This is to certify that the

thesis entitled

An Activity Based Ecology Unit Integrated
Into Eighth Grade Science Curriculum

presented by

Royaleanne Mancuso Zydeck

has been accepted towards fulfillment
of the requirements for

MS degree in Biological Science

Major professor

Date 26 July 1996

AN ACTIVITY BASED ECOLOGY UNIT
INTEGRATED INTO EIGHTH GRADE SCIENCE CURRICULUM

By

Royaleanne Mancuso Zydeck

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

College of Natural Science
Division of Science Education

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ABSTRACT

AN ACTIVITY BASED ECOLOGY UNIT
INTEGRATED INTO EIGHTH GRADE CURRICULUM

By

Royaleanne Mancuso Zydeck

Students graduating from the parochial elementary and junior high school where I teach were not adequately prepared for high school ecology. Therefore, this unit was developed to increase the students' understanding of ecology and awareness of man's responsibilities to other organisms and the environment.

Hands-on activities, field work, and cooperative learning groups were the primary method of teaching and learning. The purpose of implementing experiential learning was to stimulate student interest, increase understanding, allow everyday application, foster a sense of "ownership" of the environment, and increase retention of concepts.

The goals, stated above, were met through lecture and participation in a variety of activities. These activities included laboratory exercises, field work, games, individual and team projects, construction and maintenance of model ecosystems, review of scientific literature, and several field trips.

To determine if the goals were met, the criterion used was a comparison of student pre-test and post-test scores. In

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addition, worksheets, laboratory write-ups, interviews, and a qualitative evaluation form were utilized as tools for measurement of student success.

These evaluation tools show a dramatic increase in knowledge in this content area. The post-test scores were significantly higher than the pre-test scores. The qualitative evaluations indicate that students found the activities to be enjoyable and helpful. The results of the interviews demonstrated students have an increased understanding of man's impact on the environment.

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ACKNOWLEDGMENTS

My appreciation and gratitude must be expressed for the assistance and support received from Dr. Clarence Suelter, Dr. Merle Heidemann, Dr. Marty Hetherington, and Dr. Howard Hagerman. Their respect for others and friendly nature creates a positive, comfortable learning environment.

It is also necessary to express my appreciation for the knowledge and experience gained from the Molecular Biology and Environmental Biology courses that are part of this master's program. It is the latter course that was the inspiration for the development of this activity based ecology unit.

The funding available for this program from the National Science Foundation and the Towsley Foundation is greatly appreciated. Their generosity allowed this opportunity to become a reality.

This unit would not have been possible without my students; their patience, eager cooperation, and dedication was an integral part of its success. It is often said that teachers do not realize the impact they have on their students. It is my belief that the opposite is also true, I learn from my students everyday.

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INTRODUCTION

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THE UNIT GOALS AND SUPPORTING RESEARCH

This unit was developed in response to the absence of a formal ecology unit taught at any grade level at a parochial elementary and junior high school in suburban Detroit. Students were not adequately prepared for high school in this area. The goal was to increase the students' understanding of ecology and awareness of man's responsibilities to other organisms and the environment.

Cherif (1992), has found that ecology is often deleted from the junior high and high school science curriculum because of lack of time or teachers' inexperience in ecology. Cherif goes on to say that ecology lacks a distinct place in school curriculum and has a low priority among educators.

Hands-on experiences are considered by most science educators to be the essential conditions for children to acquire new concepts or understandings. (Butts, 1963). A study conducted by Lisowski and Disinger (1988) concluded that "field based programs in the sciences are effective in assisting students' understanding and retention of selected ecological concepts."

Therefore, this unit was designed to incorporate hands-on experiences and field work in a cooperative learning environment. The purpose of implementing experiential learning was to stimulate student interest, increase understanding of concepts, allow real-life application, to foster a sense of "ownership", and to increase retention of material. Lazarowitz (1994) states "hands-on experience is ess

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essential for meaningful learning".

Students usually enjoy practical work in the laboratory when offered a chance to experience meaningful, non-trivial but not too difficult experiences. They become motivated and interested not only in their laboratory assignment but also in studying science. (Ben-Zvi, et.al. 1977; Henry, 1975; Selmes, et.al. 1969). According to Lisowski (1987):

> "...certain field instruction strategies have a positive influence on student understanding and retention of ecological concepts. Teachers could consider using an involvement-oriented model of teaching that involves the learner and creates greater motivation and interest on the part of the students. Teachers could also create interest by involving students in real-life situations and use real environmental issues facing local communities."

The Michigan State University Environmental Biology course offered at Kellogg Biological Station was the inspiration for this unit. The course strengthened my understanding of ecology and environmental issues. The experiences and knowledge gained instilled confidence in my ability to teach this subject area. Research indicates that lack of teacher confidence in the area of ecology is one of several barriers in ecology education (Cherif, 1992).

As stated earlier, one goal of this unit was to increase student awareness of human responsibilities associated with the environment. It was hoped that the knowledge and experiences gained from this unit would help to instill responsible behavior and decisions associated with the environment. If students have an understanding of the env

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environment and the magnitude of man's impact on it, perhaps they will feel a responsibility and respect for the environment. Hungerford (1990) states, "the ultimate aim of education is shaping human behavior". Hungerford and Volk (1990) state:

> "It appears that, before individuals can engage in responsible citizenship behavior, they must understand the nature of the issue and its ecological and human implications. When individuals have an in-depth understanding of issues, they appear more inclined to take on citizenship responsibility toward those issues."

Smith-Sebasto (1995) compared behavior of students who had completed an ecology course with that of students who had not. She states:

> "Analyses of the data revealed statistically significant differences in all variables measured. Students completing an environmental studies course had a more internal locus (a feeling that they had control of) of control for reinforcement for environmentally responsible behavior, a higher perception of their knowledge of and skill in using categories of environmentally responsible behavior, and more frequent performance of selected environmentally responsible behaviors at the end of the course than at the beginning than did the students who had not taken the course."

Instilling a sense of responsibility for the environment in students is a difficult educational goal. It involves teaching both ecological concepts and environmental issues. In addition, experiences designed to allow student exploration of possible solutions to environmental problems should be included in the curriculum. These activities would foster a

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a sense of "ownership" of the problem and a sense of "empowerment" associated with the solutions to these problems. It must be stated that time did not allow for this encompassing goal to be addressed in its entirety.

The goals for the course were met through lecture and participation in a variety of activities. The activities included laboratory exercises, field work, games, individual and team projects, construction and maintenance of living ecosystems, review of scientific literature, and several field trips. The cooperative learning group size ranged from two to ten students. The amount of materials and space available determined group size.

All materials for the activities were inexpensive and readily available. Some of the activities were adapted from laboratory manuals and I designed others. The activities involved observation of natural phenomena, implementation of scientific skills, data collection and interpretation, and problem solving skills. To determine if the goals were met, the criterion used was a comparison of student pre-test and post-test scores. In addition, worksheets, laboratory write-ups, interviews, and a qualitative evaluation form were utilized as tools for measurement of student success.

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DEMOGRAPHICS OF SCHOOL

The school in which this study took place is a private, elementary and junior high Roman Catholic school located in a suburb of Detroit. Students reside in the cities of Redford, Detroit, Livonia, and Dearborn. The majority of the students are Catholic and middle class.

The total student body, kindergarten through eighth grade, is approximately 350 students. The student/teacher ratio is approximately 20 to 1. The junior high usually includes two seventh grade and two eighth grade classes.

The students are highly motivated and dedicated. The majority of them always complete their work and take pride in producing outstanding work. The junior high students often place quite high in metropolitan Detroit scholastic competitions.

The science laboratory is well equipped with the necessary materials for carrying out the science program. The yearly science budget, along with fundraisers, provides sufficient funds for needed science supplies.

A weakness of the school is the lack of a coordinated science curriculum. As a result, students are lacking in certain science skills and/or knowledge at certain grade levels. This served as an impetus for my thesis. The faculty is now including ecology in the second, fourth, and sixth grade curriculum.

CHAPTER 2

METHODS OF INSTRUCTION

DEVELOPMENT OF UNIT

This ecology unit was developed in the summer of 1994. It was designed because I had not previously taught ecology; therefore, all the materials including the lecture notes, activities, and pre/post test were new to my curriculum. The field trips were based on those I had experienced in the Environmental Biology course previously mentioned.

Many weeks were spent reviewing science textbooks, environmental books and magazines, and laboratory manuals to design the unit. The lecture notes and activities were based on these reference materials. The source for each activity is noted in Appendix A.

The amount of environmental science information is overwhelming and all of it cannot be taught in the allotted time. Therefore, I chose three main areas that I would teach. These areas or chapters were as follows: organisms and the environment, energy and the community, and humans and the environment. These chapters would provide the students with a general foundation in ecology.

After narrowing the information to three chapters, I then identified the key concepts of each chapter. I wanted to have an activity that addressed each concept. I chose activities that I felt were age appropriate, did not require expensive materials, and could be conducted in an appropriate amount of time. The analysis of activities begins on page 16. Each activity is explained and evaluated. Also, a table that lists key concepts and the activities associated with those concepts is located on page 14.

Each experiment was pretested to determine how well it demonstrated the concept, the possible results, the possible pit-falls, and how long it took.

INSTRUCTION OF UNIT

This unit was taught for two years, 1995 and 1996, to eighth graders. Each year, students met for science class for fifty minutes, five days a week. Lecture notes, field trips, activities, and pre/post tests were the same for both years.

Approximately two weeks were spent on each of the three chapters, totaling six weeks for the unit. The chapters were taught in the following order: organisms and the environment, energy and the community, and concluded with humans and the environment. The outline of the unit on page 11 identifies the key concepts and activities of each chapter.

The concepts were introduced to the students in a lecture format at the beginning of each chapter. The students then participated in a variety of activities that addressed these concepts.

Each activity was briefly explained to the students. If it involved techniques that were new to the students, I demonstrated these techniques to them. The concepts that the activity addressed were reviewed. Students worked in groups of two to fifteen depending upon the activity. When they were in the laboratory performing experiments, they worked in groups of two.

Students were required to complete a laboratory write-up for most of the activities. This written assignment included an objective, list of materials, procedure, presentation of data, and answers to questions. The questions addressed an interpretation of data, and application to real-life situations. The questions for each activity can be found in Appendix A.

Grading criteria of laboratory write-ups were based on effort, completion of the entire write-up, and neatness. Incorrect answers were indicated but not counted in the scoring. Instead, the correct answers to the questions were discussed with the class on the day the laboratory write-ups were returned and students were required to correct their papers.

Student grades for this unit were based on laboratory write-ups, demonstration of laboratory techniques, project scores, and post-test scores. The grading of each activity is explained beginning on page 16.

OUTLINE OF UNIT

The following outline indicates the concepts taught and the activities associated with them. The explanation and evaluation of these activities begins on page 16.

I. PRE-TEST

II. ORGANISMS AND THE ENVIRONMENT

A. Explain the following terms/concepts: ecology, ecologist, biosphere, biomes, ecotone

1. Worksheets addressing biomes and their locations in the world
2. Group Biome Project
3. "Who Fits Here" Game

B. Explain following concepts: ecosystem, habitat, niche

1. Exercise - Microenvironments in Your Schoolyard
2. "Wanted" Poster

C. Explain following concepts: community, population, competition, limiting factor, carrying capacity

1. Activity - How Many Bears Can Live In This Forest?
2. Exercise - Growth Of A Yeast Culture
3. Exercise - Population Hunt
4. Exercise - Competition In A Lawn
5. Several worksheets addressing these concepts

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D. Explain concept of succession

1. Several handouts and worksheets addressing this concept
2. Exercise - Forest In A Jar
3. Nature Walk Field Trip

III. ENERGY AND THE COMMUNITY

A. Explain following organism relationships: predator/prey, mutualism, parasitism, commensalism, saprophytes

1. Exercise - Inside A Termite Gut
2. Activity - Composting
3. Exercise - Benefits Of Nitrogen-Fixing Bacteria

B. Explain following energy relationship concepts: producer, consumer, carnivore, herbivore, omnivore, food chain, food web

1. Several handouts and worksheet addressing these concepts
2. Exercise - Owl Pellet Dissection

IV. HUMANS AND THE ENVIRONMENT

A. Explain human population problems

B. Explain air pollution

1. Several handouts
2. Exercise - Evidence of Air Pollution

C. Explain water pollution

1. Exercise - Filtering Water
2. Exercise - How Pollutants Affect A Yeast Culture

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3. Exercise - Factors That Affect The Temperature Of Water
4. Exercise - How Does Thermal Pollution Affect Living Things
5. Exercise - Effects of Acid Rain On Germinating Seeds
6. Exercise - How Pollution Affects Seeds
7. Field Trip To Detroit Wastewater Treatment Facility

D. Explain soil erosion

1. Teacher demonstration of the effects of trees and other barriers on soil erosion
2. Article on soil erosion

E. Explain solid/hazardous waste

1. Field Trip to Northville Landfill

F. Explain following concepts: conservation, environmental management, reforestation, recycling

1. Activity - Recycling Paper
2. Several handouts

V. POST-TEST

VI. QUALITATIVE EVALUATION FORM

TABLE 1

CONCEPTS TAUGHT AND ACTIVITIES ASSOCIATED WITH EACH CONCEPT

The following table identifies the concepts taught and all the activities associated with each concept.

CONCEPT	ACTIVITIES
BIOMES	1. Group Biome Project 2. "Who Fits Here" Game 3. Several Worksheets
ECOSYSTEMS HABITAT NICHE	1. "How Many Bears Can Live In This Forest" Game 2. Exercise - Microenvironments In The Schoolyard 3. "Wanted" Poster 4. Group Biome Project
COMMUNITY POPULATION COMPETITION LIMITING FACTOR CARRYING CAPACITY	1. "How Many Bears Can Live In This Forest" Game 2. Exercise - Growth Of A Yeast Culture 3. Exercise - Population Hunt 4. Exercise - Competition In A Lawn 5. Group Biome Project
SUCCESSION	1. Exercise - Forest In A Jar 2. Nature Walk Field Trip 3. Exercise - Competition In A Lawn
ORGANISM RELATIONSHIPS	1. Exercise - Inside A Termite Gut 2. Exercise - Composting 3. Exercise - Benefits Of Nitrogen-Fixing Bacteria
FOOD CHAIN FOOD WEB ENERGY PYRAMID	1. Exercise - Owl Pellet Dissection 2. Worksheets
AIR POLLUTION	1. Exercise - Evidence Of Air Pollution

WATER POLLUTION	1. Exercise - Filtering Water 2. Exercise - How Pollutants Affect A Yeast Culture 3. Exercise - Factors That Affect The Temperature Of Water 4. Exercise - How Does Thermal Pollution Affect Living Things 5. Exercise - Effects Of Acid Rain On Germinating Seeds 6. Exercise - How Pollution Affects Seeds 7. Field Trip To Detroit Wastewater Treatment Facility
SOIL EROSION	1. Teacher Demonstration
SOLID WASTE	1. Field Trip To Landfill
RECYCLING	1. Recycled Paper Activity

EXPLANATION AND EVALUATION OF ACTIVITIES

Each activity is explained, evaluated, and referenced below. The evaluation of each activity was based on observable laboratory and field work results, student oral and written responses when discussing the activity, and teacher observation.

GROUP BIOME PROJECT

EXPLANATION

Working in groups of four, students selected a biome from a given list of eight biome models. Each group was responsible for building a living biome model complete with representative animals and plants. Each group was responsible for the maintenance of its biome for two months. Biome models were built at the school and kept there. Five minutes of each science period was allowed for students to check on their animals and plants.

Listed below are various biome/ecosystem models the student chose:

1. Desert - included sand, cacti, snakes, lizards, tarantulas
2. Deciduous Forest - included soil, decomposing leaves, twigs, insects, worms, ferns, grass
3. Rain forest - included soil, ponds, grass, ferns, tree frog, lizards

4. Fresh Water - included soil, ponds, grass, frogs, salamanders, mud puppies, water plants
5. Salt Water - included various plants and fish

CONCEPTS ADDRESSED

This activity addressed several concepts including energy relationships among organisms, competition, limiting factors, carrying capacity, habitat, niche, and environmental factors that affect ecosystems.

EVALUATION

Some students expressed on their qualitative evaluation that the maintenance of the biome model was their favorite part of the unit.

Not only did this activity address the concepts stated above, it also included responsibilities associated with animal and plant care. Students learned about the other biomes because of their interest in each other's animals and plants. It was a daily event to observe and care for the organisms.

Students witnessed several aspects of nature including: the metamorphosis of tadpoles to frogs, the elaborate "tunnelling" methods of mice, the birth of mice, the molting of lizards, snakes, and tarantulas, the height that some frogs can jump (one jumped from the floor onto a student's head!), snakes and lizards eating live prey, and death.

Cost did not present a problem because students shared extra materials they had with other groups. For example, several students had extra tanks, filters, and animal food from home. Each student paid an average of one to five dollars to build and maintain his/her biome. If the cost exceeded the student average, school funds were available for those projects.

Students received a group grade. However, a group member's failure to share responsibility would result in a lower grade than the group grade. Students were informed of the grading criteria. It was as follows:

1. Was the model realistic?
2. Were proper plants/animals present?
3. Was the model maintained?
4. Was responsibility shared by group members?

Each section was worth twenty five points for a total of one hundred points.

REFERENCE

The directions for this project are my own design and are located in Appendix A, page 72.

"WHO FITS HERE" GAME

EXPLANATION

On day one of this activity, the class divided into two teams. Each team member chose a biome from a list of eight biomes. The teams had to include all biomes. Each team member then chose five organisms representative of that biome.

On day two, each student found six facts for each of their organisms. These facts were presented on five separate index cards. The organism's name and it's appropriate biome were not listed on the card. Student cards were graded; they were awarded one point for each fact for a total of thirty points.

On day three, the teams numbered and exchanged cards. The teams made answer keys. It was each team's goal to properly identify the organism and it's biome described on each card. Once completed, the teams exchanged and corrected their answer sheets using the answer key. I did not grade them on this part of the activity.

CONCEPTS ADDRESSED

This activity addressed the following concepts: biomes and their representative organisms, organism characteristics including niche, and energy relationship with other organisms.

EVALUATION

The competition created in this activity enhanced student enthusiasm and determination. Students were motivated to be the winning team. Excitement and anxiety rose as students worked together to determine the organism and its biome described on the card.

This activity increased student knowledge of organisms and the biomes in which they exist.

In the future, I would alter this activity to a one day classroom event. The choice of organism and research would be completed outside of class.

REFERENCE

This activity was modified from the Project Wild Book (1992) and is located in Appendix A.

MICROENVIRONMENTS IN YOUR SCHOOL YARD

EXPLANATION

Working in groups of two, students searched the school yard for micro-desert, rainforest, grassland, and pond environments. Once discovered, they documented plant and animals present, did a population count, compared plant roots, soil temperatures, amount of water present, soil type and conditions, and litter present.

CONCEPTS ADDRESSED

This activity addressed the following concepts: biomes/ecosystems, interaction of organisms, the effects of environmental conditions on organisms, and soil types.

EVALUATION

Student laboratory write-ups included presentation and interpretation of data. They were to answer the following questions: What adaptations do plants that live in a micro-desert have that help them survive in a dry climate, What adaptations do plants that live in a micro-rainforest have that help them survive in a wet climate, In which environment are there more kinds of plants, Would a dry spell have a greater effect on one environment than another, etc... Their work was graded and demonstrated an understanding of the concepts stated above.

REFERENCE

This activity was adapted from the Addison Wesley Life Science Laboratory Manual written by Bonnie Barr, 1989, and can be found in Appendix A, page 75.

"WANTED" POSTER

EXPLANATION

This was an individual project that students presented on posterboard. Students chose an organism and found the following information concerning their organism: biome, niche, habitat, food source, importance in environment, effect on humans, characteristics, and reproduction. This information, including a drawing of the organism, was visually displayed on posterboard. The goal was for them to convince the reader that their organism was "wanted"/needed in the environment.

CONCEPTS ADDRESSED

The following concepts were addressed in this activity: biomes, habitat, niche, organism relationships, and the interaction of organisms with the environment and humans.

EVALUATION

This activity increased student knowledge of the above stated concepts.

The grading of this project was based on the following criteria. Each section was worth twenty five points for a total of one hundred points.

1. Required information present
2. Information is correct
3. Creativity
4. Neatness/Effort

REFERENCE

This activity is an adaptation from a similar activity in the Project Wild Book, 1992, and can be found in Appendix A, page 78.

HOW MANY BEARS CAN LIVE IN THIS FOREST?

EXPLANATION

First, students learned the following information about black bears: where they live, how much space they require, what food they eat, and daily requirements of each food type. Next, students became "bears" and the gym became the "forest". Some bears were deemed injured, one was blind, and a few had cubs to care for. They each claimed an area of the gym as their "den".

The teacher placed different colored squares of paper about the gym. These represented the different food types.

A number on the square represented the number of pounds of that food type. Food types included meat, insects, berries, plants, and nuts. A certain amount of "food" was set out, dependent upon the number of students playing the game.

Students were then free to gather food. After a piece of food was discovered, it had to be returned to the den before students could gather another piece. When students returned to the classroom, they counted the number of pounds of each food type gathered and determined if they had met their daily requirement.

CONCEPTS ADDRESSED

This activity addressed the following concepts: black bear requirements, importance of an animal's space, carrying capacity, survival of the fittest, and limiting factors.

EVALUATION

The competition and physical activity involved in this activity created much enthusiasm and determination. Some "bears" that did not find their daily requirement of food were quite upset. Responses included "Boy, I'd be a hungry bear today, watch out". Those "bears" that were at a disadvantage, such as being blind, were really upset. They complained it wasn't "fair".

In the last twenty minutes of the class period, students determined the amount, in pounds, of each food type they had gathered. They compared this with the daily requirements of black bears. If they had not met their daily requirement, they had to list reasons why they had not. Next, they shared their results with the class.

Based on their responses, students realized that the gym did not represent enough space for the amount of "bears" present, that having a handicap is a limiting factor, that having to feed their young is a limiting factor, and that bears have to eat a lot to meet their daily requirement. They demonstrated an understanding of carrying capacity, limiting factors, the importance of space, and survival of the fittest!

REFERENCE

This activity was adapted from the Project Wild Book, 1992, and is located in Appendix A, page 79.

GROWTH OF A YEAST CULTURE

EXPLANATION

The teacher prepared a yeast culture by combining 1/2 package of yeast with 500 milliliters of molasses. Students, working in groups of two, observed the culture under the microscope and recorded a sample population count over a period of five days. The yeast population quickly increased due to the available food. As they reproduced, space and food became limiting factors and the population decreased. Therefore, students witnessed a population explosion and then a decrease.

CONCEPTS ADDRESSED

This activity addressed the following concepts: population, sampling method of counting populations, carrying capacity, and limiting factors.

This activity also addressed the concepts of respiration and fermentation. The students had studied these concepts earlier in the year and this activity offered a review of that information.

EVALUATION

Results were quite dramatic. Student laboratory write-ups included documentation and interpretation of data. Students drew the appearance and did a sample count of the culture each day of the exercise. Students graphed yeast population over time. Students responded to the following questions: during which day did the yeast population reach its maximum, what are some reasons why the population decreased in number, and name some factors that cause the population growth pattern of humans to differ from that of yeast. Their graded answers reflected an understanding that space and food were limiting factors in this situation. For example, when asked what caused a decrease in the population, students unanimously responded "food and space".

REFERENCE

This activity was adapted from Addison Wesley Life Science Laboratory Manual, 1989, and can be found in Appendix A, page 85.

POPULATION HUNT

EXPLANATION

Working in groups of two, students staked a two square foot area outside the school building. They recorded the number and type of organisms present.

CONCEPTS ADDRESSED

The concepts addressed in this activity were: populations, and the sampling populations.

EVALUATION

Students were asked to chart and graph the type and count of each organism. The laboratory write-up addressed the following questions: how many different populations did you find, and what evidence of organism interaction did you see? Based on their graded laboratory write-ups, students understood the above stated concepts. They gained an appreciation for the sample method of counting when it came to counting the amount of grass present!

This activity would have yielded more interesting results if it could have been conducted in an area that provided a variety of habitats. For example, if a pond, stream, field, and woods were all included in the sample area. This is not possible on our school grounds, but a field trip to an area like this could be planned in the future.

This activity was combined with a worksheet that explained the sample method of counting a population.

REFERENCE

This activity was adapted from the Merrill textbook, 1988, and the worksheets are from The Center for Applied Research in Education, 1989. Both can be found in Appendix A, page 90.

COMPETITION IN A LAWN

EXPLANATION

Working in groups of two, students completed two parts to this exercise. First, in a two foot square area outside the school, they recorded what plant type (grass or clover) was dominant in the lawn. They did a sample count and based their answer on which plant type was more numerous. Next, they set up a cup containing grass seeds, a cup containing wildflower seeds, and a cup containing both. They observed and recorded the growth of these seeds and the size of their roots everyday for two weeks.

CONCEPTS ADDRESSED

This activity addressed the concept of competition.

EVALUATION

The results of the created model were quite evident, within a week, the grass quickly took over the wildflower seed. Student laboratory write-ups required a response to nine questions comparing the growth of the plants in the three cups (see Appendix A, page 92 for these questions). Based on their graded laboratory write-ups, students demonstrated an understanding of competition.

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REFERENCE

This activity was adapted from the Addison Wesley Life Science Laboratory Manual, 1989, and can be found in Appendix A, page 92.

FOREST IN A JAR

EXPLANATION

Working in groups of two, students filled a glass jar half full of dirt, planted a water plant in the dirt, and then filled the rest of the jar with water, submerging the plant. This represented a pond. They placed the jar, uncapped, on the window ledge. Each day they dropped a few grass seeds in the jar to represent the wind blowing seeds into the pond. They observed, over a period of three weeks, the water evaporate, the water plant die, and the grass grow. Their pond had become a "field".

CONCEPTS ADDRESSED

This activity addressed the concept of succession.

EVALUATION

This activity demonstrated the concept very well. However, we discussed the reality of the water cycle (and lack of in this activity), and time as integral elements of the process of succession.

Students did not complete a laboratory write-up for this activity.

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REFERENCE

This activity was adapted from the Project Wild book, 1992, and can be found in Appendix A, page 94.

NATURE WALK FIELD TRIP

EXPLANATION

Students participated in a Fall and Spring after school nature walk through two different parks.

CONCEPTS ADDRESSED

The naturalist conducting the walk identified the following: tree/plant species, animal tracks, edible plants, wildflowers, fungi species, succession, climax forest, burn scars, water quality, soil erosion, breeding requirements for frogs and mosquitoes, sun requirements of different plants, and the food chain.

EVALUATION

Based on their comments and enthusiasm level, students seemed to love this outdoor activity. They were especially pleased when they got to tromp through the mud on the Spring walk. Students eagerly asked our guide questions. They were not shy about tasting any of the edible plants, either. A nature walk is highly recommended as part of an ecology unit.

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INSIDE A TERMITE GUT

EXPLANATION

Working in groups of two, students were to pull apart a live termite's gut, place the gut contents on a microscope slide, and then place a drop of an anaerobic buffer solution on the contents before viewing. Students observed the protists in a termite's gut under the microscope.

CONCEPTS ADDRESSED

This activity addressed the concept of mutualism.

EVALUATION

It was difficult to obtain termites. Several extermination companies were contacted. Once obtained, only two groups were able to locate the protists under the microscope. Students were quite disappointed in their inability to find the protists under the microscope. Perhaps this was because the anaerobic buffer solution was not placed on the specimen before viewing. Although this activity had it's difficulties, I would attempt it another time because the students expressed much enthusiasm.

REFERENCE

I participated in this activity at the Environmental Course in Biology that is part of this masters program. (Appendix A, page 96).

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EXPLANATION

Working in groups of two, students cut a 3" x 3" piece of paper, a 3" x 3" piece of plastic, a 3" x 3" piece of styrofoam, a 2" x 2" piece of apple, and measured the size of a leaf. They then filled a coffee can with soil and put the above mentioned items in the soil. Each month, for six months, the students removed the items and recorded the size.

CONCEPTS ADDRESSED

This activity addressed the following concepts: the role of saprophytes, biodegradable and non-biodegradable items, organisms present in soil, and landfills.

EVALUATION

Over time, it was evident which items were biodegradable and which ones were not. The change in size and appearance of the biodegradable items was obvious. Students did not complete a laboratory write-up for this activity, but they shared their results with the class.

REFERENCE

This activity was introduced at the Environmental Course in Biology at the Kellogg Biological Station. (Appendix A, page 98).

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BENEFITS OF NITROGEN-FIXING BACTERIA

EXPLANATION

Working in groups of two, students dug up clover plant roots. Once they located the nodules on the roots, they rinsed them in water. With a sterile knife, they cut the nodule open on a clean microscope slide. They stained and fixed the contents before viewing under the microscope. Students recorded their observations.

CONCEPTS ADDRESSED

This activity addressed the concepts of mutualism, and plant mineral requirements.

EVALUATION

This activity worked very well. Students did not experience difficulty in locating the clover, nodules, or the bacteria. It was quite thrilling for them to observe their microscopic discovery! Students did not complete a laboratory write-up for this activity. However, they did turn in their microscope drawings for a grade.

REFERENCE

This activity was adapted from the Environmental Science Activities Handbook For Teachers, 1975.(Appendix A, page 100).

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OWL PELLET DISSECTION

EXPLANATION

Working in groups of two, students dissected an owl pellet. Once the skull and various bones that they found were cleaned, students determined what organism their owl had eaten. They used a diagram of several rodent skulls to accomplish this.

Then they mounted the bones, in their proper position, on construction paper. They labeled the organism and all of its bones.

CONCEPTS ADDRESSED

This activity addressed the following concepts: food chain, predator/prey relationships, owl digestive system, and the skeletal system of the rodent.

Although studying the skeletal system is not directly related to this unit, it was an opportunity that could not be ignored.

EVALUATION

Once the initial uneasiness of working with a regurgitated food item was conquered, students expressed much enthusiasm while dissecting their pellets. Each group wanted to find the "best" (most complete) skeleton. They also enjoyed the challenge of identifying the organism and it's bones. The mounted specimens were graded. Their work reflected an understanding of the mammalian skeletal system.

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I purchased the owl pellets and the accompanying written information from Nasco Biological Supply Company. The written information explained what an owl pellet is, how to dissect it, and diagrams of various rodent skeletons. A fellow science teacher provided me with the owl pellet key.

EVIDENCE OF AIR POLLUTION

EXPLANATION

Working in groups of two, students coated six index cards with petroleum jelly. Each group member was responsible for placing three cards in a different outdoor location. The location it was placed in was noted on the card. Students placed the cards around the cities of Redford, Detroit, and Livonia.

The cards remained outdoors for one week. Once collected, students brought them to class, shared them with other groups, and noted particles (dust, dirt, seeds, garbage) present and where the cards had been placed.

CONCEPTS ADDRESSED

This activity addressed the concept of air pollution.

EVALUATION

The number of particulates present on those cards placed in industrial areas (Detroit Diesel) was significantly greater than those placed in residential areas. Students were quite surprise

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surprised at the amount of particles found on their cards.

Students were not graded on this activity.

REFERENCE

This activity was adapted from the Environmental Science Activities Handbook For Teachers, 1975. (Appendix A, page 102).

FILTERING WATER

EXPLANATION

Working in groups of two, students constructed a water filter out of a 2 liter pop bottle. They cut the bottom off and turned it upside down. They placed a cotton ball in the opening, poured three inches of gravel in, and topped this with five inches of sand.

Next, they prepared muddy water and poured half into one cup (control) and the other half was poured into the filter. Once this dripped through the filter, they compared this to the control.

CONCEPTS ADDRESSED

This addressed water pollution and waste water treatment.

EVALUATION

The results were quite dramatic. The filtered water was much cleaner than the control. Students were able to witness that sand and gravel act as filters. However, it was a slow process

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process and some students were somewhat impatient.

Students did not complete a laboratory write-up for this activity. No grade was taken.

REFERENCE

This activity was adapted from the Merrill textbook, Biology An Everyday Experience. (Appendix A, page 106).

HOW POLLUTANTS AFFECT A YEAST CULTURE

EXPLANATION

Working in groups of two, students prepared the following four cultures in test tubes: 1) Test tube one contained ten drops of a living yeast culture; 2) Test tube two contained ten drops of a living yeast culture and ten drops of a salt solution; 3) Test tube three contained ten drops of a living yeast culture and ten drops of liquid soap; 4) Test tube four contained ten drops of a nonliving yeast culture.

Next, they added ten drops of bromothymol blue pH indicator to each test tube. The following day students recorded any color changes that had occurred. Note: bromothymol blue turns green in the presence of carbon dioxide gas. Living yeast cells undergo respiration releasing carbon dioxide gas. Dead yeast cells would not be undergoing respiration, therefore the indicator solution would remain blue. Students viewed yeast cells under the microscope and estimated the number of living yeast cells. Students graphed the culture and the estimated number of yeast cells.

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CONCEPTS ADDRESSED

This activity addressed the concepts of pollution and respiration. Students had studied respiration earlier in the year.

EVALUATION

The results were somewhat confusing for the students. The living yeast culture and the yeast/soap culture turned green. The salt/yeast culture and the nonliving culture remained blue. The students thought that the nonliving yeast culture, the salt/yeast culture, and the yeast/soap culture would remain blue indicating that the yeast were dead and not releasing carbon dioxide. We discussed possible explanations for this.

Students were interested in testing the effect of bleach on yeast, so we tried this. The students wanted to use bleach because it is a common household product and also commonly used in industry. The solution remained blue indicating that the yeast were dead.

Graded student laboratory write-ups included questions that addressed the role of yeast and other microorganisms in the environment, the effect of salt and soap on them and how it affects the entire food chain, and how pollutants can be controlled.

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This activity was adapted from the Ecology Discovery Activities Kit, 1989. (Appendix A, page 102).

FACTORS THAT AFFECT THE TEMPERATURE OF WATER

EXPLANATION

Working in groups of two, students poured five containers of equal amounts of water. Students recorded the temperature of the water in each container. Container one was labeled "control". Manure was added to container two, garbage was added to container three, soap was added to container four, and bleach was added to container five. The temperature of the water was recorded for the next fifteen minutes.

CONCEPTS ADDRESSED

This activity addressed the concept of thermal pollution.

EVALUATION

All temperatures rose with the exception of the control. The greatest temperature change occurred with the manure and the garbage. Students realized how greatly pollution can affect the temperature of water.

Students turned in laboratory write-ups that included graphs of the temperature changes over time. Questions included in the laboratory write-up addressed the real life significance of this activity. For example, one question asked, "How might these materials enter water systems in

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REFERENCE

This activity is adapted from the Environmental Science Activities Handbook For Teachers, 1975. (Appendix A, page 108).

HOW THERMAL POLLUTION AFFECTS LIVING THINGS

EXPLANATION

Working in groups of two, students prepared yeast cultures in four test tubes. Test tube one was labeled control. Test tube two was placed in boiling water for twenty seconds. Test tube three was placed in boiling water for forty seconds and test tube four was placed in boiling water for sixty seconds. A stained slide of each culture was then prepared and viewed under the microscope. The number of living verse dead yeast cells were recorded. Students graphed the number of yeast cells in each test tube.

CONCEPTS ADDRESSED

This activity addressed the concept of thermal pollution.

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EVALUATION

Students experienced some difficulty in recognizing live verses dead yeast cells. Cultures exposed to forty and sixty seconds of boiling water revealed few living yeast cells. Students realized that water temperatures warmer than normal could mean death for certain organisms.

Graded student laboratory write-ups required them to explain what thermal pollution is, discuss how thermal pollution would affect the food chain if it killed algae in a stream, and to list questions they would want to ask an industrial company that was interested in using local water for it's production line. Student responses indicated an understanding of thermal pollution, it's affect on the food chain, and concerns associated with industry and thermal pollution.

REFERENCE

This activity was modified from the Merrill Focus On Life Science Laboratory Manual, 1988. (Appendix A, page 110).

HOW POLLUTION AFFECTS SEEDS

EXPLANATION

Working in groups of two, students placed twenty lima bean seeds in a beaker of water and another twenty lima bean seeds in a beaker of phosphate-free liquid soap. The following day the students rinsed the seeds in water. The seeds soaked in liquid soap were placed between layers of moist pape

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moist paper toweling and then placed in a labeled plastic bag. The same procedure was done with the seeds soaked in water. Two days later they examined the seeds, recording the number of germinating seeds in each situation.

CONCEPTS ADDRESSED

This activity addressed the concepts of germination and pollution. Students had studied germination earlier in the year.

EVALUATION

The results were quite dramatic - 0% of the seeds soaked in soap germinated and approximately 100% of those seeds soaked in water germinated.

Graded student laboratory write-ups demonstrated an understanding of seed germination and the effects of pollution on this process. Questions in the exercise asked the students: to compare their results with their classmates; how phosphate-free detergents dumped into rivers, lakes, or oceans, may affect plants and the food chain; to list household chemicals that may be pollutants; and asked them to design an experiment that compared the effects of small and large amounts of the detergent on seeds. This exercise could be amended to include other easily available "pollutants" such as bleach, motor oil, and an acidic water solution.

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This activity was modified from the Merrill Focus On Life Science Laboratory Manual, 1989. (Appendix A, page 117).

EFFECTS OF ACID RAIN ON GERMINATING SEEDS

EXPLANATION

Working in groups of two, students cut paper toweling to fit into eight petri dishes. The petri dishes were labeled as follows:

1. Rain Water pH = _____
2. Tap Water pH = _____
3. Distilled Water pH = _____
4. Salt Water pH = _____
5. Lemon Juice pH = _____
6. Vinegar pH = _____
7. Baking Soda Solution pH = _____
8. Ammonia pH = _____

They tested and recorded the pH of each solution using pH paper. Next, they placed four lima bean seeds in marked places in each of the eight petri dishes. The length and width of each seed was measured and recorded. Next, three drops of the solution was added to each seed in the appropriate petri dish. For three days, the seeds were measured and observed. Changes in size, color, odor, and whether or not they were germinating was recorded.

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CONCEPTS ADDRESSED

This activity involved the concepts of pH, pollution, seed germination, condensation, and detailed record keeping.

EVALUATION

The majority of seeds placed in a solution outside the neutral pH of 7 did not germinate. Therefore, students understood that seeds require a neutral pH solution in order to germinate.

The students found the record keeping of this activity to be quite tedious. To avoid this, if so desired, students could simply document changes in color, odor, apparent size, and whether or not the seed germinated. Another solution would be to soak the seeds overnight, place them in moist toweling and a paper bag the following day, and observe results on the third day.

Graded student laboratory write-ups included charts and graphs of their data. They graphed the pH of the solution and number of seed germinated.

Questions in the laboratory addressed the effects of acid rain on crops, how acid rain forms, and how man contributes to the formation of acid rain. Responses indicated an understanding of how man contributes to the formation of acid rain and it's effects on crops. However, students did not clearly explain how acid rain forms. The problems arose in explaining how these gasses become part of rainfall. Even though they had previously learned about condensation and the water cycle, I explained it again after grading their laborat

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REFERENCE

This activity was adapted from Merrill's Focus On Life Science Laboratory Manual, 1989. (Appendix A, page 113).

FIELD TRIP TO THE DETROIT WASTEWATER TREATMENT FACILITY

EXPLANATION

A half day tour of the Detroit Wastewater Treatment Facility.

CONCEPTS ADDRESSED

This field trip addressed the concepts of water pollution and treatment of wastewater.

EVALUATION

This was an experience neither I or the students care to repeat anytime soon. The smell was overwhelming. Their writings after the field trip reflected an appreciation for clean tap water but that they really didn't want to know what happened to their wastewater once it left their home. Although it was very educational, this is one time that ignorance truly is bliss! I would not repeat this field trip.

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REFERENCE

During the Environmental Course in Biology, we toured the Kalamazoo Wastewater Treatment Facility. That facility was definitely more tolerable than the Detroit facility.

FIELD TRIP TO BFI LANDFILL AND RECYCLING CENTER

EXPLANATION

We visited the BFI landfill in Northville, Michigan. In a conference room at the site, students were taught the making of and maintenance of a landfill. A model of a landfill, complete with its layers, was displayed. Samples of the various plastic liners that are used were passed around. Students were also taught how recycled products are sorted, processed, and bundled.

Next, students were taken to an operating landfill, a new landfill under construction, and a closed landfill. Students were taken to the recycling center and watched the materials being sorted and bundled.

CONCEPTS ADDRESSED

This field trip addressed the concepts of recycling, decomposers, biodegradable and non-biodegradable products, and hazardous waste.

EVALUATION

The company conducted a very organized, educational experience for the students. The amount of garbage was

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shocking. Their writings after the field trip expressed concerns regarding the amount of man's garbage and where to put all of it. Although the smell was not pleasant, it was bearable, unlike the wastewater treatment facility.

REFERENCE

Touring a landfill during the Environmental Course in Biology, was an experience I will not soon forget. I thought it was just amazing to see how much garbage man creates. I thought it was very important for my students to see this in order to have a greater understanding of the problem.

MAKING RECYCLED PAPER

EXPLANATION

Working in groups of two, students shredded waste paper. Next, they put it in a blender with water. They then poured in through a screen. It was left to dry overnight. Later, they were free to experiment with colored paper, flowers, or whatever they thought of to use in making paper.

CONCEPTS ADDRESSED

Recycling of paper was the concept addressed in this activity.

EVALUATION

Student creativity was quite interesting and varied. Student work was not graded. However, we did discuss the color of

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color of the paper and how to alter it, problems associated with using bleach to whiten the paper, and the strength and texture of the paper.

REFERENCE

This activity was adapted from the Addison Wesley Life Science textbook. (Appendix A, page 120).

CHAPTER 3

RESULTS

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PRE-TEST AND POST-TEST

A pre-test and post-test was administered before and after the unit was taught. The tests were exactly the same. The comprehensive test consisted of multiple choice and short answer questions. (Appendix B). The time span between the pre-test and post-test was the length of the unit, approximately six weeks.

Tables 3 and 4, located on pages and , list student pre-test and post-test scores. The student numbers were assigned randomly. In year one, the pre-test mean was 65%, the mode was 65%, and the median was 65%. The post-test mean was 90%, the mode was 96%, and the median was 91%. In year two, the pre-test mean was 65%, and the median was 66%. The mode was not discernable because the occurrence of a common score did not exceed two students. The post-test mean was 88%, the mode was 96%, and the median was 90%.

Students demonstrated considerable improvement in test performance. The mean post-test score of 89% exceeded the mean pre-test score of 65% by 24%. This is an average of year one and year two mean post-test scores. Figures 1 through 4 clearly illustrate the students increase in test score.

Thirty nine percent of the students (year one and two combined) passed (70% or higher) the pre-test, 61% failed. However, almost all (96%) of the students passed the post-test, 4% failed. The students that failed, did not pass either the pre-test or post-test. However, their post-test scores we

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scores were approximately ten percentage points higher than their pre-test scores.

The mean pre-test score of 65% would translate to a D academic grade in most schools and a score of 89% would translate to a B academic grade; using this basis, the mean score rose two academic grades.

A breakdown of the scores based on academic grades is shown in Table 2 and indicates that 3/54 students scored an A/B on the pre-test and 51/54 students scored an A/B on the post-test.

Table 2

Comparison of Pre-Test and Post-Test Academic Grades
Year I & II Combined

This table compares the pre-test and post-test academic grades. The grading scale listed below is the standard grading scale used by most schools. Note the increase in number of A's and B's on the post-test compared to the pre-test.

Academic Grade	**Number Of Students With This Grade (out of 54)**	
	Pre-Test	**Post-Test**
A (90-100)	**0**	**31**
B (80-89)	**3**	**20**
C (70-79)	**18**	**1**
D (60-69)	**19**	**1**
F (59 and lower)	**14**	**1**

Table 3

PRE-TEST/POST-TEST DATA - YEAR I

Pre-test and post-test results by student, # correct out of 89 questions and % correct. Student numbers were assigned randomly.

	PRE-TEST			POST-TEST	
Student	Score # Correct	%	Student	Score # Correct	%
1	48	54%	1	74	83%
2	47	53%	2	79	89%
3	57	64%	3	87	98%
4	60	67%	4	75	84%
5	58	65%	5	84	94%
6	58	65%	6	85	96%
7	70	79%	7	84	94%
8	72	81%	8	83	93%
9	71	80%	9	84	94%
10	70	79%	10	85	96%
11	61	69%	11	80	90%
12	68	76%	12	85	96%
13	72	81%	13	89	100%
14	62	70%	14	87	98%
15	65	73%	15	86	97%
16	58	65%	16	85	96%
17	58	65%	17	87	98%
18	55	62%	18	80	90%
19	67	75%	19	79	89%
20	50	56%	20	78	88%
21	62	70%	21	76	85%
22	61	69%	22	79	89%
23	55	62%	23	77	87%
24	31	35%	24	72	81%
25	47	53%	25	55	62%
26	52	58%	26	81	91%
27	34	38%	27	77	87%
28	63	71%	28	85	96%
29	58	65%	29	86	97%
30	53	60%	30	67	75%
31	63	71%	31	81	91%

Pre-test		Post-test	
Mean = 58	**65%**	**Mean = 80**	**90%**
Mode = 58	**65%**	**Mode = 85**	**96%**
Median =	**65%**	**Median =**	**91%**
Range = 3	**35% - 81%**	**Range = 5**	**62% - 100%**

Table 4

PRE-TEST/POST-TEST DATA YEAR II

Pre-test and post-test results by student, # correct out of 96 questions and % correct. Student numbers were assigned randomly.

	PRE-TEST	
Student	Score # Correct	%
1	51	53%
2	60	63%
3	69	72%
4	73	76%
5	71	74%
6	26	27%
7	70	73%
8	69	72%
9	65	68%
10	63	66%
11	75	78%
12	55	57%
13	54	56%
14	63	66%
15	59	61%
16	54	56%
17	70	73%
18	57	59%
19	68	71%
20	62	65%
21	66	69%
22	56	58%
23	68	71%

Mean = 62 65%
Mode = n/ n/a
Median = 66%
Range = 2 27% - 78%

	POST-TEST	
Student	Score # Correct	%
1	83	86%
2	87	91%
3	85	89%
4	88	92%
5	89	93%
6	36	38%
7	91	95%
8	88	92%
9	83	86%
10	88	92%
11	93	97%
12	78	81%
13	77	80%
14	88	92%
15	85	89%
16	82	85%
17	89	93%
18	77	80%
19	92	96%
20	89	93%
21	84	88%
22	85	89%
23	86	90%

Mean = 84 88%
Mode = 88 96%
Median = 90%
Range = 3 38% - 97%

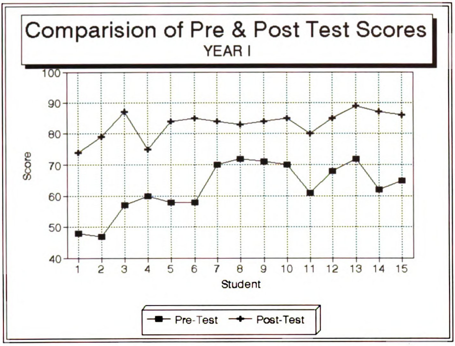

Figure 1

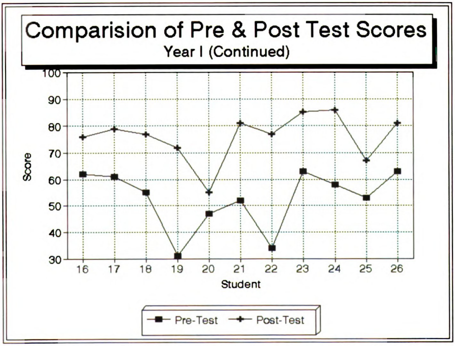

Figure 2

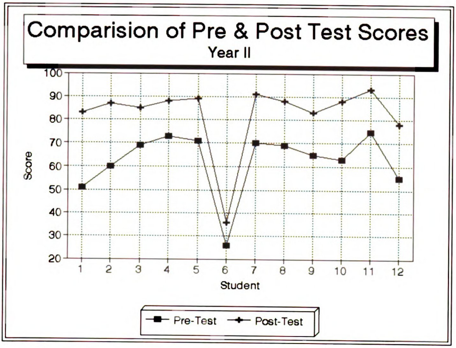

Figure 3

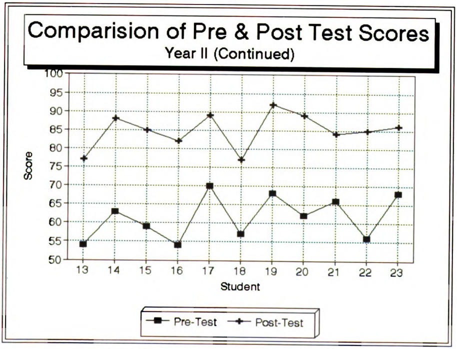

Figure 4

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Appendix

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QUALITATIVE EVALUATION

The second year the unit was taught, students were asked to respond to a series of qualitative questions concerning the unit. This gave the students an opportunity to evaluate the unit as well as their own intellectual growth.

Several questions addressed their understanding and enjoyment of the laboratory exercises, activities, and field trips. Some questions asked the students if they experienced an increased understanding of several concepts due to this unit. Lastly, some questions addressed man's affect on and responsibility to the environment. The evaluation included the following types of responses: true/false, rating scale, and free response. The evaluation instrument can be found in Appendix C.

The majority of the responses were very positive. See Table 6. Most expressed an enjoyment of the activities and field trips. When asked if they found the exercises to be enjoyable and useful, 92% agreed. When asked if they looked forward to the activities, 83% agreed.

The majority of the students felt that the activities and field trips increased their understanding of the concepts. For example, when asked if the field trip to the wastewater treatment facility and to the landfill helped them to understand how these systems function, 78% indicated that the trip increased their understanding.

When asked if building their biome model helped them to learn about that biome, 97% stated that it did. When asked if

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observing other group biome models helped them to learn about biomes other than their own, 100% agreed that it had helped. When asked if playing the game "Who Fits Here?" helped them to learn about animals and the biomes they live in, 94% stated that it had helped them learn that. When asked if they realized that food, space, and physical handicaps can be limiting factors when playing the game "How Many Bears Can Live In This Forest?", 99% said that playing this game helped them to understand limiting factors.

When asked if the "Forest In A Jar" exercise helped them to understand succession, 100% agreed that it did. When asked if placing an index card with petroleum jelly on it outside helped them to believe that there are particulates in the air, 91% agreed.

When asked if the laboratory exercise "Effects of Thermal Pollution on Yeast" helped them to understand that thermal pollution harms organisms, 100% stated that it did. When asked if building a water filter helped them to understand how one works, 99% agreed that it did.

The majority of students felt that they experienced an increased understanding of ecology concepts due to this unit. For example, when asked if this unit improved their understanding of ecology, 100% agreed that it did. When asked if they have a better understanding of the terms biosphere, population, habitat, limiting factor, and competition due to this unit, 96% agreed.

When asked if they have a better understanding of the terms producer, consumer, herbivore, omnivore, carnivore, food

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chain, and energy pyramid, 96% stated that they did. When asked if they have a better understanding of pollution, acid rain, soil erosion, and destruction of habitat, 96% stated that they did.

Table 5

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Table 5
QUALITATIVE EVALUATION RESULTS - PART I

Summary of student repsonses to questions located in appendix C, page 128.

PART 1: Rating Scale:		
	Strongly Agree	5
	Agree Somewhat	4
	Neither Agree Nor Disagree	3
	Disagree Somewhat	2
	Strongly Disagree	1

PERCENT RESPONDED					
Statement	**5 Strongly Agree %**	**4 Agree Somewhat %**	**3 Neither Agree Nor Disagree %**	**2 Disagree Somewhat %**	**1 Strongly Disagree %**
1	78%	22%	0%	0%	0%
2	35%	57%	8%	0%	0%
3	30%	57%	13%	0%	0%
4	39%	44%	17%	0%	0%
5	48%	30%	14%	4%	4%
6	78%	22%	0%	0%	0%
7	70%	26%	4%	0%	0%
8	83%	13%	4%	0%	0%
9	74%	22%	4%	0%	0%
10	52%	39%	9%	0%	0%

Table 6

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Summary of

Table 6

QUALITATIVE EVALUATION RESULTS - PART 2

Summary of student responses to true/false questions located in appendix C, page 128.

	TRUE		FALSE	
Statement #	Responses	%	Responses	%
1	20	87%	3	13%
2	23	100%	0	0%
3	23	100%	0	0%
4	17	74%	6	26%
5	22	96%	1	4%
6	23	100%	0	0%
7	22	96%	1	4%
8	14	61%	9	39%
9	22	96%	1	4%
10	21	91%	2	9%
11	23	100%	0	0%
12	20	87%	3	13%

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RESULTS OF THE QUALITATIVE EVALUATION

I. Please respond with T for True and F for False for the following statements.

1. Building our biome helped me to learn about that biome.

   87% True 13% False

   *Note: These students (13%) did not complete the assignment.

2. Observing other group's biomes helped me to learn about biomes other than our own.

   100% True 0% False

3. Taking care of an animal requires time and effort.

   100% True 0% False

4. Playing the game "Who Fits Here" helped me learn what animals exist in the different biomes.

   74% True 26% False

5. When we played "How Many Bears Can Live In This Forest", I realized that food, space, and physical handicaps can be limiting factors.

   96% True 4% False

6. The "Forest In A Jar" lab helped me to see how a pond could become a field.

   100% True 0% False

7. Dissecting the owl pellet helped me to understand that rodents are part of the food chain.

   96% True 4% False

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8. I found particles on the index card I coated with petroleum jelly and placed outside. This helped me to learn that there are particles in the air.

61% True 39% False

*Note: Some students did not complete this activity.

9. When we built our own water filter out of a two liter pop bottle, I learned that rocks and sand can act as a filter for water.

96% True 4% False

10. I learned that garbage and manure can increase the temperature of water.

91% True 9% False

11. I learned that increases in water temperature could mean death for certain organisms.

100% True 0% False

12. I learned that germinating seeds are sensitive to the pH of the solution they are in.

87% True 13% False

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II. Use the rating scale below to answer the following questions.

Strongly Agree	5
Agree Somewhat	4
Neither Agree nor Disagree	3
Disagree Somewhat	2
Strongly Disagree	1

1. This unit improved my understanding of ecology.

   5 - 78%   4 - 22%   3 - 0%   2 - 0%   1 - 0%

   100% Agreed

2. The laboratory activities were enjoyable and useful.

   5 - 35%   4 - 57%   3 - 8%   2 - 0%   1 - 0%

   92% Agreed

3. The directions for the laboratory activities were clear and easy to follow.

   5 - 30%   4 - 57%   3 - 13%   2 - 0%   1 - 0%

   87% Agreed

4. I looked forward to the laboratory activities.

   5 - 39%   4 - 44%   3 - 17%   2 - 0%   1 - 0%

   83% Agreed

5. The field trip to the landfill and wastewater treatment facility helped me to understand how those systems work.

   5 - 48%   4 - 30%   3 - 14%   2 - 4%   1 - 4%

   78% Agreed

6. I have a better understanding of ecosystems and the plants and animals they contain due to this unit.

   5 - 78%   4 - 22%   3 - 0%   2 - 0%   1 - 0%

   100% Agreed

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7. I have a better understanding of the terms biosphere, population, habitat, limiting factor, and competition due to this unit.

5 - 70%   4 - 26%   3 - 4%   2 - 0%   1 - 0%

96% Agreed

8. I have a better understanding of the energy relationships among plants and animals due to this unit. (producers, consumers, energy pyramid, etc.)

5 - 83%   4 - 13%   3 - 4%   2 - 0%   1 - 0%

96% Agreed

9. I have a better understanding of the problems affecting ecosystems due to this unit. (acid rain, soil erosion, destruction of habitat, pollution, etc.)

5 - 74%   4 - 22%   3 - 4%   2 - 0%   1 - 0%

96% Agreed

10. I would recommend this unit to be taught to other 8th graders.

5 - 52%   4 - 39%   3 - 9%   2 - 0%   1 - 0%

91% Agreed

QUALITATIVE EVALUATION FREE RESPONSES

The following sample student statements reflect their understanding of man's interaction with the environment:

I. Responses to question number one. Name three labs you liked and explain why.

1. "I liked the owl pellet lab because I felt like a scientist."
2. "I liked the bear game because it was fun."
3. "I like the game 'Who Fits Here' because we learned what animal does what."
4. "I liked making the biomes because I love animals."
5. "I liked the bear game, it was great to learn how bears need a lot of space and food to survive."
6. "I liked the 'Forest In A Jar' lab because it was neat to see a pond turn into a field."
7. "I liked the water filter lab because we learned how water gets cleaned."
8. "I liked the yeast lab because I liked to watch them multiply and to use the microscope."
9. "I liked putting the seeds in different pH solutions. It was interesting to see the results."
10. "I liked the nature walks. Now I know what a lot of the stuff in the woods is."
11. "I liked composting because it was cool to see the changes in the stuff we put in there."

II. Responses to question number two. Did studying the information in this chapter help you to realize man has an impact on the environment? If so, what part of the unit helped you realize this.

1. "Yes, it did. Ms. Mancuso's lectures helped me learn this."
2. "The lectures on man's effect on nature and learning about the different types of pollution."
3. "Yes, going to the landfill made me realize this. I can't believe how much waste man gets rid of everyday."
4. "Yes, the thermal pollution where the yeast died helped me to realize this and going to the landfill."
5. "The lab where we saw the pollution in the air helped me to realize this. When we saw the particles on the index card."
6. "Yes, the whole unit and all the activities helped me realize this."
7. "Yes, the field trips when we went to the wastewater place and the landfill."
8. "Yes, learning about the food chain because when man harms any part of it the whole thing is affected."
9. "Yes, the activities where we polluted the water the way man does."

III. Responses to question number three. What is man's impact on the environment? What is our relationship with the environment? What are man's responsibilities concerning the environment?

1. "We have a responsibility to take care of our environment."
2. "A lot of times, man ruins the environment."
3. "Man does some good and some bad things. On the bad side, we pollute nature, cut down trees, and kill animals illegally. On the good side, we plant trees, help injured animals, and try to decrease the amount of pollution we create. Our responsibility is to treat nature with respect and not harm it."
4. "We have to keep our environment clean so we can preserve it for future generations."
5. "We must stop polluting our environment."
6. "We need our environment for many things so we have to take care of it. We use its natural resources."
7. "If one thing in nature is affected, it affects <u>everything.</u>"
8. "We have to reduce, reuse, and recycle."
9. "It is kind of 50/50, man harms it but man also helps it out."
10. "Many of us ignore our responsibilities."
11. "Man destroys animal habitats when we build shopping centers, subdivisions, and malls where nature used to be."

CHAPTER 4

CONCLUSION

CONCLUSION

This ecology unit was developed and tested because students were leaving the study school and entering high school without a formal study of ecology. Therefore, the students were not adequately prepared for high school in this area. Also, this unit was designed to incorporate many hands-on activities to stimulate student interest in this area.

The goals of this unit were to increase student knowledge of ecology, to stimulate interest in ecology through the use of hands-on activities, and to develop an understanding of man's impact on the environment.

A comparison of the pre-test and post-test scores reveal that student knowledge of environmental science did increase. Qualitative evaluations indicate that students enjoyed the activities and that the activities helped them to understand the concepts. Student verbal and written comments indicate an awareness of man's impact on the environment.

The majority of students were dedicated in their efforts to make this a successful unit. They eagerly participated in the activities and assignments. Their scores, analyzed earlier, and their laboratory write-ups reflected their determination and self-pride. I believe it was a unit the students enjoyed studying. Students like learning about nature and they like hands-on activities so this unit had the components for success.

I really enjoyed teaching ecology and I was very pleased with the student results. I found I was more confident and organized teaching it the second year. I will continue to include this unit in my curriculum. The plans for the future, including improvements, are explained in the following chapter.

As I observed the students working, I noted that some of the activities need to be amended for the future. These amendments include combining similar labs, involving real-life problem solving, and shortening some of them. Amendments for each activity were noted in the Explanation and Evaluation of Activities section of this paper.

Other changes include developing an ecology curriculum that addresses certain concepts and objectives to be taught at different grade levels. This information will be presented in kindergarten through sixth grade. This will allow the junior high science teacher to reduce the amount of time spent on this unit. The six weeks spent teaching this unit was too long. A teacher can only spend a certain amount of time on a unit in order to meet the curriculum requirements for the year.

Several of the laboratory exercises and activities could be adjusted for the primary and intermediate grades. If these activities were implemented at the earlier grade levels, less time would need to be spent on them in the junior high. Also, some of the junior high laboratory exercises address the same concepts. Perhaps these activities could be combined to reduce the number of activities. Both of these changes would reduce the amount of time spent teaching this unit.

Activities that allow students to solve environmental problems need to be incorporated. This would allow students the opportunity to develop a sense of ownership and empowerment of the issues. The students would develop an understanding that they can take an active role in solving environmental problems. They then would have the knowledge and problem solving skills to become responsible citizens.

The result of this project was the development of an educational and stimulating ecology unit. Students leaving the study school will have a solid background in this content area. Hopefully, the knowledge gained will affect future decisions associated with the environment and their interaction with it.

APPENDIX A

LABORATORY EXERCISES, ACTIVITIES, WORKSHEETS, AND HANDOUTS

BIOME PROJECT

DIRECTIONS

1. Work in groups of four.

2. Choose a biome that you want to build. Verify with me.

3. You must have appropriate animals and plants in your biome.

4. It must be realistic. No plastic plants or animals.

5. You must maintain the biome, in school, for two months.

6. Determine a clever name for your biome, the animals, and plants. Create a sign with this information on it and place in on or near the biome.

7. Use any materials from home or borrow from friends. If you need to spend money, spend no more than five dollars per person. If this happens, see me.

WHAT YOU WILL BE GRADED ON

1. Was your biome realistic? Did you set it up correctly?

2. Do you have the proper plants present? Do you have the proper animals present? Do you have enough of each?

3. Did you maintain your biome properly? Was it cleaned, if need be? Were the animals fed properly? Did you treat the animals with respect?

4. Did you share your end of the work involved? Did you help care for the animals? Did you help with expenses? Did you help put it together?

REFERENCE

This activity is my own design.

"WHO FITS HERE" GAME

INTRODUCTION

In this game, the class will divide into two teams. Each team member will select a biome and his/her choice of five organisms found in that biome. On separate index cards (for each organism), you will list six characteristics or facts about each organism. You must not state the name of the organism or the biome it is found in.

Each team will number their cards and make an answer key stating the name of the organism and the biome it is found in. Teams will exchange cards. The team scoring the most correct answers will be the winner.

MATERIALS

pen
paper
resource material to obtain facts about organism

PROCEDURE

DAY ONE

1. Divide into two teams.

2. Choose a team leader.

3. Make a list of all the biomes.

4. Team leader: Have each team member choose a biome.

5. Once everyone has selected a biome, select 5 organisms representative of that biome.

DAY TWO

1. Research your 5 organisms. You may use encyclopedias, books, magazines, etc.

2. Select 6 characteristics or facts about each of your 5 organisms. Do NOT include the name of the organism or the name of the biome it is found in.

3. Write the 6 facts or characteristics on a separate index card for each organism. Turn your cards in for a grade.

DAY THREE

1. **Team leader: Collect index cards from each team member. Mix them up and number each card.**

2. **Make an answer key with the appropriate name and biome for each index card.**

3. **Exchange your index cards with the other team.**

4. **Working as a team, try to determine the name of each organism and it's biome. Write your answers on a piece of paper.**

5. **When finished, give your answer sheet to the other team.**

6. **Correct the other team's answer sheet using your answer key.**

7. **Determine the number they got wrong. Mark this on the top of their answer sheet. Tell the teacher your results.**

REFERENCE

Western Regional Environmental Education Council, Inc. Project Wild. Bethesda, Maryland: Western Regional Environmental Education Council. 1992.

MICRO-ENVIRONMENTS IN THE SCHOOLYARD

INTRODUCTION

Both micro-deserts and micro-rainforests can be found in a schoolyard or a vacant lot. Micro-deserts develop in places that receive little rainfall, such as under eaves or shrubs. They also develop on paths and around bases on a ballfield. A lawn is an example of a micro-rainforest. Without water, a lawn will turn yellow quickly.

OBJECTIVE

To observe the abiotic differences characteristic of desert and rainforest biomes and to investigate the adaptation differences necessary for plants to survive in each of the environments.

MATERIALS

4 stakes
string
meter stick
2 small cans
water
thermometer

PROCEDURE

1. Find a micro-desert and a micro-rainforest on your school grounds. Using four stakes and some string, mark off a square meter of each micro-environment.

2. Count the plants in the micro-desert. In the micro-rain forest you will want to count the plants in a sample. From the sample, estimate the number of plants in the square meter.

3. How many different kinds of plants are there in each micro-environment? Pull up one plant from each biome. How do the roots of the two plants compare? What are the adaptations of the plants in each biome?

4. You might want to compare the abiotic conditions found in a micro-desert and a micro-rainforest. Do the following:

   Compare the soil's ability to soak up water in each micro-environment. To do this, cut both ends from two small cans. Push one can about 3 cm into the soil of the micro-desert. Push the second can about 3 cm into the soil of the micro-rainforest. Fill both cans with water.

Time how long it takes for the water to soak into the soil of each micro-environment. Record your data.

Compare the temperature of the micro-desert and the micro-rainforest. Measure the temperature at ground level both in the morning and in the afternoon.

GOING FURTHER

Transplant the plants from the desert environment to the rainforest and from the rainforest to the desert. Will the desert plant be overtaken by the micro-rainforest? Will the Rain forest plant survive in the desert? You can collect five micro-desert plants and five micro-rainforest plants from your neighborhood and create these environments in your classroom.

COMPLETE THE FOLLOWING DATA TABLE

	Micro-Desert	**Micro-Rainforest**
Total # of plants in sample		
Total # of plants in square meter		
Different kinds of plants		
Roots of one plant		
Adaptations of plants in biome		
Time needed for water to soak into soil		
Temp. in morning		
Temp. in afternoon		

QUESTIONS

1. What adaptations do plants that live in your micro-desert have that help them survive in a very dry climate?

2. What adaptations do plants that live in your micro-rain forest have that help them survive in a wet climate?

3. In which micro-environment - the desert or the rain

forest - are there more kinds of plants? How would you explain your observation?

4. Would a dry spell have greater effects in one micro-environment than in another? Explain your answer.

5. Summarize the adaptation differences between plants in the micro-desert and in the micro-rainforest.

REFERENCE

Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

"WANTED" POSTER

DIRECTIONS

1. Choose any animal or plant.

2. Determine the following information about your organism: its biome, ecosystem, habitat, niche, significant characteristics, how it reproduces, its positive and/or negative impact on other organisms, man, and the environment.

3. Design a poster that reads like a "want ad" for your organism. Use the above information as the necessary "requirements" for the "job". Indicate that your organism is needed/wanted in nature. Be as creative as you like. You must include a drawing of your organism. Create a catchy title.

YOU WILL BE GRADED ON

1. Do you have all the required information on your poster?

2. Is your information accurate?

3. Do you have a drawing of your organism?

4. Were you creative? Were you neat?

REFERENCE

Western Regional Environmental Education Council, Inc. Project Wild. Bethesda, Maryland: Western Regional Environmental Education Council. 1992.

HOW MANY BEARS CAN LIVE IN THIS FOREST?

OBJECTIVE

Students will be able to define a major component of habitat and identify a limiting factor.

METHOD

Students become "bears" to look for one or more components of habitat during this physically-involved activity.

BACKGROUND INFORMATION

It is recommended that this activity be preceded by one or more activities on adaptation: basic survival needs, components of habitat, crowding, carrying capacity, habitat loss, habitat improvement, herbivores, carnivores, and omnivores, and limiting factors.

In this activity, the black bears are the focus in order to illustrate the importance of suitable habitat for wildlife. One or more components of habitat - food, water, shelter and space in a suitable arrangement - are emphasized as one way to convey the concept of "limiting factors".

Black bear habitat limits black bear populations, especially through the influences of shelter, food supply and the social tolerances or territoriality of the animal. Shelter or cover is a prime factor. Black bears need cover - for feeding, hiding, bedding, traveling, raising cubs and for denning. With limits of space, adult bears will kill young bears or run them out of the area. These young bears must keep moving around either until they die or find an area vacated by the death of an adult.

When food supplies are reduced by factors such as climatic fluctuations, competition becomes more intense. Some adult bears might temporarily move to seldom-used areas of their home range, sometimes many miles away. They must live on what food is available in the area. These individuals may become thin and in poor condition for winter hibernation or, in the case of young bears, be forced from the area by more aggressive adults.

All components of habitat are important. Food, water, shelter and space must not only be available - but must be available in an arrangement suitable to meet the animals' needs. For black bears, shelter is especially important.

All possible conditions are not covered by the design of the activity. However, by this simple illustration, it is possible for students quickly to grasp the essential nature of the concept of limiting factors.

The major purpose of this activity is for students to recognize the importance of suitable habitat. Inadequate food and/or shelter are two examples of what is called a limiting factor - something which affects the survival of an animal or a population of animals.

MATERIALS

5 colors of construction paper
black felt pen
envelopes
pencils
one blindfold

PROCEDURE

1. Make up a set of 2" x 2" cards from the colored construction paper for a group of 31-35 students. Make 30 cards of each of five colors to represent food as follows:

   brown - nuts (acorns, pecans, walnuts, hickory nuts); mark five pieces N-20; mark 25 pieces N-10.

   blue - berries and fruit (blackberries, elderberries, raspberries, wild cherries); mark five pieces B-20; mark 25 pieces B-10.

   orange - insects (grub worms, larvae, ants, termites); mark five pieces I-12; mark 25 pieces I-6.

   red - meat (mice, rodents, peccaries, beaver, muskrats, young deer); mark five pieces M-8; mark 25 pieces M-4.

   green - plants (leaves, grasses, herbs); mark five pieces P-20; mark 25 pieces P-10.

The numbers on the cards represent pounds of food.

There should be less than 80 pounds of food per student so that there is not actually enough food in the area for all the "bears" to survive. The following estimates of total pounds of food for one bear in ten days are used for this activity:

nuts	20 pounds = 25%
berries and fruits	20 pounds = 25%
insects	12 pounds = 15%
meat	8 pounds = 10%
plants	20 pounds = 25%
	80 pounds = 100%

NOTE: These figures represent a typical bear's food. The components of an actual bear's diet will vary between areas, seasons and years. For example, a bear in the state of Alaska would likely eat more meat (fish) and fewer nuts than a bear in Arizona. One similarity among black bears everywhere is that the majority of their diet is normally made up of vegetative material. If you want, you can also include "water" by making an additional 50 squares of light blue paper. Mark each stack of ten cards with one of these letters: R, L, ST, SP, and M (representing rivers, lakes, streams, springs and marshes - all places where a bear could find water).

If you have a group of more or less than 31-35 students, use this chart to help determine how many cards to make.

Cards		Number of Students				
		10-15	16-20	21-25	26-30	31-35
Nuts	N-20	2	3	3	4	5
Nuts	N-10	8	13	17	21	25
Berries	B-20	2	3	3	4	5
Berries	B-10	8	13	17	21	25
Insects	I-12	2	3	3	4	5
Insects	I-6	8	13	17	21	25
Meat	M-8	2	3	3	4	5
Meat	M-4	8	13	17	21	25
Plants	P-20	2	3	3	4	5
Plants	P-10	8	13	17	21	25

2. In a fairly large open area (50' x 50'), scatter the colored pieces of paper.

3. Have each student write his or her name on an envelope. This will represent the student's "den site" and should be left on the ground (perhaps anchored with a rock) at the starting line on the perimeter of the field area.

4. Have the students line up on the starting line, leaving their envelopes between their feet on the ground. Give them the following instructions: "You are now all black bears. All bears are not alike, just as you and I are not exactly alike. Among you is a young male bear who has not yet found his own territory. Last week he met up with a larger male bear in the big bear's territory, and before he could get away, he was hurt. He has a broken leg. (Assign one student as the crippled bear. He must hunt by hopping on one leg). Another bear is a young female who investigated a porcupine too closely and was blinded by the quills. (Assign one student as the blind bear. She must hunt blindfolded). The third special bear is a mother bear with two fairly small cubs. She must gather twice as much food as the other bears. Assign one student as the mother bear.

5. Do not tell the students what the colors, initials, and numbers on the pieces of paper represent. Tell them only that the pieces of paper represent various kinds of bear food. Since bears are omnivores, they like a wide assortment of food, so they should gather different colored squares to represent a variety of food.

6. Students must walk into the "forest". Bears do not run down their food; they gather it. When students find a colored square, they should pick it up (one at a time) and return it to their "den" before picking up another colored square. (Bears would not actually return to their dent to eat; they would eat food as they find it).

7. When all the colored squares have been picked up, the food gathering is over. Have students pick up their den envelopes containing the food they gathered and return to class.

8. Explain what the colors and numbers represent. Each color is a kind of food and the numbers represent pounds of food eaten. Ask each student to add up the total number of pounds of food he or she gathered - whether it is nuts, meat, insects, berries or plant materials. Each should write the total weight on the outside of his or her envelope.

9. Using a chalkboard, list "blind", "crippled", and "mother". Ask the blind bear how much food she got. Write the amount after the word "blind". Ask the crippled bear and the mother bear how much they got and record the information. Ask each of the other students to tell how much food they found; record each response on the chalkboard. Tell the students each bear needs 80 pounds to survive. Which bears survived? Is there enough to feed all the bears? How many pounds did the blind bear collect? Will she survive? What about the mother bear? Did she get twice the amount needed to survive: What will happen to her cubs? Will she feed her cubs first or herself? Why? What would happen to her if she fed the cubs? What is she ate first? If the cubs die, can she have more cubs in the future, and perhaps richer, years? (The mother bear will eat first and the cubs will get whatever, if any, is left. The mother must survive; she is the hope for a continued bear population. She can have more cubs in her life; only one needs to survive in order for the population to remain static).

10. If you included the water squares, each student should have picked up at least one square representing a water source, or he or she does not survive. Water can be a limiting factor and is an essential component of habitat.

11. Ask each student to record how many pounds of each of the five categories of food he or she gathered. Ask each student next to convert these numbers into percentages of the total poundage of food each gathered. Provide the students with the background information about black bears so that they can compare how much food they gathered with the required daily requirement. Ask each student to attempt to guess how healthy their bear would be. How do the bears' requirements for a diet seem to compare with the needs of humans for a balanced and nutritious diet?

12. Ask the students to arrive at a class total for all the pounds of food they gathered as bears. Divide the total by the 80 pounds needed by an individual bear (approximately) in order to survive in a ten-day period. How many bears could the habitat support? Why then did only ___ bears survive when your class did this activity? Is that realistic? What percentage of the bears survived? What percentage would have survived had the food been evenly divided? In each case, what percentage would not survive? What limiting factors, cultural and natural, would be likely to actually influence the survival of individual bears and populations of bears in an area?

REFERENCE

Western Regional Environmental Education Council, Inc. Project Wild. Bethesda, Maryland: Western Regional Environmental Education Council. 1992.

CULTURING YEAST

INTRODUCTION

Yeasts are the most familiar and important type of sac fungi to people. During fermentation they break down sugars to produce alcohol and carbon dioxide. Brewers use yeasts to make beer. Bakers use yeasts to make bread dough rise.

Yeasts, unlike other fungi, have no hyphae. Very young yeast cells have no cell walls and the vacuoles are hard to see. When the cell is about one-third grown, the cell wall begins to appear as a delicate membrane. Within a few hours after they are produced, yeast cells have matured. They are then single round or oval cells enclosed by a thin cell wall. They have easy-to-see vacuoles, food granules in the cytoplasm, and very small nuclei.

Yeast cells can reproduce by budding. A bulge appears on the side of the cell. This bulge grows rapidly and may produce other buds while still attached to the mother cell. This appears as a chain of cells of various sizes.

The structure of yeast cells and their growth in a culture can be observed through a microscope using high power.

In this activity, you will observe yeast cells under the microscope, budding, an increase in the population and then a decrease.

MATERIALS

package of yeast	graduated cylinder	cotton balls
molasses	large beaker	dropper
water	microscope	microscope slides
cover slips	iodine stain	flasks or bottles

PROCEDURE

1. In a large beaker, mix together 50 mL of molasses and 450 mL of water. Then add half a package of yeast and stir. Pour the culture into several flasks or bottles. Fill each about half full, and seal with cotton.

2. Put a drop of the culture on a microscope slide, add a small drop of iodine stain, cover with a cover slip, and examine under high power. Observe the cells through the microscope. Draw what you see. Estimate the number of cells visible in the field under high power.

3. Place the flasks of yeast culture in a warm place overnight. The next day, observe the culture. Record

how it looks and smells.

4. Prepare a new microscope slide of the culture as above. Record your findings by drawing what you see through the microscope.

5. By counting the number of cells visible under high power in the microscope field on different days, you can estimate how fast the culture grows.

DATA AND OBSERVATIONS

Complete the following data table.

	Day 1	Day 2	Day 3	Day 4	Day 5
General appearance of culture					
Odor of culture					
Taste of culture					
Drawing of culture under microscope					
Estimated # of yeast cells in high power field					

QUESTIONS

1. Draw and label the parts of a budding yeast cell. Use the following labels: bud, cell wall, vacuole, nucleus and food granules.

2. What is the approximate rate of growth of the culture? Divide the estimated number of cells on day 2 by the estimated number of cells on day 1.

3. What evidence did you find that fermentation was occurring in your yeast culture?

4. Explain the changes you observed in the yeast culture between the first and second days.

5. Using the data you have obtained, construct a graph on graph paper. Use the horizontal axis to plot the time and the vertical axis to plot the number of cells counted.

6. During which day, did the yeast population reach its maximum?

7. Why did the yeast population decrease in number?

8. What would be considered limiting factors in this situation?

9. What is a limiting factor?

10. Name some factors that cause the population growth pattern of humans to differ from that of yeast.

REFERENCE
Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

YEAST POPULATION STUDY

OBJECTIVE

To discover and graph a comparison of the number of yeast cells present at a given time with the number present five days later. To learn how to use the sample method of counting populations.

MATERIALS

graph paper
pencil
ruler
notebook

PROCEDURE

1. Observe Figure 1. If shows a sample of a yeast population over a five-day period. The lines you see would appear on a special glass slide used for counting yeast cells under a microscope. Assume that each dot represents 1,000 yeast cells.

2. In your notebook, make a table like the one below. Then count the number of yeast cells observed on Day 0 box by box. To avoid duplication, any dots appearing on a line to the right or bottom of a box should be counted as part of that box. Dots appearing on a line at the top or left will not be counted as part of that box.

3. Record your count under Day 0 in your table.

4. Repeat the procedure for days 1 through 5 and record your results in your table.

5. Using the data you have obtained, construct a graph. Use the horizontal axis to plot the time and the vertical axis to plot the number of cells counted.

QUESTIONS

1. Between which days was there the most growth? The least growth?

2. During which day did the yeast population reach its maximum number?

3. What are some reasons why the population decreased after reaching a peak?

4. Name some factors that cause the population growth pattern of humans to differ from that of yeast.

COMPLETE THE FOLLOWING DATA TABLE

Number of Yeast Cells Present	Day 1	Day 2	Day 3	Day 4	Day 5

REFERENCE

Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

POPULATION HUNT

INTRODUCTION

In this outdoor activity, you will be observing different populations present in a community.

MATERIALS

notebook	scissors	string	popsicle sticks
chalk	pencil	hand lens	thermometer
ruler	plant/insect identification books		

PROCEDURE

1. Select a square of sidewalk, lawn, garden, or playground in an area your teacher has indicated you may work.

2. Using a ruler, measure a square that is 50 cm on each side, as shown in *a*.

3. Push a popsicle stick into the dirt at each corner of the square, or use chalk to mark the distance. If you have used popsicle sticks to mark the square, tie a string to one stick and run it to the others, as shown in *b*.

4. Record the temperature of the air and soil, the light conditions, and the amount of moisture in the area (dew on the grass, puddles on the sidewalk).

5. Watch for insects, worms, and grubs. Note the variety of plants. You may see moss growing in the crack of a sidewalk or algae in a damp spot. Each species is part of a different population.

6. Record the name and number of each different population you see. Make an estimate if there are too many organisms in a population to count. Use the sample method of counting for numerous populations.

7. Look for and record evidence of animals in the area such as chewed leaves, cocoons, or shed animal skins.

QUESTIONS

1. How many different populations did you find in the square?

2. What evidence did you see that there was interaction between the populations you observed?

REFERENCE

Heimler, Charles H. Focus On Life Science. Columbus, Ohio: Merrill Publishing Company. 1989.

COMPETITION IN A LAWN

INTRODUCTION

Plants that live in a lawn must have adaptations that allow them to be cut once a week and still survive. In this investigation you will determine which better adapted for lawn life - grass or clover.

If a lawn is left alone, which plant will dominate?

MATERIALS

grass and clover seed
3 paper cups
dirt

PROCEDURE

1. Obtain three paper cups. Label the cups A, B, C. Fill each cup to about 2 cm from the top with dirt.

2. Scatter some grass seeds on the dirt in cup A. Scatter some clover seeds on the dirt in cup B. Scatter both grass and clover seed on the dirt in cup C.

3. Each day water the cups. Put the same amount of water in each cup. Do not overwater.

4. Keep the grass and clover cut. Never let it grow higher than 3 cm.

5. After the grass and clover have been cut at least three times, pull four grass plants from cup A.

6. Measure and record the length and number of roots on each plant. Also, record the color and number of leaves on each plant. Record the same things for four clover plants from cup B. Also, record the same things for four clover and four grass plants from cup C.

7. Continue to water the plants in cup C, but do not cut them. At the end of three weeks, pull a grass plant and a clover plant. Compare their leaves and their roots.

8. Allow the rest of the plants in cup C to grow until one type of plant crowds out the other.

9. In the schoolyard, set up a two foot square area using popsicle sticks and string. Estimate the number of grass and clover plants. Determine which is dominate.

QUESTIONS

1. Were the roots of the grass plants longer when they were grown alone or with clover?

2. In which cup A or C did the grass plants have more roots? In which cup B or C did the clover plants have more roots?

3. In cup C, did grass or clover grow the larger root system?

4. In which cup A or C did the grass plants grow more leaves? Was there any color difference between the plants in the two cups?

5. In which cup B or C did the clover plants grow more leaves? Was there any color difference between the plants in the two cups?

6. In cup C, did grass or clover grow more leaves? Larger leaves?

7. In which cup do the plants have the greenest color? Which type of plant in cup C is likely to make more food?

8. Suppose you now have equal amounts of clover and grass growing in your lawn. Do you think the proportion of these plants will remain the same if the lawn is maintained for two years? How do you know?

9. If a grass and clover lawn is not cut, which plant is likely to dominate?

10. What might be the stages in the succession of an unattended lawn?

REFERENCE

Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

FOREST IN A JAR

INTRODUCTION

Succession is a term used to describe changes in an environment over time. Such changes affect the kinds of wildlife that live in the environment. Most forests, grasslands, deserts and other lands are actively changing in character. Many of these changes happen slowly, giving the human observer an impression of a stable environment. Some of these changes literally happen overnight, as in the case of a fire.

Succession is generally thought of as an orderly process. Theoretically, succession begins with bare ground and is completed when a climax forest, grassland or other environment becomes established. **Seral** or early successional plants are generally short-lived, thrive in sunlight, colonize rapidly and spread their seeds far and wide. Roadsides, recent burns, clear cuts and other areas of recent disturbance are good places to find examples of early succession.

The first plants change the environment by adding nutrients to the soil from fallen leaves and other plant parts and providing shade to the soil. This change allows different plants to grow. The presence of these newer plants changes the environment to allow even later stage successional plants to develop. **Climax** or late successional plants usually thrive in shade, live a long time and reproduce more slowly. A plant community has reached a climax state when the plants present generally maintain the same population size over time. Old growth forests are good examples of a climax stage of succession.

Succession influences what kinds of animals live in an area. As succession proceeds from a young system to an older one or vice versa, the habitat available to animals changes character. Therefore, the kinds of animals that live in the area are associated with the area's stage of succession.

Ponds provide another example of succession. As a shallow pond fills with sediments, marshy plants often are established. As the soil dries even more, land plants move onto the old pond shore. Eventually, what was a pond can become a forest many years later! In this activity, students will be able to see in miniature how a wetland area can be succeeded by a forest habitat. The major purpose of this activity is for students to recognize the process of succession.

MATERIALS

pint or quart size jars
water
soil
aquatic plants
bird seed

PROCEDURE

1. Place two inches of soil and three inches of water in a jar. Place the jar at a window, without a lid, and allow it to settle overnight.

2. Plant an aquatic plant in the jar. It should grow well in this environment. If your classroom has no windows, substitute a grow light.

3. Do not replace the water that evaporates from the jar.

4. Once or twice a week, have students add three or four bird seeds to the jar. While there is water in the jar, the seeds should germinate and then rot. Continue adding seeds even after the water evaporates.

5. As the water evaporates down to the soil, the aquatic plant will die. The bird seeds will now typically find the environment suitable for successful growth. Sunflower seeds, which grow large, can be added to represent forest trees. You will now need to add water, as a substitute for rainfall, to keep the grass growing.

6. Have each student make a poster, drawing, or other visual representation of what they saw happen to their "pond". Ask them to talk about what they have learned about how environments can change.

7. Take a field trip to a pond. What plants are growing in the water? What plants are growing on the shore? What parallels are there between this real pond and "pond" in the jar? Make a second drawing of this real pond. Compare the similarities and differences between the two.

REFERENCE

Western Regional Environmental Education Council, Inc. Project Wild. Bethesda, Maryland: Western Regional Environmental Education Council. 1992.

INSIDE A TERMITE GUT

INTRODUCTION

One of the most often cited symbiotic associations of a host-microbial interaction is the termite and its hindgut microbiota.

The termite relies on its hindgut microbiota (anaerobic protozoa and bacteria) for the digestion of wood. Defaunated termites (those that do not have their hindgut microbiota) die of starvation when fed a diet of wood.

There are approximately 2,000 known species of termites. One species, Reticulitermes flavipes, is generally accessible from either pest exterminators or found in the late spring through summer seasons in fallen trees in a variety of soil types. It is a subterranean termite that nests in wood and soil. In addition to collection of the infested wood, these insects can be baited and trapped using corrugated cardboard positioned between the fallen wood and subterranean "entrance". The ideal condition for maintaining these insects involves incubation in a plastic sealable container which has 6 12 inch wood blocks layered between moist paper towels. The container should be maintained at high humidity, although not flooded with water.

MATERIALS

ice container	microscope	forceps
microscope slides	cover slips	anaerobic buffer
aerobic buffer	distilled water	

PROCEDURE

1. Place the termites on ice. Within five minutes the insects will be immobile.

2. Once inactive, the intestinal tract of the insect can be removed by merely using fine tip forceps and by grasping the anterior and posterior end and pulling. The dissected gut will remain intact until punctured or squashed.

3. The gut should then be placed into a drop of buffer that was previously placed on a microscope slide and then quickly covered with a coverslip. The coverslip can be depressed slightly to burst the gut tract.

4. As a contrast, the use of distilled water or aerobic buffer for these observations will show both immobile and slower cells as well as deformed cells.

ANAEROBIC BUFFER

This is prepared anaerobically by boiling under a stream of nitrogen gas, adding a reducing agent (glutathione) and sealing with a rubber stopper.

Alternatively, a solution (final pH 6.8) of KH_2PO_4 (6.9 mmolor; 0.94 g/L) K_2HPO_4 (10.8 mmolar; 1.88 g/L) NaCl (24.5 mmolar; 1.43 g/L) and KCl (21.5 mmolar; 1.6 g/L) can be boiled, pipetted to totally fill a Pyrex screw cap tube with cap, sealed with a cap, and immersed in a ice-water bath.

The boiling effectively removes oxygen, and the quick cooling in a screw cap tube prevents oxygen from reentering the buffer. Tubes prepared in this fashion can be maintained at room temperature or refrigerated for several weeks. Once the screw cap tube is opened, however, it should be used within an hour period. Using this buffer, the motility and activity of the gut microorganisms will be very striking.

REFERENCE

Environmental Course in Biology, Michigan State University, Kellogg Biological Station.

COMPOSTING

INTRODUCTION

Composting is the decay of organic matter in soil. The decay of the matter is due to the bacteria and fungi that is present in the soil. These organisms (bacteria and fungi) eat the matter. They release waste products that enrich the soil, making it fertile for growing crops.

In this exercise, you will observe the decay of organic matter in soil. You will experiment with different materials, determing which are biodegradable and which are not. Biodegradable means that it can be decomposed - bacteria and fungi can eat it and break it down. We will see what bacteria and fungi like and do not like to eat!

MATERIALS

3 inch by 3 inch piece of paper
3 inch by 3 inch piece of plastic
3 inch by 3 inch piece of styrofoam
2 inch by 2 inch piece of apple
a leaf, measure its size (length and width at widest part)
soil
coffee can

PROCEDURE

1. Obtain all material. Make sure they are the proper size.

2. Fill coffee can with soil.

3. Put measured materials in soil. Mix them in the soil. Do not just lay them on top.

4. Cap the coffee can.

5. Remove materials once a month for six months. Record size of each item each month in a data table.

6. At the end of six months, answer the following questions and turn in a laboratory write-up complete with title, objective, materials, procedure, data, and questions.

QUESTIONS

1. Did the size of any of the materials change?

2. Which materials changed in size?

3. Did they get smaller or bigger?

4. Which materials did not change in size?

5. What caused the materials to change in size?

6. Based on your results, what materials are biodegradable?

7. What materials are not biodegradable?

8. What significance does this information have for farmers? Landfills? Nature? Humans in general?

9. What problems might these materials create in a landfill? What could we do to solve them?

<u>REFERENCE</u>

Environmental Course in Biology, Michigan State University, Kellogg Biological Station, 1992.

BENEFITS OF NITROGEN-FIXING BACTERIA

INTRODUCTION

The roots of members of the legume plant family, such as beans, peas, and alfalfa, also contain nodules of nitrogen-fixing bacteria. This useful relationship between legume plants and bacteria is an example of symbiosis, the intimate relationship between organisms of different species that live together. The form of symbiosis in which both individuals benefit from the relationship is known as mutualism.

If you carefully dig up a clover plant growing on a lawn and gently wash the soil away from the roots, you should be able to see little swellings on the roots called nodules. These nodules contain nitrogen-fixing bacteria (Rhizobium), which are helpful to the plant. They change the nitrogen of the air, which plants are not capable of using directly, into nitrates, which the plant needs to form proteins. Nitrogen-fixing bacteria play an important role in the nitrogen cycle.

MATERIALS

spoon	forceps	water	scalpel	microscope
cover slip	methylene blue stain			

PROCEDURE

1. Carefully dig up a clover plant and gently wash away the adhering soil from the roots. Observe the nodules and remove a large one. Rinse it with water.

2. Exercise care as you sterilize a scalpel and a pair of tweezers by quickly passing each through a flame and allowing it to cool.

3. Carefully cut the nodule open with the sterile scalpel. Use the tweezers to smear the cut surface on a clean microscope slide that holds a small drop of water. Another way of obtaining a smear is to crush a nodule between two slides.

4. Allow the smear to dry. Hold the slide with forceps and "fix" the smear by carefully passing the slide quickly through a flame three times.

5. Add methylene blue stain. After one minute, rinse the stain with water and allow it to dry in the air.

6. Examine under low and high power of the microscope. Describe the nitrogen-fixing bacteria.

REFERENCE

Galle, Janet R. and Patricia A. Warren. Ecology Discovery Activities Kit. West Nyack, New York: Center for Applied Research in Education. 1989.

EVIDENCE OF AIR POLLUTION

INTRODUCTION

In this activity, you will observe evidence of air pollution. Sometimes it is easy to see air pollution. For example, when we see thick, dark smoke pouring out of a factory smokestack. Most of the time, however, it is not easy to see the pollutants that are in the air. This activity will make it easier for us to see that pollutants are in the air everywhere.

MATERIALS

6 index cards
petroleum jelly

PROCEDURE

1. Work in groups of two.
2. Coat each index card with a thin film of petroleum jelly.
3. Each group member will be responsible for placing three of the index cards outside, anywhere they would like. Mark the location placed on the index card.
4. After one week, collect the cards and bring them to class.

DISCUSSION

1. List some of the locations the cards were placed in.
2. Which one(s) look like they have the most particles on them?
3. Were you surprised when you saw the card? Why?
4. What does this demonstrate to you?
5. Now that you have seen the results, if you could place your cards anywhere in the world, where would you like the place them? Why?
6. Do you think air pollution is a problem? What is the U.S. trying to do to reduce air pollution? What could you do to reduce air pollution?

REFERENCE

Del Giorno, Bette J. and Millicent E. Tissair. Environmental Science Activities Handbook For Teachers. West Nyack, New Jersey: Parker Publishing Co., Inc. 1975.

FILTERING WATER

INTRODUCTION

In this activity, you will observe how settling tanks and filters help clean water.

MATERIALS

large jar (half filled with water and soil mixture)
3 small glass jars
ruler
clear plastic bottle with bottom cut off
sand
pebbles
cotton
masking tape

PROCEDURE

1. Put tape on 3 small jars. Label them 1,2,3.

2. Pour some of the dirty water from the large jar into jar 1 to a depth of 4 cm. Be sure the water and soil are well mixed in the large jar immediately before you pour.

3. In a data table like that shown below, observe and record the water's appearance and smell in jar 1.

4. Set jar 1 aside and do not shake it or move it. You will observe it later.

5. Cover the cut edge of the plastic bottle with tape, as shown.

6. Close the narrowing opening of the bottle with cotton.

7. Carefully arrange layers of pebbles and sand in the bottle, as shown.

8. Pour more of the dirty water from the large jar into jar 2 to a depth of 4 cm. Again, be sure the water is well mixed before you pour.

9. Hold the bottle over jar 3. Then pour the dirty water from jar 2 into the bottle. The water will take a couple of minutes to go through the layers and into jar 3.

10. Carefully swirl the remaining dirty water in the large jar and compare its contents to that of jar 1 and jar 3. Record your observations.

QUESTIONS

1. Which part of the water treatment process did jar 1 represent?

2. Which part of the water treatment process did the bottle represent?

3. What could you do to get the water in jar 3 cleaner?

COMPLETE THE FOLLOWING DATA TABLE

	Appearance	Smell
Jar 1		
Jar 3		
Large Jar		

REFERENCE

Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

HOW POLLUTANTS AFFECT A YEAST CULTURE

INTRODUCTION

Pollutants can be harmful to the living things in an ecosystem. This experiment will show you how simple substances can affect a yeast colony.

Remember that living organisms undergo respiration. This means that they use food and oxygen to produce energy and the waste product, carbon dioxide. A dead organism would not undergo respiration.

MATERIALS

4 test tubes
test tube rack
marker
liquid soap
salt water
living yeast culture
nonliving yeast culture
eye dropper
bromothymol blue pH indicator

PROCEDURE

1. Label your test tubes 1,2,3,4 with the marker. Place them in the test tube rack.

2. Organize the experiment as follows:

Test tube 1	10 drops living yeast culture
Test tube 2	10 drops salt water + 10 drops living yeast culture
Test tube 3	10 drops liquid soap + 10 drops living yeast culture
Test tube 4	10 drops nonliving yeast culture

3. Add 10 drops of bromothymol blue pH indicator to each test tube.

4. Put the filled test tubes in their rack and place in a safe area for 24 hours.

5. The following day, retrieve your experiment and observe each test tube. Record any color changes for the second day. **NOTE:** Bromothymol blue indicator turns green if carbon dioxide is present.

6. Observe each test tube solution under the microscope.

Estimate the number of yeast cells present. Record this and the magnification you used.

QUESTIONS

1. Make a data table that includes the test tube number, the estimated number of yeast cells present, and the magnification used.

2. Using graph paper, graph the test tube contents on the horizontal axis and the estimated number of yeast cells present on the vertical axis.

3. In which test tubes did the bromothymol blue change color?

4. Why did the bromothymol blue change color? Where did the carbon dioxide gas come from?

5. Why didn't it change color in some test tubes? What does this indicate?

6. Did the pollutants in test tubes 2 and 3 affect the living yeast cultures? How do you know?

7. What is the reason for setting up test tubes 1 and 4?

8. Do you know of any situation when either salt or soap might be released into the environment?

9. Explain what part small living things like yeast colonies play in the environment.

10. If pollutants can kill this part of the food chain, how might that affect the entire environment?

11. List ways that pollutants can be controlled to prevent their negative effect on the environment.

REFERENCE

Galle, Janet R. and Patricia A. Warren. Ecology Discovery Activities Kit. West Nyack, New York: Center for Applied Research in Education. 1989.

FACTORS THAT AFFECT THE TEMPERATURE OF WATER

INTRODUCTION

In this activity, you will determine what materials cause the temperature of water to change. Remember that thermal pollution is the increase in water temperature due to various pollutants. This rise in temperature may cause the death of various organisms in the water.

MATERIALS

5 thermometers
5 equal sized containers
water
graduated cylinder
one tablespoon manure
half cup garbage
one tablespoon soap
one tablespoon bleach

PROCEDURE

1. Work in groups of two.

2. Measure an equal amount of water and pour that amount into each cup.

3. Label cup one "Control". Label cup two "Manure". Label cup three "Garbage". Label cup four "Soap". Label cup five "Bleach".

4. Place a thermometer in each cup of water. Record temperature reading.

5. Place materials in their appropriate cup.

6. Record the temperature reading of each cup every 5 minutes for the next 15 minutes.

7. Record the information in a data table. Graph your data.

8. Answer the following questions and turn in a laboratory write-up complete with title, objective, materials, procedure, data, and questions.

QUESTIONS

1. Did the water temperature change in any of the cups?

2. In which cups did the temperature change?

3. Did the temperature go up or down?

4. Which material caused the most dramatic temperature change?

5. What real-life significance does this have? How do these materials affect nature?

6. How might these materials enter water systems in nature?

REFERENCE

Del Giorno, Bette J. and Millicent E. Tissair. Environmental Science Activities Handbook For Teachers. West Nyack, New Jersey: Parker Publishing Co., Inc. 1975.

HOW DOES THERMAL POLLUTION AFFECT LIVING THINGS?

INTRODUCTION

Sometimes the environment becomes too warm for living things. Thermal pollution is heat that is discharged into the soil, water, or air of a biological community. This heat can harm or kill living things.

Some industries heat water during the process of cooling their electric generators. While still warm, the water is sometimes dumped into small streams or ponds. Many of the organisms that make up the food chains and food webs in these water biomes may be killed.

In this activity, you will find out if heated water can kill or stop the growth of living things and determine if yeast cells can live in heated water for even a short time.

MATERIALS

4 test tubes	8 dry yeast granules	4 droppers
toothpicks	test tube rack	glass beaker
glass slide	blue stain*	hot plate
test tube holder	coverslip	microscope
clock	marking pencil	

*To prepare blue stain add 0.1 gram methylene blue to 99.9 mL of distilled water.

PROCEDURE

1. Label four test tubes 1 to 4. Hold the test tubes in the rack.

2. Fill each test tube with 4 mL of tap water.

3. Put the granules of dry yeast on a piece of paper. With a toothpick, slide 2 granules of yeast into each test tube.

4. Shake the tubes back and forth to break apart the yeast granules.

5. Heat a beaker of water over a hot plate.

6. Attach a test tube holder to tube 2 and hold it in the boiling water for 20 seconds as shown in figure 2. Then return it to the rack. CAUTION: Always use the test tube holder when placing the test tubes in or out of the boiling water.

7. Repeat this process for test tube 3 but keep the test tube in the water for 40 seconds.

8. Repeat this process for test tube 4 for 60 seconds.

9. Stir up the yeast cells in test tube 1 by filling a dropper with the yeast solution and squirting it back into the tube three times.

10. Place one drop of yeast solution from test tube 1 on a clean slide.

11. Using a clean dropper, add a drop of blue stain to the drop of yeast.

12. Use a toothpick to mix the stain with the drop of yeast solution.

13. Add a coverslip. Locate the yeast cells on low power and then turn to high power. Yeast cells will appear as small dots on low power. Look at figure 3 to see their appearance at high power.

14. Look for live yeast cells. These will appear light blue in color. Look for dead yeast cells. These will have the same dark blue color as the stain on the slide.

15. For each yeast cell in one field of view, make a mark in Table 1 to show if it is alive or dead. Continue counting until 50 cells have been recorded. If there are less than 50 cells in one field of view, move to another area of the slide and continue counting until 50 has been reached.

16. Repeat steps 9 to 15 with test tubes 2,3, and 4.

<u>COMPLETE THE FOLLOWING DATA TABLE</u>

Test Tube	Time in Boiling Water	Number of live yeast cells	Number of dead yeast Cells	Total number of cells counted
1				
2				
3				
4				

QUESTIONS

1. Define the following key terms: community, environment, food chain, food web, and thermal pollution.

2. Which tube contained the most live cells?

3. Why were so many cells in this tube alive?

4. Which tube contained the most dead cells?

5. Why were so many dead cells in this tube?

5. Why was test tube 1 not placed in boiling water?

6. Using your results, write three sentences that explain what thermal pollution is.

7. Suppose that algae living in a stream react in the same way as yeast cells did in this exercise. What would happen to food chains in the stream if thermal pollution occurred?

8. A new industry wants to move to your town. This industry wants to use water from the local river for its production line. What questions should the townspeople ask the new industry about the water?

9. Using graph paper, graph the test tubes (indicate how long they were exposed to the boiling water) on the horizontal line and graph the number of living yeast cells on the vertical line.

REFERENCE

Daniel, Lucy. Focus of Life Science Laboratory Manual. Columbus, Ohio: Merrill Publishing Company. 1989.

EFFECTS OF ACID RAIN ON GERMINATING SEEDS

INTRODUCTION

Water vapor in the air mixes with sulfur dioxide, nitrogen oxide, and other chemicals to form weak acids. The chemicals come from the combustion of fossil fuels and the smelting of sulfide minerals. Rain and snow falling over much of the United States, Canada, and Europe have a pH low enough to be considered acidic. Acid rain affects aquatic organisms, vascular plants, and earthworms.

In this activity, you will learn how to read a pH scale, and determine if a variety of liquids are acids, bases, or neutral. You will determine the effects of acid rain on the germination of bean seedlings.

MATERIALS

ammonia	metric ruler	scissors
paper towels	8 small beakers	baking soda solution
petri dish	tapwater	distilled water
6 pH solutions	vinegar	forceps
bean seeds	lemon juice	rainwater

PROCEDURE

1. A liquid may be an acid, base, or neutral. Pure water is neutral and has a pH of seven. Acids have values below seven and bases have values above seven. The pH of liquids can be determined by using chemically treated paper called pH paper. When placed in a liquid, pH paper changes color. Refer to the pH scale below.

		Acidic				Neutral					Basic		
1	2	3	4	5	6	7	8	9	10	11	12	13	14

2. Hold a piece of Ph paper with forceps. Dip the pH paper into the liquid and remove it. DO NOT allow the forceps to touch the liquid. If you do, wash the forceps with tap water before testing another liquid.

3. Match the color of the pH paper in the color chart. Read the corresponding pH number. Record the number in Data Table 1.

4. Discard the pH paper in a container provided by your

teacher. Use a new piece of pH paper for each test.

5. Test the liquids in each of the small beakers. Record your data in Data Table 1 and complete the last column of the table.

6. Cut eight circles the size of a petri dish from the paper towels. Assuming the cut paper towel is a clock, place the letter A in the 12:00 position, the letter B in the 3:00 position, the letter C in the 6:00 position, and the letter D in the 9:00 position.

7. Dampen the circles with one of the pH solutions.

8. Place two circles on the bottom of the petri dish and two on top. Place the labeled one of top.

9. Measure the four seeds and observe the color one at a time. Record your measurements and observations in Table 2.

10. Arrange the seeds in the petri dish according to the letters as you measure them and cover with the remaining 2 circles. Also, label the bottom of the petri dish with the letters A,B,C, and D in their appropriate place. Write the name of the chemical the paper towels were saturated in on the bottom of the petri dish also.

11. Allow the seeds to remain undisturbed for three days. Make sure the paper towel circles remain moist. If the towels are not moist, add more pH solution. Always add the same amount to each dish.

12. Beginning with the third day, observe the seeds on alternate days. Record the amount of growth, color, and shape in Table 2.

13. Compare your results with other groups in your class. Complete Table 3.

COMPLETE THE FOLLOWING DATA TABLES

TABLE 1

Liquid	pH	Acid, Base, Neutral
Rain water		
Tap water		

Distilled water		
Salt water		
Lemon juice		
Vinegar		
Baking Soda		
Ammonia		

TABLE 2

Record pH of liquid, growth, color, and shape of seed					
Seed	Day 1	Day 2	Day 3	Day 4	Day 5
A					
B					
C					
D					

TABLE 3

pH of Liquid	Number of Seeds Germinated
2	
3	
4	
5	
6	
7	
Rain water	

QUESTIONS

1. What appears to be the best pH solution for successful seed germination and growth?

2. What is the least ideal pH solution for seed germination?

3. From the data collected by the class, what pH do you think rainwater has?

4. What impact on crops could increased acidity have?

5. How is acid rain formed?

6. What does acid rain do to the environment?

7. How do humans contribute to acid rain?

8. Using graph paper, graph the solution and its pH on the horizontal line and the number of seeds germinated on the vertical line.

REFERENCE

Daniel, Lucy. Focus on Life Science Laboratory Manual. Columbus, Ohio: Merrill Publishing Company. 1989.

HOW POLLUTION AFFECTS SEEDS

INTRODUCTION

The danger to plant and animal life is becoming an ever-increasing problem as more and more pollutants are added to the air and water. Even common household products contain chemicals that harm living organisms.

Remember that germination is the process of a seed developing into a mature plant. The process has several steps. First, the seed coat swells and splits, and the young root emerges and begins growing downward in response to gravity. The young stem and leaves have a negative response to gravity and grow upward pushing their way through the soil. When the young leaves are exposed to sunlight , they begin the process of photosynthesis. The young plant is on its way! Remember that water, oxygen, and proper temperature must be present in order for this process to begin.

In this activity, you will compare the amount of germination that occurs in bean seeds under different conditions, and how detergents affect seed germination.

MATERIALS

2 beakers	labels	liquid detergent
stirring rod	masking tape	paper towels
water	40 bean seeds	2 plastic bags

PROCEDURE

1. Place 20 pinto beans in each of two small beakers. Add water to one beaker until the seeds are completely covered. Add detergent to the other beaker until the seeds are completely covered.

2. Label each beaker with your name, the date, and the treatment (water or detergent).

3. After 24 hours, pour off the liquid from the seeds soaking in water. Discard the liquid.

4. Rinse the seeds in water. Place the seeds between two layers of paper towels, moisten the towels with water, and slide the towels with the seeds into a plastic bag. See figure 1.

5. Remove the label from the jar in which the seeds were soaking. Place the label on the plastic bag. Close

the top of the bag with tape.

6. Pour off the liquid from the beans in detergent. Discard the liquid.

7. Rinse the seeds in water, and then place them between moist paper towels. Insert the towels in a labeled plastic bag. Close the top of the bag with tape.

8. Examine the seeds in the bags after 48 hours. Look for signs of germination. NOTE: The appearance of a small root shows that the seed is germinating. Count the number of seed germinated in each bag and record the number in Data Table 1.

9. Compute the percentage germinated by multiplying the number of seeds germinated by 5. NOTE: The percentage is the number of seeds likely to germinate if you began with 100 seeds in each beaker.

COMPLETE THE FOLLOWING DATA TABLE

Seeds soaked in	Number of Seeds Used	Number of Seeds Germinated	Percentage Germinated
Water			
Detergent			

QUESTIONS

1. What is meant by a "germinating seed"?

2. What treatment shows the least percentage of germination?

3. What treatment shows the highest percentage of germination?

4. Compare your results to another classmate's. Do the percentages germinated agree for the most part?

5. Compare your results to your classmate's results again. Does the highest percentage of germination occur with the same treatment? Does the lowest percentage of germination occur with the same treatment?

6. What does the comparison between your results and your

classmate's results help to show?

7. Detergents are used in many industries and then dumped into rivers, lakes, or oceans. If detergents are harmful to seeds, explain how they may be pollutants to other plants living near bodies of water.

8. How may detergents be harmful to plants living in bodies of water?

9. Why might it be very harmful if all plant life in bodies of water were destroyed detergents?

10. Can you name other household chemicals that may be pollutants?

11. Explain how you could determine if very small and very large amount of detergents are both harmful to see germination.

REFERENCE

Daniel, Lucy. Focus on Life Science Laboratory Manual. Columbus, Ohio: Merrill Publishing Company. 1989.

MAKING RECYCLED PAPER

INTRODUCTION

In this activity, you will be making recycled paper.

MATERIALS

8 sheets shredded newspaper in bowl of 0.5 L water
warm water
egg beater
fork
2 tablespoons wallpaper paste
large bowl
window screen
masking tape
paper towels
plastic wrap
wood block

PROCEDURE

1. Use the egg beater or fork to beat the newspaper in the water until the paper breaks into fibers. The mixture should look creamy.

2. In a separate bowl, add the starch or paste in 0.5 L of warm water. Beat the mixture until the starch or paste dissolves.

3. Add the dissolved starch or paste to the creamy mixture and stir.

4. Fold masking tape around the border of the screen to cover the sharp edges.

5. Dip the screen into the mixture. Use your hands to spread a thin layer of the mixture on the screen. Remove the screen horizontally.

6. Cover your desk or table with a few layers of paper towel. Place the screen on the towels with the fibers facing up.

7. Place the plastic wrap over the screen. Using the block of wood, press down evenly on the plastic to remove most of the water from between the fibers.

8. Let the screen dry for one to two days.

9. Peel off the paper and examine its quality. Write your name on the paper to further test its quality.

QUESTIONS

1. Describe the quality of the recycled paper compared to newspaper. Does the recycled paper serve its purpose?

2. How might you further test the quality of the recycled paper?

3. Why is recycling paper worthwhile even though it requires a certain amount of processing?

4. The color of the paper was a gray color. Paper companies use bleach to whiten the paper. Why might this be an environmental problem? What could be used instead?

REFERENCE

Barr, Bonnie B. Life Science Laboratory Manual. Menlo Park, Colorado: Addison Wesley Publishing Company. 1989.

APPENDIX B

STUDENT PRE-TEST AND POST-TEST

NAME ______________________ DATE ____________ CLASS ____________

UNIT 8 TEST

The Environment

Choose the term or phrase that correctly completes the statement or answers the question. Fill in the matching circle on the answer sheet.

1. A(n) ______ is the place in the ecosystem where populations of organisms live and grow.
   a. habitat b. community c. canopy d. ecotone
2. The very narrow zone on Earth that life is limited to is the ______ .
   e. ecosystem f. resource g. niche h. biosphere
3. The process of conserving resources and protecting ecosystems is called ______ .
   a. water treatment b. environmental management c. biodegradation d. reforestation
4. ______ are organisms with chlorophyll that make their own food.
   e. Consumers f. Decomposers g. Scavengers h. Producers
5. Some animals in the tundra are well protected by ______ .
   a. sweat glands b. webbed feet c. white feathers or fur d. an exoskeleton
6. Sulfur dioxide combines with water vapor in the air to form ______ .
   e. acid rain f. particulates g. smog h. fog
7. A(n) ______ is a geographic region with distinct climate, a dominant plant type, and organisms adapted to that region.
   a. climax community b. biome c. natural community d. ecotone
8. The contest among organisms to obtain resources, such as living space, is called ______ .
   e. predation f. competition g. consumption h. biocontrol
9. ______ resources include petroleum, natural gas, and coal.
   a. Artificial b. Nonpolluting c. Renewable d. Nonrenewable
10. That part of the biosphere that surrounds an organism is its ______ .
    e. environment f. ecosystem g. ecology h. niche
11. ______ is the maximum number of individuals of a population that a habitat can support.
    a. Limiting factor b. Carrying capacity c. Five thousand d. One million
12. Examples of ______ pollution include power lines and telephone poles.
    e. noise f. air g. visual h. thermal
13. An example of succession is ______ .
    a. when annual plants replace perennials b. an increase in rainfall c. the absence of a new species d. change in a field over time
14. A(n) ______ is divided into levels representing producers and consumers.
    e. ecosystem f. community g. energy pyramid h. biosphere
15. One major source of water pollution is ______, or human wastes.
    a. sulfur dioxide b. acid rain c. cyanobacteria d. sewage

NAME ______________________ DATE ____________ CLASS ____________

16. Something in the environment that stops a population from increasing in size is a ______ .
    e. limiting factor f. biocontrol g. scavenger h. niche

17. The ______ is found in a temperate deciduous forest.
    a. downy woodpecker b. uakari c. prairie dog d. *Rafflesia*

18. Through ______, Earth's supply of natural resources may be extended.
    e. exploitation f. consumption g. conservation h. zoning regulation

19. The area between one biome and the next biome is called a(n) ______ .
    a. interphase b. ecosystem c. climax community d. ecotone

20. A(n) ______ consists of all the organisms of one species within a community.
    e. food web f. population g. food chain h. energy pyramid

21. Loss of topsoil caused by water, wind, ice or gravity is called ______ .
    a. erosion b. deforestation c. farming d. mulching

22. A ______ is the role or function of the organism within a community.
    e. habitat f. limiting factor g. resource h. niche

23. The pattern of succession in a climax community depends mostly on soil conditions and ______
    a. climate b. soil microbes c. human interference d. number of plants

24. ______ species, such as whooping cranes, are animals found only in small numbers.
    e. Extinct f. Preserved g. Endangered h. Unprotected

25. Grazing animals are best adapted to the ______ biome.
    a. desert b. grassland c. tundra d. taiga

26. ______ are organisms that eat and remove dead animals.
    e. Predators f. Commensals g. Scavengers h. Parasites

27. ______ raises the temperature of a body of water.
    a. Cyanobacteria b. Thermal pollution c. Sewage d. Acid rain

28. A(n) ______ is a complex network of feeding relationships involving many food chains.
    e. energy pyramid f. niche g. food web h. habitat

29. The biome that includes the greatest total mass of organisms is the ______ biome.
    a. ocean b. tropical rain forest c. freshwater d. grasslands

30. ______ fuels include coal, natural gas, and petroleum.
    e. Alternative f. Nonpolluting g. Renewable h. Fossil

NAME ______________________ DATE ____________ CLASS ____________

31. ______ are the scientists who classify Earth's major land and water ecosystems.
a. Oceanographers b. Economists c. Botanists d. Ecologists

32. ______ occurs when two organisms both benefit from living together.
e. Parasitism f. Mutualism g. Commensalism h. Predation

33. A major disadvantage of nuclear power plants is ______.
a. damming of major rivers
b. salt corrosion of water pipes
c. disposal of radioactive wastes
d. increased dependence on fossil fuels

34. The size of the human population is controlled by ______.
e. birthrate and death rate
f. infant death rate only
g. improved sanitation
h. availability of antibiotics

35. The taiga biome is found in the northern hemisphere, ______.
a. where permafrost occurs
b. south of the Arctic ocean
c. above the tree line
d. north of the temperate region

36. Reforestation, which involves ______, is the wise practice of forest management.
e. improvement cutting f. planting small trees g. selective cutting h. strip felling

37. Plants adapted to pollination by just one species of animal are common in the ______ biome.
a. tundra b. taiga c. tropical rain forest d. conifer

38. Modern technology and improved health has lowered the ______ of the human population.
e. death rate f. birthrate g. total size h. growth rate

39. Restoration and protection of habitats can lead to ______ of wildlife.
a. extinction b. endangerment c. hunting d. preservation

40. The dominant species in a beech-maple forest are ______.
e. all large tree species
f. beech and maple trees
g. beech trees only
h. maple trees only

41. Plants with widespread or deep roots are often found in the ______ biome.
a. deciduous forest b. tundra c. desert d. grasslands

42. Pollution by sulfur dioxide can be reduced by all of the following methods except ______.
e. exposing coal to radiation
f. use of smokestack scrubbers
g. treating coal with bacteria
h. washing coal

43. Some fish are adapted to swift running water by ______.
a. swimming fast to stay in one place
b. feeding on roots of water plants
c. becoming predators
d. laying eggs on the shore

44. An example of a simple food chain is ______.
e. acorns owls mice
f. owls acorns mice
g. acorns mice owls
h. mice acorns owls

45. ______ involves the complete removal of trees in a small section.
a. Improvement cutting b. Block cutting c. Selective cutting d. Strip cutting

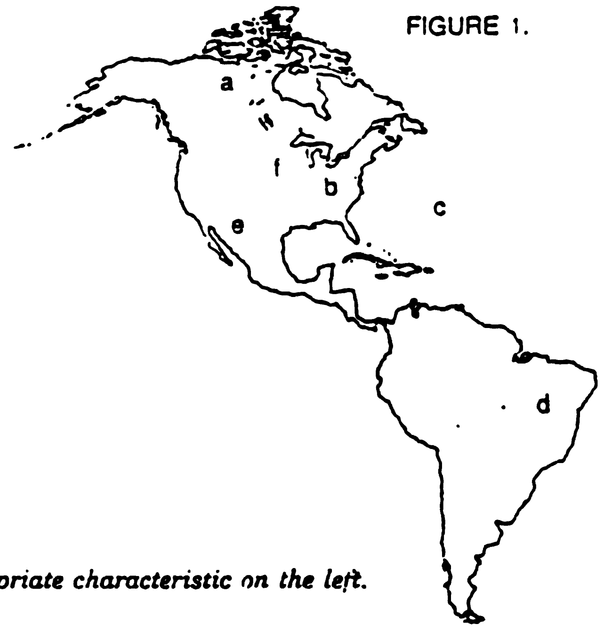
NAME ______________________ DATE ______________ CLASS ______________

II. Understanding Concepts

Skill: Interpreting a Map

Match each letter in the map of the Western Hemisphere in Figure 1 to the correct biome.

FIGURE 1.



_______ 1. tropical rain forest

_______ 2. desert

_______ 3. grassland

_______ 4. tundra

_______ 5. ocean

_______ 6. deciduous forest

Match the biome on the right with the appropriate characteristic on the left.

a. taiga
b. temperate deciduous forest
c. tropical rain forest
d. tundra
e. grasslands
f. desert

_______ 7. rainfall very high

_______ 8. has four distinct seasons

_______ 9. land is flat, poorly drained, soil is frozen

_______ 10. limiting factor is lack of water

_______ 11. limiting factor is unpredictable rainfall

_______ 12. ground is wet and there is often fog

_______ 13. has the most species

_______ 14. summer temperatures very high, winter temperatures very low

_______ 15. tree leaves change color and fall

_______ 16. wide range of temperatures from night to day

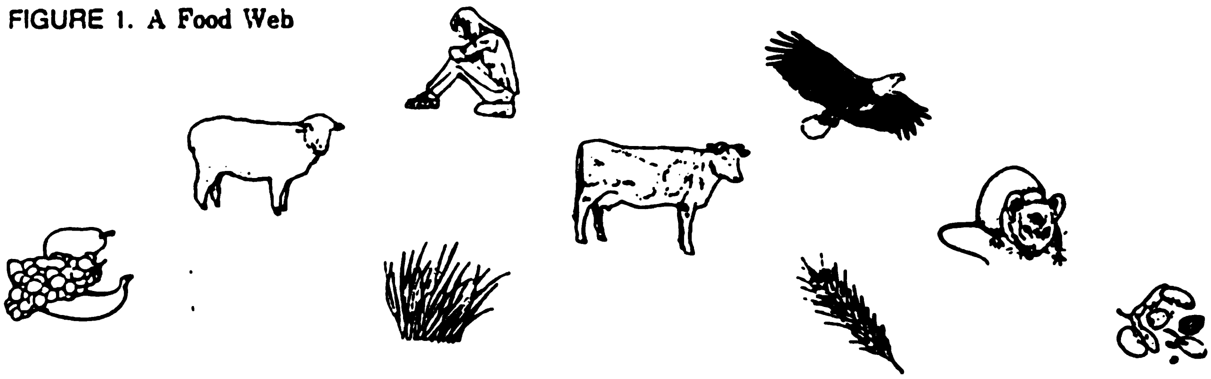
NAME ______________________ DATE ____________ CLASS ____________

II. Understanding Concepts

Skill: Estimating

1. In Figure 1, draw arrows connecting each group of organisms, showing the flow of energy through this food web.

FIGURE 1. A Food Web



Use Figure 1 to complete the following statements by circling the correct italicized term.

2. The organisms on the bottom of the food web are *producers, consumers*.
3. The eagle is a *primary, secondary* consumer.
4. The sheep is a *primary, secondary* consumer.
5. Humans eating beef from a cow are *primary, secondary* consumers.
6. If this were an energy pyramid, there would be a *greater, fewer* number of primary consumers than secondary consumers.
7. If grain and seed production were to decrease, then the eagle population would *increase, decrease*.
8. What technological advances have allowed the human population to increase rapidly in the 20th century?

____

____

____

9. Explain the relationship between an organism's niche and its community. Then describe the niche and community of a termite.

____

____

____

NAME ______________________ DATE ____________ CLASS ____________

III. Applying Concepts

Match each organism in the column on the left with its role in the environment.

a. producer **b. decomposer** **c. scavenger**

_______ **1. alga**

_______ **2. maggot**

_______ **3. fungus**

_______ **4. oak tree**

_______ **5. vulture**

_______ **6. bacterium**

7. Why are scavengers an important part of a community?

____

____

____

Match the pairs of organisms on the left with the correct description of each relationship.

a. mutualism **b. commensalism** **c. parasitism** **d. predator–prey**

_______ **8. orchid–tree trunk**

_______ **9. flagellates–termites**

_______ **10. owl–mice**

_______ **11. ticks–humans**

_______ **12. clownfish–sea anemones**

_______ **13. intestinal worms–humans**

14. Where are humans placed in an energy pyramid?

____

____

15. What are the limits of the biosphere on Earth? Where do most organisms live in the biosphere?

____

____

____

APPENDIX C

QUALITATIVE EVALUATION

QUALITATIVE EVALUATION OF ECOLOGY UNIT

I. Please respond with T for True or F for False for the following statements.

1. Building our biome helped me to learn about that biome.

2. Observing other group's biomes helped me to learn about biomes other than our own.

3. Taking care of an animal requires time and effort.

4. Playing the game "Who Fits Here" helped me learn what animals exist in the different biomes.

5. When we played "How Many Bears Can Live In This Forest", I realized that food, space, and physical handicaps can be limiting factors.

6. The "Forest In A Jar" lab helped me to see how a pond could become a field.

7. Dissecting the owl pellet helped me to understand that rodents are part of the food chain.

8. I found some particles on the index card I coated with petroleum jelly and placed outside. This helped me to learn that there are particles in the air.

9. When we built our own water filter out of a two liter pop bottle, I learned that rocks and sand can act as a filter for water.

10. I learned that garbage and manure can increase the temperature of water.

11. I learned that increases in water temperature could mean death for certain organisms.

12. I learned that germinating seeds are sensitive to the pH of the solution they are in.

II. Please respond to the following short answer questions.

1. Name three labs that you liked and explain why.

2. Did this ecology unit help you to understand that man has an impact on the environment? If so, what part of the unit helped you to realize this? The activities (which ones), the field trips (which ones), or lecture?

3. What is man's impact on the environment? What are man's responsibilities to other organisms and the environment?

III. Use the rating scale below to answer the following questions.

Strongly Agree	5
Agree Somewhat	4
Neither Agree nor Disagree	3
Disagree Somewhat	2
Strongly Disagree	1

1. This unit improved my understanding of ecology.

2. The laboratory activities were enjoyable and useful.

3. The directions for the laboratory activities were clear and easy to follow.

4. I looked forward to the laboratory activities.

5. The field trip to the landfill and wastewater treatment facility helped me to understand how those systems work.

6. I have a better understanding of ecosystems and the plants and animals they contain due to this unit.

7. I have a better understanding of the terms biosphere, population, habitat, limiting factor, and competition due to this unit.

8. I have a better understanding of the energy relationships among plants and animals due to this unit (producers, consumers, energy pyramid, etc.)

9. I have a better understanding of the problems affecting ecosystems due to this unit (acid rain, soil erosion, destruction of habitat, pollution, etc.)

10. I would recommend this unit to be taught to other 8th graders.

APPENDIX D

LECTURE NOTES

OVERVIEW OF ECOLOGY UNIT

I. ORGANISMS AND THE ENVIRONMENT

- A. Ecosystem
  1. Population, community
  2. Habitat, niche, competition
  3. Biomes, succession
- B. Factors that affect an ecosystem
  1. Landforms, food, water, soil, space, climate, shelter

II. ENERGY AND THE COMMUNITY

- A. Relationship among organisms
  1. Predator, prey, mutualism, parasitism, commensalism, decomposers
- B. Energy relationship among organisms
  1. Consumer, producer
  2. Food chain, food web

III. HUMANS AND THE ENVIRONMENT

- A. Population growth
- B. Water pollution
- C. Air pollution
- D. Soil erosion
- E. Wildlife destruction
- F. Solid and hazardous waste

ECOLOGY UNIT NOTES

I. ORGANISMS AND THE ENVIRONMENT

A. Ecology
1. Study of organisms and their interactions with the environment
2. Ecologists - people who study...

B. Biosphere
1. Area of earth, 8 km above earth and below sea level, where organisms live

C. Four basic needs of organisms
1. Food, water, shelter, space

D. Biomes
1. A region with a distinct climate (temperature, rainfall, humidity, etc.), plants, and animals.
2. Names and descriptions of... see chart
3. Ecotone - area between 2 biomes

E. Ecosystem
1. Living organisms interacting with each other and the non-living environment
   a. Examples: pond, ocean, lake, stream, forest, city, fallen log, soil, etc...
   b. Non-living parts: sun, air, water, soil (rock), climate
2. Factors that affect an ecosystem
   a. Food, climate, landforms (mts., plains, hills, valleys affect amt. sun and rain), soil (amt.and type), water, space, shelter

F. Community
1. Many organisms living together in a certain area
2. There are different types of communities. Different communities have different organisms and characteristics.
   a. Example: A marsh and a desert

G. Habitat
1. Where an organism lives

H. Niche
1. Role or job of organism in that community
   a. Example: decomposers

I. Population
1. Organisms of 1 species in an area.
   a. Example: all bass in a lake etc..
2. Carrying Capacity - maximum number of animals that an ecosystem can hold before problems arise
3. Limiting Factor - something in the environment that stops a population from increasing in size

J. Competition
1. Organisms that have similar needs compete for food, water, land, etc... when overpopulated/crowded - survival of fittest

K. Succession
1. Change in a community over time, plant and animal species replaced by others
2. Occurs naturally (earthquakes, volcanoes, forest fires) or may be spurred by man

II. ENERGY AND THE COMMUNITY

A. Organism relationships
1. Predator - animal that captures others for food
2. Prey - those eaten
3. Mutualism - 2 different organisms live together and both benefit, "friendly" relationship Ex: termite gut
4. Parasitism - 1 organism lives off another and causes harm to the host Ex: certain bacteria, fungi, viruses
5. Commensalism - 1 organism lives on another but causes no harm, 1 benefits/1 doesn't but not harmed Ex:orchid/ivy growing up tree
6. Decomposers - organisms that live off and break down dead organisms, "recycle" Ex: bacteria, fungi, vultures

B. Energy relationship among organisms
1. Producers - use energy from sun to make food energy Ex: plants, some microorganisms
2. Consumers - eat green plants for energy
   a. Primary consumers - eat producers
   b. Secondary consumers - eat primary consumers
3. Food Chain - transfer of energy and nutrients from 1 organism to another Ex: sun, plant,

insect, bird,wolf, decomposers. Change in one part of the chain affects other parts.

4. Food Web - many different food chains in a community/linked Ex: sun, grasses, eaten by rabbits, mice, grasshoppers, rabbits and mice eaten by snakes, rabbit, mice, snakes eaten by owls
5. Energy Pyramid - diagram of relationship of producers and consumers, illustrates number of producers, primary consumers, secondary consumers, etc.

III. HUMANS AND THE ENVIRONMENT

A. Human Population
1. Continually increasing, demand for food, water, land, and other resources increasing
2. Zero population growth
3. Food shortage
   a. poor countries - diet: rice, wheat, beans
   b. wealthier countries - meat and varied diet
   c. resolve problem: more farm land, produce crops that have a higher yield, pesticides, biocontrols (ladybugs eat insects that eat crops)

B. Air Pollution
1. Natural pollutants - volcanic ash and dust, forest fires, burning of fossil fuels
2. Man-made pollutants - automobile exhaust, industry, burning materials
3. Effects: heart, respiratory diseases, crops, trees, buildings
4. Prevention -
   a.lead free gas
   b.catalytic converters (convert harmful gasses into carbon dioxide and water vapor)
   c.using filters called scrubbers in smokestacks
   d.treating high sulfur coal with bacteria that absorbs some of the sulfur
   e.crushing and washing coal before use

C. Water Pollution
1. Needed for drinking, laundering, bathing, lawns, disposal of human wastes, producing electricity, agriculture, industry
2. 3% of earth's water is fresh and 2/3 of that is in glaciers
3. Pollution of lakes, streams, oceans, groundwater - harmful chemicals and oils

dumped into water. Examples of chemicals: PCB chemicals in paints, inks, electrical insulators; mercury, dioxin, lead, oil, pesticides, radioactive wastes. Effects: plants absorb, harms food chain

4. Thermal pollution - industries dump hot water, causes increase growth of cyanobacteria and green algae - too many and use up oxygen for other organisms
5. Acid rain - harmful gasses produced from burning of fuels combine with rain and return to earth. Effects: alters soil fertility, liberate toxic metals in some groundwater and food chain (fish dying), trees, crops, buildings, metals.
6. Prevention -
   a. biological control of pests vs. pesticides
   b. decrease water use
   c. water treatment facilities instead of dumping human wastes
   d. recycling water
   e. cooling towers
   f. drip irrigation

D. Soil Erosion

1. Formation of soil - 2.5 cm. takes 500-years to form
2. Erosion - removal of soil by water, wind, ice, gravity. In 1977, U.S. lost 3 million tons of soil by erosion.
3. Effect - topsoil provides necessary nutrients for plants. Number 1 problem globally.
4. Prevention -
   a. natural vegetation (trees, grasses, etc.) decreases rate of erosion
   b. planting rows of evergreens as windbreaks
   c. mulch (grass clippings) helps soil retain moisture, plant cover crop after main crop has been planted - protects soil, reduces runoff - plowed under after season - increases fertility of soil
   d. contour plowing - plowing across a slope instead of up and down, produces furrows that hold water
   e.strip cropping - rows of crops are alternately planted with grass or clover which hold water and retard flow of rain water
   f.terracing - hillside converted into broad, flat steps that hold water
   g. crop rotation - planting same crop

depletes soil of nutrients. Rotation crop usually alfalfa, soybeans, legumes - bacteria in roots of legumes restores N to soil that grains remove

E. Destruction of Wildlife
   1. Cause - clearing of forests, grasslands, swamps, wetlands, dammed streams, polluted air and water, illegal hunting
   2. Effect - habitat destruction, diseases plants and animals, endangered and extinct animals
   3. Prevention - protected, regulated hunting; refuge stations, state and national parks, wilderness areas, reforestation, zoos - captive breeding programs

F. Solid Waste
   1. Cause - more than 50% comes from agriculture, but it is animal and crop wastes which decomposes and enriches the soil; mining, industry, business, and homes
   2. What becomes of it?
      a. open dumps - source of disease, rats, fleas breed; rain water flows off and becomes polluted and flows into nearby ponds and rivers
      b. incineration - air pollution
      c. sanitary landfills - 80% of wastes from cities put in these, garbage is compacted and covered with a layer of soil each day, this decreases disease and pollution of water and soil. Problem: leaks, land available
   3. Prevention - reduce, reuse, recycle (glass, paper, rubber, iron, steel, aluminum)

G. Hazardous Waste
   1. Harmful or dangerous waste
   2. What becomes of it?
      a. in past - stored in drums and buried
      b. special landfills - located in thick clay (isolated it from groundwater), collects rainwater, leak detection system
      c. burning - air pollution
      d. W. Germany detoxifies 60%
   3. Prevention - eliminate or reduce

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