Describe at least three strengths of the resource:

Describe at least one drawback/weakness of the resource:

Describe how this resource might be useful for infusion into YOUR curriculum?

Cost and ordering information (if available):

Other comments:
Lesson Six: EE Curriculum Resources

Objectives: Students will be able to:

1) review one environmental education curriculum resource and assess the instructional methods, EE goal levels, grade levels, and subject areas addressed.

2) identify environmental education curriculum resources available for specific grade levels and subject areas.

Method: In small groups, students compare their reviews of an EE resource from Assignment #3; groups present findings to the class. All resources are then made available for student investigation in a "curriculum fair". The Lesson concludes with a "resource bowl" to summarize resource highlights.

Instructional Time: 2 hours

Readings:

1) "Annotated Bibliography of EE Resources" (BR pp. 79-87)

Background: Many teaching/learning strategies were modeled by students in Lessons Four and Five. After experiencing these EE activities, students will probably be interested in sources for such infusion activities. A number of fine EE resources are available which contain supplemental curriculum activities. Familiarity with these resources can make the task of selecting infusion activities more streamlined and deliberate --- focusing on EE goal levels and instructional methods for accomplishing them.

The major purpose of Lesson Six is for students to assess the instructional methods, EE goal levels, grade levels, and subject areas addressed in various EE resources.
Materials:

1) EE curriculum resources from resource library, and other sources as available
2) resource review forms (one per student)
3) "resource bowl" prizes (optional)... pine cones, environmental buttons, wildlife stamps...

Procedure:

* Note to Instructor: Prior to this Lesson, students are to have completed Assignment #3.

1) Resource review in small groups (30 minutes):

   a) Form small groups of students who have reviewed the same resource. For example, all students who reviewed NatureScope are in one group; all students who reviewed Living Lightly on the Planet are in another group. Each group should discuss the findings of its members and complete a compiled "EE Curriculum Resources Review" group worksheet. (Optional: have each group make enough copies of this worksheet for distribution to all students at the next class meeting.)

   b) Each group should write at least three questions (with answers!) pertaining to the resource for the final "Resource Bowl" and give these to you. Examples of questions might be:

   "Which resource was developed by the American Forest Foundation?" (Project Learning Tree)

   "Sharing Nature With Children" focuses on which Wisconsin DPI subgoals? (probably awareness and values... but the group can decide)

   "How would a set of NatureScopes be obtained?" (through the National Wildlife Federation)

2) Small group presentations (20-30 minutes, depending on number of groups).
Each group provides an overview of its findings regarding the resource to the class. Make sure to cover information pertinent to quiz bowl questions!

3) Curriculum Fair (40-50 minutes):

Arrange the curriculum resources around the classroom. Students are free to circulate and investigate the available resources. This is an opportune time for students to work on Assignment #2:

"identify or develop one supplemental EE curriculum activity to help teach at least one of the objectives written for each of the five EE subgoals (both major and minor emphasis)."

4) "Resource Bowl" Wrap-Up (20 minutes):

a) Using the questions contributed by groups, host a game show format "Resource Bowl" and involve students in an active review of the EE curriculum resources available. If desired, you could award "prizes" to the winner(s).

Extensions: Invite students to bring in other EE resources which they find useful and describe these to the class (e.g., EE News).

Evaluation: Use the "Resource Bowl" to conclude and summarize available EE curricular resources.

Questions were sort of an inner itch, an urge to go forward. Questions, that is, real questions, had this about them, they were risky things to play about with, but they were exciting. You never quite knew where you were going to land.

Fynn, in Mr. God, This is Anna
Lesson Seven: School Site and Community Resources for EE

Objectives: Students will be able to:

1) demonstrate the ability to utilize school site and community resources in environmental education instructional planning.

2) describe at least five community resources which could be included in an environmentally-related resource inventory.

Method: Students investigate school site resources for EE, and learn strategies for inventorying and using environmentally-related community resources. Assignment #4, inventorying community resources, is given to those students enrolled for graduate credit.

Instructional Time: 2 hours

Readings:

1) "Inventorying and Using Community Resources" (BR pp. 88-90)

2) "Guidelines and Features for Outdoor Classrooms" (BR pp. 91-98)

3) "Have You Ever..." (BR pp. 99-100)

4) "School Site Inventory Activities" (BR pp. 101-108)

Background: One of the most diverse and readily available resources for EE can easily be overlooked: the school site. No field trip school bus is required... just by stepping outside the classroom with students, a wide variety of educational resources are at hand. Urban, suburban, and rural school settings all have unique resources which can open up new avenues for EE. Community resources are another rich reservoir for environmental education. Resource people in the community can serve as guest speakers, sources of information, and mentors. Physical resources in the community can provide opportunities for
field trips, student research projects, study sites, and ecomanagement.

Benefits to students from utilizing school site and community resources can include greater environmental sensitivity, increased knowledge of the local environment, and awareness of regional resources. Skills and concerns developed by students while investigating local resources can be applied toward the resolution of important environmental issues facing the school and community.

The major purpose of Lesson Seven is for students to gain experience in using school site and community resources in EE instructional planning.

**Materials:**

1) school site investigation materials (instructor's choice)
2) overhead transparency (1) of "Resource Inventory Worksheet of Kincaid Wildlife Refuge"
3) resource inventory worksheets (one per student)

**Procedure:**

1) Investigating School Site Resources (**90 minutes**):
   
a) Go outside to the school site! There are over 60 activities described for school site investigations in the Book of Readings (pp. 99-106). Some activities are very brief, some are more involved and require simple equipment. School sites, student needs, weather, class schedules, and other factors will vary; therefore, the actual selection of activities is up to you, the instructor. You may wish to involve students in the activity selection process.

   * Note to Instructor: If the activity "Bird Behavior Bingo" (from *NatureScope: Birds, Birds, Birds*; Appendix D) was not instructed during Lesson Three, it could be used now.

b) Students can work in small groups, and rotate through several different activities during the 90 minute period. Or, the class can work as a large group to complete one activity, then proceed to a second and third activity as time permits.
Since the community is the student's environment, it should be a central resource in his study of environmental problems.

Mayer and McKenzie

c) Conclude by emphasizing the quality and quantity of resources available for EE on the school site. You might end by inviting responses to this question (#6 from "School Site Inventory Activity Cards"):

"What are ten significant things that teachers and students could do this year (at little or no expense) to improve the environment of the school grounds area for living and learning?"

2) Inventorying Community Resources (20 minutes):

a) Brainstorm a list of possible resources which could be inventoried for teaching specific EE goals. These suggestions from "Inventorying and Using Community Resources" (Book of Readings page 89) may be helpful:

"What kinds of resources can be inventoried for an environmentally-related resource inventory? A few examples are: resource people such as wildlife biologists, game wardens, botanists, commercial fishermen, trappers, hunters, waste disposal personnel, waterworks personnel, sewage plant operators, insect and rodent control specialists, greenhouse operators, environmental organizations activists, and ranchers/farmers. Other examples would include physical resources such as: wildlife refuges and parks, national/state forests, farms, ranches, typical ecosystems (biomes), zoos, fish hatcheries, sewage plants, waterworks, garbage dumps (landfills), electrical utilities, commercial airports, strip mines, fertilizer industries, toxic waste dumps, university facilities such as departments of fisheries or wildlife, local parks having environmental potential, environmental centers, and recycling centers."

b) Discuss with students the purpose and benefits of a community resource inventory. By compiling an inventory, students become more familiar with community resources and consider how to use these resources instructionally.

You might want to read aloud the first two paragraphs in "Inventorying and Using Community Resources" (Book of Readings, page 88) as an illustration. A school is described with abundant natural resources on the school site and in the community. Sadly, the
resources so close at hand are not used. Students are not allowed out of the "two-by-four classrooms" (two covers of a book and four walls of a classroom).

c) Using the overhead transparency provided of the "Kincaid Wildlife Refuge", outline the process of inventorying a resource. (The transparency is included in the students' Book of Readings, pg. 90.)

3) Introduce Assignment #4: Inventorying Community Resources (Only for Students Enrolled for Graduate Credit) (10 minutes)

a) Introduce the assignment described in the evaluation section of this Lesson. Assignment #4 is only for students enrolled for graduate credit in the course (NR 614).

b) Each student enrolled for graduate credit selects a different resource to inventory from the brainstormed list. (Students could place their initials next to resources on the list, indicating to others which resources were covered and which were still available to be inventoried.) Each student will then complete a resource inventory worksheet for the chosen resource and distribute copies of the worksheet to all students in the class.

* Note to Instructor: Inform students that the next (and final) class meeting, Lesson Eight, will be a guided work session on Assignment #2. Students should bring the appropriate materials to this class meeting.

**Extensions:** Invite a curriculum specialist or other qualified person to speak to students about potential community resources for environmental education.
Evaluation: Assignment #4

Inventorying Community Resources

The student will:

1) inventory one environmentally-related community resource.

2) complete and return the resource inventory worksheet to the course instructor describing the resource.

3) duplicate the resource inventory worksheet for distribution to the class (one copy per student).

Grading:

Assignment #4 is graded Pass/Fail. Students enrolled in NR 614 must complete Assignment #4 with a passing grade in order to receive graduate credit for the course. Assignments receiving a failing grade are to be reworked and resubmitted until a passing grade is awarded. Assignments will be evaluated based on:

a) evidence of a careful inventory of one community resource, demonstrated by the thoughtful and concise completion of the worksheet.

b) balanced coverage and completion of all inventory criteria in the worksheet.

c) successful distribution of the worksheet to all students in the class.

Due Date:

To be determined by the course instructor.

Late Assignments:

An assignment not received by the instructor on the day which it is due receives a failing grade, and the student will receive an incomplete for the NR 414/614 course grade. The student will be required to complete assignment #4 with a passing grade in order to receive credit for the course.
The Resource Inventory Worksheet

Name of the Resource: ________________________________________

Appropriate Content Area Usage: __________________________________

Appropriate for the Following: Field Trip __; In Class Use ___; Investigation by Students ___; Other ___ (Please Explain) _______________________

Address/Location: ________________________________________________

Contact Person and Address: ________________________________________

Telephone: ______________________

Suggestions for Use: ______________________________________________

Use Limitations/Restrictions: _______________________________________

Check which of the following EE subgoals can be taught using the resource:

awareness __; knowledge __; values and attitudes __; citizen action SKILLS __; citizen action EXPERIENCE __
Lesson Eight: Designing An Instructional Plan

Objectives: Students will be able to:

1) develop an instructional plan for infusing at least five supplemental environmental education curriculum activities into selected subject area curricula.

Method: In a guided work session, students continue their progress on Assignment #2: designing an instructional plan for infusing EE into their curricula.

Instructional Time: 2 hours

Readings: None

Background: Two of the barriers to environmental education often expressed by K-12 teachers are the lack of time to prepare EE lessons and the lack of resources to do so. Therefore, this final Lesson is a two hour planning session for students to utilize EE curriculum resources, evaluate instructional methods, and design an instructional plan based on the goals of EE.

The major purpose of Lesson Eight is to provide a guided work session in which students design an instructional plan for environmental education.

Materials:

1) EE curriculum resources from resource library, and other sources as available

2) Assignment #2 materials

Procedure:

1) Review Assignment #2 with students (from Lesson Two).
2) Explain that students will be participating in a guided work session to design an instructional plan for EE. You, as the instructor, will be circulating throughout the group to assist students in their planning.

3) Guide students in the design of their instructional plans according to the assignment criteria. Encourage students to utilize the instructional methods experienced in the course, school site and community resources, and available EE curriculum resources. No need to reinvent the wheel!

4) After the work session, ask each participant to complete the UW-SP course evaluation form.

**Extensions:** Students could participate in the development, implementation, and/or evaluation of their school district’s EE plan!!!

**Evaluation:** Work on Assignment #2 until completed.
List of Appendices

Environmental Education Teaching Strategies
NR 414/614


BIBLIOGRAPHY


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Yockers, Dennis. *School Site Inventory Activities*. East Lansing, Michigan. Michigan State University. (no date)
ENVIRONMENTAL
EDUCATION
TEACHING
STRATEGIES

NATURAL RESOURCES
414/614

A BOOK OF READINGS

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<td>&quot;Annotated Bibliography of EE Resources&quot;, from Annotated Bibliography of Environmental Education Resources</td>
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18. "Have You Ever...", from Yockers, Dennis. School Site Inventory Activities. Michigan State University.

19. "School Site Inventory Activities", from Yockers, Dennis. School Site Inventory Activities. Michigan State University.
APPENDIX N

Instructor and Steering Committee Evaluation Forms for Draft Version of *Environmental Education Teaching Strategies*, NR 414/614
NR 414/614: ENVIRONMENTAL EDUCATION TEACHING STRATEGIES

COURSE FOUR OF THE TEACHER OUTREACH PROGRAM IN ENVIRONMENTAL EDUCATION

Instructor Evaluation of Curriculum

Evaluator: ___________________________ Date: ___________

Instructors: Thank you for taking time to critique this draft version of the curriculum for the fourth course Environmental Education Teaching Strategies. Your recommendations for improving the curriculum are essential, and will be integral in revising this draft of the course.

PART I: Question 1 lists specific points to guide your critique on various aspects of the curriculum. Please make comments directly on the curriculum itself, and return it with this form (but not the Book of Readings) in the post-paid envelope by Monday, June 10, 1991.

1. For each of the eight lesson plans, please evaluate effective aspects of the lesson and also ways the lesson could be strengthened:

   a) What is your overall reaction to the lesson?

   b) Is the amount of suggested instructional time realistic?

   c) Are the readings which accompany the lesson appropriate? Should additions or deletions be made?

   d) Is the background information provided on the lesson sufficient and accurate?

   e) Are the steps in the "Procedure" section clear, logical, and sequential? Would you rearrange/add/omit any portion?

   f) To what extent are the lesson extensions valuable?

   g) Does the suggested evaluation strategy and/or assignment accurately measure student learning?

   h) How well does the lesson accomplish the goals and objectives for the course?
Can you suggest an alternative teaching method, learning activity, audio/visual, demonstration, or reading to better meet the goals and objectives? (This is a DRAFT curriculum, so we would really like to have your suggestions and improvements!!!)
Please submit any written materials or references which you are able to provide.

PART II: Please answer questions 2-11, including comments as desired.

For questions 2-6, please circle the number which best represents your critique of the curriculum:

2. The curriculum taken as a whole meets the goals and objectives developed for the course during planning sessions at CWES.

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</table>

Comments:

3. The methods and activities selected to meet the course objectives are appropriate for inservice teacher training in environmental education.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
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</table>

Comments:
4. The eight lessons progress cohesively and logically to form a unified course in EE teaching methods.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
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<tbody>
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</table>

Comments:

5. The layout format of the curriculum (e.g., margin size, font size, graphics, quotes, reading ease) is appropriate.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
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</table>

Comments:

6. I am enthusiastic about instructing this curriculum in its present form.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
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</table>

Comments:
7. What resources and materials would you like to have to supplement the NR 411/611 Principles of Environmental Education resource library for you and your students to use during the duration of your course?

8. Critique the four proposed assignments included in the course.

9. What is the strongest part of the draft curriculum? What part of the curriculum most needs to be changed or revised for maximum effectiveness and quality?

10. Is there a portion of a lesson (or a complete lesson) which you would be willing to instruct at the CWES planning weekend June 21-23, 1991? If so, which one?

OTHER COMMENTS:

THANKS FOR ASSISTING IN THE EVALUATION OF THIS CURRICULUM
APPENDIX O

Evaluation Results for Draft Version of Environmental Education Teaching Strategies, NR 414/614
Evaluation Results: Draft Version of Environmental Education Teaching Strategies

The draft version of the fourth course, Environmental Education Teaching Strategies, was evaluated by instructors and steering committee members between May 13 and June 10, 1991. (The evaluation form is included in Appendix N.) Of the 25 instructors receiving drafts to review, 10 responded by returning their evaluation forms. Of the 8 steering committee members receiving drafts to review, 4 responded by returning their evaluation forms. Overall, a 42% return rate of evaluations was obtained.

As in the prior evaluations, the first question asked evaluators to assess lesson effectiveness and strengths by recording written comments directly on the draft curriculum and returning it with the evaluation form. For questions two through six, evaluators responded using the following Likert scale:

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<tr>
<th>Strongly Disagree</th>
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<th>Agree</th>
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Evaluator responses were averaged and accompany each of the following questions:
Evaluation Question

2. The curriculum taken as a whole meets the goals and objectives developed for the course during the planning sessions at CWES. (x = 4.3)

3. The methods and activities selected to meet the course objectives are appropriate for inservice teacher training in environmental education. (x = 4.3)

4. The eight lessons progress cohesively and logically to form a unified course in EE teaching methods. (x = 4.3)

5. The layout format of the curriculum (e.g., margin size, font size, graphics, quotes, reading ease) is appropriate. (x = 4.5)

6. I am enthusiastic about instructing this curriculum in its present form. (x = 4.4)

As before, the draft curricula was revised to reflect the consensus of instructors and steering committee members based on evaluative information. The revised, final version of Environmental Education Teaching Strategies was distributed to instructors and steering committee members at the June 21-23, 1991 meeting at the Central Wisconsin Environmental Station. The course was taught in a "dry run" format during the weekend. (The course curriculum for Environmental Education Teaching Strategies is found in Appendix M.)