A MODEL OF CURRICULUM DEVELOPMENT FOR THE NATURE CONSERVANCY PRESERVES IN OKLAHOMA

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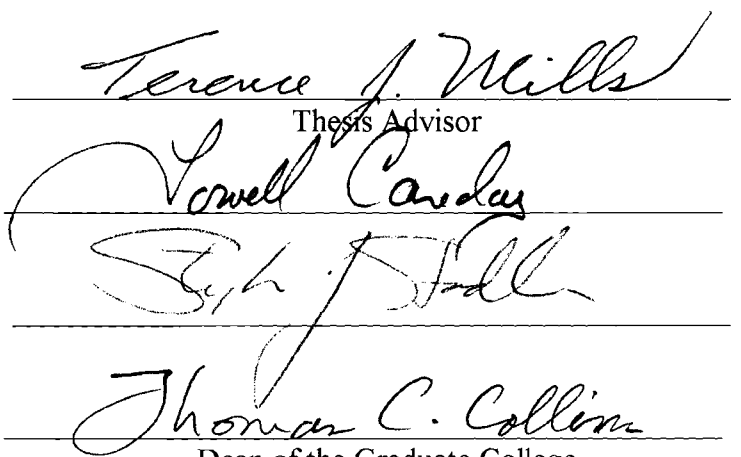

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PREFACE

My sincere appreciation to Dr. Ted Mills, Science Professor, Oklahoma State University, my advisor, both for his assistance with this project and for the opportunity to work with him on projects for OSU. His insight and wisdom gained from a lifetime of work in the environmental education field were invaluable. I would also like to thank Dr. Lowell Caneday, another member of my committee, for his willingness to review and assist as I considered important aspects of well-rounded environmental education curriculum, and Dr. Stephen Stadler for his assistance with this document.

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INTRODUCTION

Some researchers, such as Alexander, believe that awareness of environmental issues appears to be increasing among the public (1990). This increased awareness may be partially because of the existence of curriculum materials that are available in schools across the country through programs such as Project WILD K-12 Activity Guide (Western Regional Education Council, Inc., 1992) and Project Learning Tree Environmental Education Activity Guide Pre-K-8 (PLT) (American Forest Foundation, 1993) environmental education supplements . Because of the success of these programs, educators and parents demand more materials that present environmental subject matter to students. It has been documented that the demand for these types of materials has been growing (Alexander, 1990).

Typically, the environmental curricula are only a small part of the year's studies. However, one Glens Falls, N.Y. high school teacher calls the environmental studies portion of the curriculum the most important three weeks of the year (Alexander).

Current school curricula on the environment are often criticized. One explanation of this criticism is the comment that educators have been reactionary in their focus, simply considering contemporary problems, resulting in materials that are uncoordinated, unconnected and "peripheral" (Bybee, 1991). Similarly, Blosser (1990) says that

"curriculum materials and instructional approaches must be used that cause conceptual change. Learners must be involved in experiences that challenge their current conceptions."

Instructional curriculum is commonly associated with the school setting. However, non school agencies often offer learning opportunities in environmental science. These opportunities may include interdisciplinary studies. Curriculum supplements developed in these settings could include elements that increase the usability and viability of the materials, including: (1) use of situations and concerns that are socially relevant; and (2) the development and use of problem-solving skills. Generally, environmental education teaching materials that include these elements also address some issues that relate to the public health and to the quality of life on Earth.

To successfully incorporate these elements, a very specific curriculum may be needed, something more than is obtained when activities and information are simply pulled from existing textbooks. According to Bybee, this practice of drawing from here and there sometimes leads to disjointed lessons without a common thread which "do not contribute to a resolution of the planetary crisis" (1991).

Private agencies such as The Nature Conservancy (TNC) have a desire to provide quality educational information to the public that includes both global scientific information and information specific to projects of that particular agency. The mission of this nonprofit agency is to preserve animals and plants and the unique ecosystems in which they live. This is accomplished by helping existing landowners who "register" their land, and by land purchases. These lands are then managed according to scientific techniques

believed to be environmentally sound. Education of landowners has been an important part of the Registry program. The TNC mission has always included this environmental education element. However, the agency is just beginning to see the need to expand that educational element to the public. The most recent Organizational Priorities of TNC, presented in November 1995, note that activities and experiments in compatible human use will have "learning as a priority and teaching as an obligation."

This expansion is happening because The Nature Conservancy management personnel believe that knowledge of environmental science and related issues often results in a population that is more likely to "think globally, act locally." An important key to developing this attitude is the provision of a personal - or local - link to the concepts. Education is one focus of the 1995 Strategic Plan of the Oklahoma Chapter of The Nature Conservancy.

"How to" guides to curriculum development presently exist, and are designed primarily for science teachers. Skill Development Modules such as those developed by Hungerford, Payton, Tomera, Litherland, Ramsey and Volk (1985) provide an excellent resource for science teachers interested in module development toward environmental literacy.

Other materials, such as Project WILD K-12 Activity Guide (WREEC, 1992) or The Applied Biology/Chemistry Series (Center for Occupational Research and Development, 1992), can be incorporated into school science programs if the teachers have attended a special training session to learn how to lead hands-on activities. Materials such as Investigating Your Environment (U.S. Forest Service, U.S. Department of

Agriculture, 1981) provide excellent examples of activities for environmental education teaching units.

Statement of the Purpose of the Study

This study was made to address several questions about the development of environmental education curriculum materials. How does a curriculum writer decide what concepts are important when writing a supplement for a particular agency? What types of activities are most successful in teaching these concepts? What key persons should have input into the process? How are the varying viewpoints of sponsoring entities balanced so that the resulting product is acceptable to all? How should the product be evaluated? Finally, how should the product be introduced to teachers so that it is used in the classroom?

Basic guidelines exist for curriculum writers by following existing curriculums. However, can specific - and effective - environmental science curriculum packages be created which link a local environment to environmental concepts, personalizing the learning experience so that the student can integrate what they have learned into their daily life?

The purpose of this study was to answer these questions through: (1) analysis of the process of creating an environmental education supplement for the middle grades; (2) creation of a middle school curriculum supplement based on Oklahoma's Nature Conservancy Preserves; and (3) evaluation by survey and anecdotal data from participating teachers how successful the curriculum is in expanding learning and awareness of individual students. Together, this information serves as a model for

developing materials that provide local connections for environmental concept education.

The largest portion of the study concerns the actual development process of a curriculum supplement entitled "Spirit of the Last Great Places." The supplement is attached to this document as Appendix A. and appears as a teachers' manual. Please refer to the supplement when references to certain sections or activities are made.

The development process of "Spirit of the Last Great Places" included many steps: (1) development of a curriculum proposal (including a timeline and budget); (2) identification of key concepts, according to the organization's values and philosophies; (3) development of a topical outline; (4) identification of the relationships of concepts to actual locations; (5) formation of an advisory panel of educators and science specialists to serve in a review capacity; (6) development of sample lessons; and then, (7) the actual development of lesson plans (including objectives, background information, materials, procedures and evaluations). These sample lessons incorporated what is currently known about the learning process; in particular, the "learning cycle" as described by Robert Karplus in "Three Guidelines for Elementary School Science" (Karplus, 1969). This cycle involves three steps: (1) an initial experience with the concept, preferably "hands on"; (2) support of the concept through vocabulary; and (3) an activity that allows extrapolation of the concept to the personal world of the learner.

However, the development process does not conclude with the completion of the lesson plans. Some means of promoting the materials to the teachers who will be using them is required. This "promotion" might include a training process that allows the teacher to experience a sense of attachment and familiarity with the materials.

Final steps include use of these teacher training procedures, and also the development of an instrument used to evaluate the success of the curriculum. Does it teach what it should teach? Further evaluation should include pre- and post-testing of the effectiveness of the curriculum with actual students. Did attitudes change after use? How do students feel about what they have learned? However, for this study, as no teacher is yet using the supplement in its entirety, this type of evaluation is not yet possible. The development model concludes with the process of revising the materials based on the findings of the evaluation instruments, both after teacher review and after analysis of the student data.

Other considerations when creating a model curriculum could include learning outcomes recommended by the State Education Departments. Current national and state guidelines for curriculum development that currently exists for school science curriculums could also be considered.

Definition of Terms

For this study, "curriculum" is defined as: an interrelated set of plans and experiences that a student undertakes under the guidance of the school (Marsh, C. and Willis, G., 1995); "Project WILD" refers to the Project WILD K-12 Activity Guide, (Western Regional Environmental Education Council, Inc., 1992); and "Project Learning Tree (PLT)" refers to the Project Learning Tree Environmental Activity Guide PreK-8 (American Forest Foundation, 1993).

Significance of the Study

This study will contribute to the knowledge base of curriculum development. It

will also provide a small-scale model that can be used specifically by non school agencies within states or regions which desire to make an environmental science educational contribution to their communities by linking environmental concepts to the ecosystems found in their locality and/or state.

Assumptions and Limitations

One assumption that must be made is that, prior to working with the curriculum package being developed, neither students nor teachers have had educational emphasis on environmental education (although this may not be true). If prior environmental education had occurred it might be assumed that an existing attitude might influence the teacher's response (positive or negative) toward the supplement and its successful use in the classroom.

Limitations include the size of the teacher sample available for evaluating the initial curriculum. This sample included teachers who expressed an interest in using the curriculum. These teachers may already have an interest and an awareness in environmental science, which is necessary to teach these materials. Therefore, evaluation did not include those teachers who attached no importance to environmental problems.

Another limitation was the students who were pre- and post-tested for ecological knowledge and attitudes before and after use of the materials. These students were in classes taught by teachers who were trained in the curriculum. It is likely that the students may have already studied units in school focusing on earth or environmental sciences. It was difficult to assure that a broad base of student abilities and interests was represented by the sample class.

Organization of the Document

Following the Introduction, the Review of the Literature section summarizes information currently available that considers either the need for or the construction of environmental education materials. The Method section traces the steps of the curriculum development process. Because the process does include distribution and evaluation of materials, distribution options, and methods of evaluating the effectiveness of the materials are both considered.

REVIEW OF THE LITERATURE

The literature reviewed confirms the worldwide interest in environmental education. This environmental education curriculum must be different, striving not only to educate with facts but to provoke thought, possibly resulting in altered attitudes. A brief review of some of the types of environmental curriculums that have been created follows. These examples should give the reader an idea of what has been prepared and how this information can help in the development of other curricula.

Richard Peters notes (Winter 1993/94) that "today's children must begin to comprehend the character and complexity of the global community." Peters believes that this need is strong and paramount to being an effective citizen of the 21st century. Peters is one of many educators who is espousing the need for daily school lessons that offer children opportunities to interact with and learn from natural and social phenomena.

This new environmental education thrust goes beyond simply learning the scientific facts. The thrust involves a change in basic conceptual understanding - a philosophy resulting in life style changes that is sometimes called "deep ecology." Michael Zimmerman (1993) says that intellectual conclusions alone are not enough to cause an attitude shift toward nature. He calls for a "change of consciousness, an intuitive sense of identification with all things."

Globally, there are three worldwide treaties that are striving to create this type of consciousness: the Convention on the Rights of the Child (September 1990); the Protocol I of 1977 on the Protection of Victims of International Armed Conflicts (December 1978);

and the Convention Concerning the Protection of the World Cultural and Natural Heritage (December 1975). The United States is a party to only the last of these multilateral treaties.

Arthur Westing (1993) notes that a great majority of nations have made commitment to provide environmental education because of these treaties. He notes that environmental education has been expanding at all grade levels within the developed countries of the world. The World Commission on Environment and Development has declared environmental education should "foster a sense of responsibility for the state of the environment and to teach students how to monitor, protect and improve it." Westing says that throughout the world, both students and educators must learn to accept new ways of thinking. He suggests that schools restructure their curricula to foster a holistic or global and long-term viewpoint.

Industries, companies and organizations throughout the United States and the World are responding to the apparent need for environmental education. This is resulting in a large variety of curricula, often developed in a haphazard fashion, sometimes to advance the particular agenda of an entity which is either philosophically or economically concerned with the environment. One example of an Oklahoma curriculum supplement which offers eclectic activities and strong concent but no centralized theme is Environmental and Conservation Instructional Activities, (Oklahoma State Department of Education, 1977). There is nothing wrong with curricula of this type if the materials explain the basic environmental concepts according to the current scientific knowledge, with consideration given to the interrelatedness of all things.

When developing an environmental science curriculum, the developer's philosophy and the paradigms of curriculum that are to be embraced must be given attention (Horton & Hanes, 1993). These must be the initial considerations, because it is these philosophical views that allow the writer to decide the important pieces of the curriculum. After this philosophical foundation is established, the curriculum can be developed based upon, according to Horton and Hanes, one of three curriculum paradigms: Positivism, Phenomenological/Interpretive and Critical.

Models for curricula exist worldwide. Two such models are: A Case Study of a School-Based Curriculum Development as a Model for INSET (Israeli Environmental Education Project (1986); and Intermediate Level Environmental Education in Sudan: A Proposal for a New Program (1992). The first study, by Keiny and Weiss, was a conceptual model developed by a team of teachers; the subject matter was water regulation in a desert environment. The second, by A. El-Zubeir, concerned a revision of an existing environmental education curriculum and an assessment of the educational value of the revised curriculum. El-Zubeir included descriptions of the contents and the instructional and evaluation process.

The testing and development of an environmental education curriculum model are the subject of a study by Forbes and Smyth (1984) in which the curriculum was structured around five key questions, amplified to fit the topic and the applied circumstances. The authors provided information about both the development and the testing of this curriculum.

A very large resource is Biological Diversity: Makes a World of Difference. A

Curriculum for Teachers and Interpreters (1990). This 215-page curriculum from the National Park Service contains ten units focusing on biological diversity, and includes activities with objectives, material lists and procedures.

Another curriculum for the middle school is A Prototype Environmental Education Curriculum (H. Hungerford, H., 1985) from UNESCO. This three-year curriculum is divided into three components: (1) ecological foundations; (2) environmental science and environmental health; and (3) issue investigation and citizenship action training.

Another lengthy document, from the Rhode Island State Dept. of Education, Dept. of Environmental Management, is Oscar's Options: A Supplementary Environmental Education Curriculum (Bell, 1986), a two-volume supplementary curriculum designed for teachers of children in grades 4-8. Interdisciplinary lessons involve different activities and skills.

The creator of a much smaller curriculum, as a contribution from a nonprofit entity to a school system, has the task of choosing from volumes of information. He/she must narrow down lesson topics and focus on specific facts. These actions will result in the most valuable lessons possible on a small budget with minimum pages.

Through researching the above sources, and others like them, a knowledgeable curriculum developer should gather valuable information about format and content for his/her material. He/she will also gather ideas for objectives, activities and evaluations. Developers would also benefit from awareness and study of education and learning theory and modern culture.

METHOD

The process of developing the curriculum supplement, "Spirit of the Last Great Places," is the concern of the first portion of this section. Options for distribution and evaluating effectiveness follow the development section. Decisions on formatting and concept emphasis are critical and time-consuming. The "fleshing out" of concepts demands research, writing, critique, and revision. Distribution options require the advice of educators and agencies. Evaluation demands a microscopic look at the details of concept units, their soundness and the relationship of activities to concepts.

Development

The process of curriculum development begins with a consideration of the purpose of the curriculum project as it relates to the developing agency. Is there a need for this new material - either for the educational community or for the agency, or perhaps both? Has the agency completed earlier curricula? How was it received by the educational community? Was it used by educators?

Once an agency has decided why there is a need for curriculum development, a search for knowledgeable writers of the curriculum begins. Such writers might be found at nearby colleges or universities, or in the community of educators in the surrounding area. The candidates should be educated and practiced in curriculum development with either knowledge of or access to classroom teacher expertise. They should be willing to work with a panel of advisors who can provide specific content recommendations for the project, who will make sure that the project is on track throughout various stages of development.

The Oklahoma Chapter of The Nature Conservancy (TNC), located in Tulsa, OK, produced a television program, "The Last Great Places," in 1993. This program dealt with biodiversity in Oklahoma and TNC preservation efforts across the state. Both the media and the public praised the program. The producing station, KOTV-Channel 2, Tulsa, received an Excellence in Programming Award.

The Executive Director of the Oklahoma Chapter, Herb Beattie, believed that the chapter's educational efforts should not stop there. He saw the need for Oklahoma teachers to be able to use the Preserve locations to teach students the amazing biodiversity present in Oklahoma. Dr. Ted Mills, at OSU's College of Education, Department of Curriculum and Instruction, was approached and asked to submit a grant proposal to fund the creation of the materials. The original request noted that the project would include:

- Development of ten Curriculum Units, written according to Oklahoma Department of Education standards, and aimed at students in grades 4-5;
- Materials that are multidisciplinary and cross-cultural, involving both classroom and outdoor experiences;
- Coordination of the project by an advisory board;
- Curriculum to focus on biodiversity in Oklahoma as represented by TNC Preserves, with a large portion of the material devoted to the Tallgrass Prairie Preserve in Osage County;
- Editing of video tapes resulting in two or three twenty-minute videos;
- Completed length of between sixteen and twenty-five pages;
- Manual to be ready for distribution by August 1994.

Pre-proposal research. "The Last Great Places" video was viewed several times as was a second TNC video about the Tallgrass Prairie Preserve in Osage County. This Preserve is the largest in Oklahoma, and one of the largest in the nation. Purchased in 1989, it covers 37,000 acres and is managed to recreate the tallgrass prairie ecosystem, an

ecosystem that has been nearly completely lost. This prairie, which covered nearly the central third of the United States, has become the "breadbasket" of North America, and is now used for agricultural purposes, with few natural grassland species remaining. Concepts that were emphasized in the videos were identified. Informational pieces from TNC Preserves across the state were read, and other environmental curricula concerned with ecology and biodiversity were investigated.

Some questions remained to be answered, including: How many units were needed? What was the desired format for the units? Was the target age group too small? How large should class size be? Should visual aids be included with the instructional materials?

Discussion on the project was held by OSU personnel (Mills and McIntyre), and agreement was reached that the desired information could not be adequately covered in a 16 to 25-page supplement, and that the target age group should cover 4th through 8th grade, to encourage more teachers to use the materials. Class size could range from 18 to 25 students. Other questions, such as formatting and content topics, should only be answered with the assistance of an advisory panel of experts. This panel should include teachers and professionals working in the environmental education field.

A budget, timeline, and general lesson plan outline were prepared. The budget included expenses for: salary, office maintenance (supplies, utility/phone expenses), duplication (12 final copies), and travel. The timeline began with the date of proposal acceptance, and indicated progress through a seven-month period to completion. It included dates of committee meetings, sample lesson completion, rough draft and final

draft deadlines. The original time line appears in Table I.

TABLE I

INITIAL PROJECT TIMELINE

Date	**Activity**
By Jan. 21	Designate committee members.
Jan. 17-21	Analyze tapes, list key concepts, ideas.
Jan. 21	Tape analysis complete.
Jan. 21-31	Prepare topical outline.
Jan. 31	Advise committee of outline/progress, request comments.
Feb. 1-11	Prepare sample lesson.
Feb. 14	Advise committee of sample lesson, request comments.
Feb. 18	Comments due.
Feb. 21- April 1	Prepare rough draft of all lessons.
Week of April 4	Distribute rough draft to committee members.
Week of April 14	Committee meeting for review.
By April 22	Rough draft changes made.
April 22	Redistribute rough draft to committee members. Comments due by May 9.
May 9-27	Tape edit/Coordinate with lesson draft.
May 9- July 8	Final draft in process.
July 8	Final draft complete.
July 11	Send final draft to committee. Comments due by 7/18.
July 18	Initiate printing.
August 1	Copies available for TNC.

Suggestions for the general lesson plan outline included: lesson objectives, method and materials, background concepts, key terms/vocabulary, and procedures as well as suggested checks of understanding, suggested readings and possible activity expansions and variations. A proposal/memo of understanding was submitted, noting changes from the original request.

Proposal Discussion. The initial grant proposal was discussed at a meeting between Nature Conservancy staff and involved OSU personnel on January 7, 1994. The proposal was accepted two weeks later, in late January, with one additional change: $3,000 was added to the budget to allow for the training of teachers who would receive manuals. The organization of the training would be decided later. It was apparent after discussion that teachers would be much more likely to use the materials if introduced to them in a workshop format. This format might be similar to that required by the Project WILD and Project Learning Tree national environmental education programs.

McIntyre suggested a possible table of contents. A ten-unit format was also proposed. The first two units would focus on ecological principles, the next two on Oklahoma environments. Topics four through eight would look at the Tallgrass Prairie Preserve (according to TNC wishes). Topic Unit 9 would investigate migratory birds in Oklahoma. The final unit would deal with stewardship and action. Early estimates of document length noted that at least 40 pages would be required, and that this might result in lengthening the timeline.

Advisory panel. Approval for the project was received from TNC by the end of January. The first task was to find suitable members for the advisory panel. This panel needed to include members with varying backgrounds. Representatives were sought which: (1) were from state agencies with programs that dealt with the environment; (2) were specialists in ecology (to help with lesson content); (3) were university professors with expertise in science education; and (4) were representatives of industry. Additional members were sought who were Nature Conservancy staff members (including staff from

the Tallgrass Prairie Preserve), and educators working with students of the target age group. Names were matched to these descriptions, and initial contacts were made.

Research. Background research for the curriculum supplement began. The two Nature Conservancy videos were reviewed again. Ideas which were emphasized in the videos, including ecological principles, were noted. The following list includes those major ideas.

- ecosystems
- biodiversity
- stewardship
- habitat
- erosion
- renewable/nonrenewable resources
- Tallgrass prairie
- "Big Four" Tallgrass Prairie grasses
- sustainable ecosystems
- bison
- fire management
- grass/bison/grazing relationships

Research on these principles began. This research included looking at the definition of the term and considering how it would fit into the general scheme of an educational supplement.

A meeting with Nature Conservancy personnel was set for March 15, 1994, two months into the project, to update them on progress with the advisory panel and the supplement. TNC approved the list of possible panel members and possible topic subjects.

Immediately following that meeting, all potential panel members were contacted. Eight persons accepted this responsibility. Those who agreed to serve received a confirmation letter. They also received a copy of the Nature Conservancy video "The Last

Great Places." April 20 was set as the date for the first meeting with the advisory panel members.

Advisory Panel Correspondence. By April 20, 1994, three months into the project, panel members had received background materials for the project. These materials included the Table of Contents, a concept outline of the ten-units and a sample lesson. The concept outline included the topic divisions for the ten units, the primary concepts to be covered in those units and the vocabulary terms that might be included in those units. Also included were connections between each of those topic units and specific preserves in Oklahoma. An important link was made between concepts and the particular TNC preserve location that would be the focus of that unit. A primary purpose of this curriculum was to allow students to relate concepts to a nearby location. Hopefully this would be a place that they could visit, or that was already familiar to them.

Prior to the April 20 meeting, panel members were asked to review the materials and consider the following questions:

- Do the lessons follow a logical sequence?
- Are the principles and contents of each lesson accurate?
- Is the sequence of the concepts logical in each lesson?
- Do you see any ideas which have been left out but should have been included?
- Are there any unnecessary inclusions?
- What suggestions do you have for lesson activities that incorporate the concepts as given for each lesson?

First Advisory Panel Meeting. At the April meeting, panel members had many valuable suggestions. Two questions were of primary concern. The first was, what will make teachers want to use these materials? By consensus, panel members believed that

the format and content of the materials would be the key. Necessary features such as procedural steps and expansion opportunities as well as content considerations were discussed. Would the materials be written so the students could personally relate to topics and activities?

The second question was, how will the curriculum be made available to state teachers? Avenues of providing this information to teachers were discussed. These included use of "The Web," a publication sent to educators who have been trained in Project WILD and Project Learning Tree in Oklahoma, and use of Oklahoma Science Teachers Association and Oklahoma Education Association newsletters. Then, the importance of training teachers to use the materials rather than simply sending materials through the mail, was stressed. This led to discussion on the importance of assuring that teachers could receive staff development points for such training.

A large portion of the meeting focused on the format and content of the teachers' manual. Panel members requested a "how to use this manual" page in the introductory section. This page would help teachers understand the basic philosophy and the organization of the materials. Panel members observed that far too many concepts were introduced in most lessons and that the objectives were more like goals. Panel members suggested ways to combine various topic units and narrow the focus. Members believed that these suggestions would prevent duplication and aid in a logical progression from topic to topic.

Vocabulary was a major concern of committee members. Were words defined in the text immediately after use, or included in a glossary? Was the vocabulary too

advanced for the average 4th - 8th grade teacher? A member suggested that defin appear at the front of each topic unit in a background informational section. All p members emphatically agreed. This section would provide teachers with an over the concepts covered in that unit. The implications of the expanded background s (as far as total length of the curriculum supplement) became apparent when rough were written.

Length of the supplement was also affected by a request that all necessary worksheets for activities be included in the supplement. The worksheet provided serve as a Master Copy that teachers would reproduce for use by their students.

Another question: What about estimated time required to conduct a lesson Should times be included or left to the discretion of the teachers? The panel decid including times was not necessary. Each activity should probably target a complet of 45 to 60 minutes, to fit the typical class session.

The four units which cover the Tallgrass Prairie Preserve information were reviewed. Some changes were made to focus the content and to eliminate confusi terms. Panel members discussed the migratory bird section. One member noted tl information covered included two types of birds. One type was the neotropical mi those bird species which migrate to Central and South America for the winter mor return to North America - and Oklahoma - to nest each spring. The second type v waterfowl, and other migrants like bald eagles. It was decided that the emphasis s on migratory species in general. The general intent of the tenth unit, to teach prob solving skills and an awareness of environmental decision-making dilemmas, was

explained and approved at this meeting. Finally, panel members decided that an introductory page covering the organization of the materials and how to use them should be included.

Following this April meeting, advisory panel members were given an opportunity (with deadline) to respond to the concept draft. A revised version would be sent within a month of the meeting. Another advisory panel meeting was set for June 6, slightly more than four months into the project. At that time the panel would review a draft version of Topic Units One and Two.

Formatting Work. Work began on revising the format of the Topic units, and on reorganizing the presentation of the environmental concepts. Many of the more specific terms were eliminated as general concepts of the topic units were broadened. Major questions that were considered were: What are the most basic, most important concepts? What specific terms, primary in importance, can fall under the umbrella of the general concept? How can these concepts be related to TNC preserves? What types of activities will effectively teach the desired terms and the ecological relationships they represent?

Input from the advisory panel on the formatting of the units themselves was incorporated during development. Sections on background information (a brief summary and explanation of the important concepts that the activities would teach), procedures (step-by-step guidelines how to conduct each activity), evaluation (ways to assess whether learning has taken place) and expansion opportunities (ways to expand the activities to accommodate older learners or learners who need a greater challenge) were included in each topic unit. Initial work to "flesh out" the concepts with activities began.

Two activities were to be included in each topic unit. The theme of moving from a global to a local (or personal) perspective was carried out within each topic unit by writing the first activity with a general focus on the concept, allowing a "hands on" experience by the learner. The second activity was written to localize or personalize the concept. The student could experience how that concept directly affected his/her locality (a Preserve location), or him/herself in his/her local ecosystem.

Second Advisory Panel Meeting. At the June 6 meeting, the panel reviewed and approved the Organization and "How to Use This Manual" page. The importance of the learning cycle was discussed, and its prominence in the development of the units. A revised Table of Contents section, incorporating suggestions made at the April meeting, was also available. The panel reviewed the completed Topic One in detail. Panel members offered few suggestions, and were pleased with how their ideas had been incorporated into the format and design of the materials.

Sponsors Meeting. The next step was to return with an update to those companies that were sponsors for The Nature Conservancy Project. These included Phillips Petroleum Company, Public Service Company of Oklahoma, KTOV Channel 6 (Tulsa), the Tulsa World, and Stegman/Sere Productions. Each sponsor had made a financial contribution to the project. The agenda for this meeting, to be held June 15, 1994, included not only discussion of two completed units of the teachers' manual, but also discussion of how the teachers training would be handled when the materials were finished.

A final item for discussion at the meeting was the extension of the August

deadline. This extension was necessary because the time required for advisory committee input and revisions had not been adequately considered in the original timeline. At least a two-week "window" is required to allow for initial mailing (2-4 days), panel member review time (5-7 days), and return mail time (2-4 days). The amount of time required to research and write full background information and prepare worksheets for every topic activity was not considered initially either. The revised timeline appears in Table II.

TABLE II
REVISED TIMELINE (June 15, 1994)

Date	Activity
Jan. 31 - Feb. 4	Analyze tapes, list key concepts and ideas
Feb. 4	Tape analysis complete
Feb. 7-18	Prepare topical outline
Feb. 21 - Mar. 4	Preparation of sample lessons
Mar. 4 - April 1	Prepare rough draft of lesson plans
Mar. 15	Meeting at OSU (Mills, McIntyre, TNC) Designation of Advisory Panel members
March 19	Fieldtrip to Tallgrass Prairie Preserve
Week of April 11	Distribute rough draft to committee
April 20	Committee meeting/comments
Week of April 25	Changes/alterations drafted
April 29	Redistribution of rough draft (additional comments due by May 9)
May 9-27	Tape edit/coordination with lesson drafts (Stegman unable to schedule meetings at this time - tape edit delayed until later in project)
May 9 - Sept.	Final draft in process
May 15	Field trip to Preserve
June 6	Advisory panel meeting Review Topic One in semifinal form
June 21	Initial teaching of one activity at OSU Environmental Summer Academy (Unit 5)
June 22	Field trip to Tallgrass Prairie Preserve with Summer Academy
July 18	Tentative Advisory Committee Meeting for review of completed topics (1-2, 5-8) - NOT HELD

Date	Activity
July 18 - Aug. 29	Work on Topic 8, 3, 4, 9 and 10 Topics sent to Committee as completed
Aug. 29	TENTATIVE Advisory Committee Meeting for Review of Completed Topics (3, 4, 9, 10) - NOT NEEDED
Aug. 29 - Oct. 1	Final revisions
Oct. 3	Final draft sent to Advisory Panel. Comments due by Oct. 10.
Oct. 17	Manual sent to printer
Nov. 1	Copies available for Nature Conservancy
Fall 1994	Teacher training and Manual Distribution

At the meeting, sponsors heard details of two possible models for distribution: (1) workshops offered through Education Extension at OSU (designed like the Project WILD training workshops) and conducted at OSU by a graduate student funded through an assistantship; and (2) workshops of varying length given by an employee of The Nature Conservancy at locations around the state.

Option 1: a graduate student in Environmental Science Education would teach workshops through the Education Extension program at OSU. Workshop locations would be determined according to OSU locations, and promoted through OSU mailings and course catalogs. Students would obtain graduate credit and meet state continuing education requirements for educators by taking this class. Workshops would include an outside assignment and participants would be graded. An OSU faculty member would have to be present to help in teaching each workshop.

Benefits of this option were to be: (1) OSU affiliation with the program; and (2) OSU promotional assistance. Possible negative aspects of this option were: (1) person(s)

teaching the workshops would change from year to year; (2) lack of flexibility in locations; (3) lack of flexibility in length of workshops (to receive one hour of graduate credit, workshop must total 15-18 contact hours, plus an assignment); and, (4) University regulations must be followed, including charging tuition and requiring enrollment in the graduate college.

Option 2: A TNC staff member would serve as Education Coordinator. Responsibilities would include providing workshops at various locations around the state. Anyone interested could attend, at little or no cost. Attendance at a workshop would still be required to obtain the materials, but workshop length could be changed to fit the need. A shorter, 4-5 hour school inservice could be given, providing a brief overview and sampling of activities.

Benefits of this option were to be: (1) continuity in program instruction from year to year; (2) flexibility in workshop location; (3) flexibility in length of workshops/inservices; (4) cost dependent upon number of workshops given. Negative aspects of this option were to be: (1) lack of affiliation with the university; and (2) cost of promoting materials would be carried by TNC rather than the university.

These options were presented and discussed at length, and tabled until the workshops that OSU had agreed to provide as part of the contract were completed. Under the contract, OSU was to offer training to a minimum of 60 people in fall and spring workshops offered through OSU Extension.

The extension of the deadline to November 1, 1994 was approved by the sponsors. The month of September would be used for final revisions. Panel members would receive

the final draft in early October. Comments were due back by Oct. 17, when the manual would be sent to the printer.

Sponsors reviewed the first two topic units. All comments were favorable, and work on the remaining eight topic units began.

Topic Research. Work on the remaining topic units began with more research into the concepts to be covered in each section. Environmental science texts were read, and many activities that dealt with those concepts were reviewed. A summary was then written as the background information section for the teacher. After drawing from many environmental education curriculum supplements and using personal creativity, two activities were written or selected for each of the ten units. Twice, these activities were taken from previously written curriculum supplements. Often, an existing activity was modified to fit the specific needs of these materials, or several activities were simplified and combined. Some activities were creative collaborations; other activities were original. A listing of the activities and the origin of each appears in Table III.

TABLE III

ORIGIN OF ACTIVITIES

Activity	Origin
1A: Ecosystem Webs/Cinquain poetry	combination of existing activities
1B: Okla. Ecosystems and Biodiversity	collaboration: Mills/McIntyre
2A: Go Bats!	adaptation of Project WILD activity
2B: What's Your Niche?	McIntyre
3A: Water Moves	Mills/Ewing (see References)
3B:Water/Wetland Investigations	combination of existing activities
4A: Exploring Soil	combination of existing activities

TABLE III - ORIGIN OF ACTIVITIES (continued)

Activity	Origin
4B: Looking at Erosion	combination of existing activities
5A: Rainfall on the Prairie	adaptation of PLT activity
5B: Make a Grass	adaptation of PLT activity
6A: "On Some Other Prairie"	collaboration: Mills/McIntyre
6B: Prairie Food Web	collaboration: Mills/McIntyre
7A: Bison Tic-Tac-Toe	collaboration: Mills/McIntyre
7B: How Many Whatzits?	McIntyre
8A: Prairie Ecology	McIntyre/existing activities
8B: Prairie Hi-Lo	adaptation of existing activity
9A: Migration Station board game	McIntyre
9B: A View from the Air	McIntyre
10A: A Land Use Case Study	existing activity (see References)
10B: Personal Views and Action	McIntyre/existing activity

Activities were then written in draft form with sections for materials, setting and procedure. Possible expansions and evaluations for each activity were eventually added.

As the development of the Topic Units progressed, consideration was given to what types of activities had been used in previous units. In addition, what disciplines were involved? Was the activity site indoors or outdoors? Was the activity active or sedentary? Every attempt was made to add variety so that topic unit activities differed in method and incorporated all learning styles. Some activities required physical activity, others provoked thought and used creativity. Some were similar to laboratory setups. Many used simulation to teach concepts.

Advisory Panel Review. Rough drafts of each unit were sent to advisory panel members after completion. Five of the eight panel members actively participated in the

review process, returning the draft with suggestions for improvements or ways to clarify background information and activities. These suggestions were acted upon, and an edited draft version was prepared.

It was unnecessary to call the advisory panel together again. The five active members remained active through correspondence, offering editing tips. The three panel members who were not active continued to be nonparticipants.

Graphic Artist Changes and Printing. In late September 1994 (eight months into the project), a draft version of "Spirit of the Last Great Places" was taken to a Tulsa graphic artist. A few graphics were added as was white space for note-taking. The copy was arranged into an eye-pleasing, usable format. The graphic editor's version became the final edition of the materials. This edition was printed in early November, in time for the first workshop. The completed curriculum supplement was a reality about 285 days after the project began. Total length, including Glossary, References and Appendix sections, was 147 pages.

Workshops and Inservices

The first workshop was scheduled and arranged through OSU Extension and held two Saturdays in November 1994 from 9:00 a.m. to 5:00 p.m. (16 contact hours with an outside assignment requirement). The workshops opened with a welcome and brief introduction of the project. A 25-question test followed, to test the participants' knowledge before the workshop. Next, an icebreaker activity was used to help participants become familiar with one another. The introductory portion of the workshop concluded with the showing of The Nature Conservancy video, "The Last Great Places."

During the main portion of the workshop, each topic unit was reviewed. Class members participated in part of at least one activity per teaching unit, working in groups, completing worksheets and following procedures. Enough of each activity was done for the participants to understand the procedure and how students might react. The activity portion was followed by a concept review to clarify background information for class members.

The workshop concluded with the post-test (same instrument as given at the beginning of the workshop). Originally, it was hoped this test could measure the success of the materials. However, the test showed how much knowledge the participants possessed before the workshop (pre-test) and how many facts the participants picked up during the workshop. This is discussed further in the "Evaluation of Materials" section.

Twenty-one persons enrolled in the first workshop. Five of these were representatives from Public Service Company of Oklahoma (a primary sponsor of the project). The others were teachers from around the state. Verbal comments about the materials were very positive, but no opportunity was given to write comments specifically about the materials until the second workshop in Spring 1995.

Four of the attendees wanted to have the materials presented at an inservice for teachers in their school, Patrick Henry Elementary in Tulsa. They returned to their school and requested that these materials be considered for this inservice. Approval was given by the school administration and the inservice was scheduled.

The six-hour Patrick Henry inservice was given January 3, 1995. Thirty-one teachers attended. Focus of the inservice was the interdisciplinary uses of the materials,

and how these materials could meet the needs assessment that school had prepared for 1994-95. At the inservice, teachers were divided into five groups, with groups consisting of teachers from different grade levels or subjects. Each group took two topics, and discussed how the materials could be used in science and other subjects, and with children younger than fourth grade. They also discussed how these materials might be used to increase community involvement, coordinate studies between several grade levels and subjects, and promote reading skills. Each group presented their conclusions to the class, and all comments were made available in written form for all teachers.

On February 24-25, 1995, twenty-four persons received training in the second 16-hour workshop offered through OSU Education Extension for one hour of graduate credit. Of those who attended, ten taught students in grades K-6, eight taught students in grades 6-8, four were OSU graduate students, one was OSU staff, and one was a Project WILD facilitator. Ten had completed Masters degrees and one had a Doctorate.

Some comments written on evaluations included: "The workshop was absolutely great. One of the most useful classes I've taken! Excellent!" "I have really enjoyed this class. I'm looking forward to being able to use it in my 7th grade Life Sciences the next two weeks when we get into the Ecosystem. This is very challenging material for them and will be very useful." "Enjoyed the workshop! Good activities, well presented!" "I found the class very educational, entertaining and useful." "Well organized and orchestrated. Easy to use materials. Relevant and interesting information." "Thoroughly enjoyable. Well prepared!" "I think it's important to raise awareness among teachers in our state about this information. I think it would be great if inservices on this material

were provided statewide. I learned a lot (regardless of my test score!) and enjoyed the class. I think the average teacher could benefit from this material." "Very interesting. I liked the activities mixed with the theory and facts. The video is a definite "plus" I didn't expect. It will be very useful and help the students visualize things they may never see otherwise. Thanks!"

The materials were also taught in June 1995 in a 16-hour class at Phillips University, Enid, Okla. Six teacher/students enrolled for one hour of graduate credit. Most recently, the guide was presented in a six-hour inservice at Shattuck High School (twelve teachers) in August 1995 as a staff development program.

The materials will continue to be offered through OSU Extension with a fall session in November 1995, and a spring session to be set as well. As of September 1995, 98 teachers have received training to use the teachers' guide. Another twenty at a summer camp for science and math teachers held at the Vocational/Technical school in Drumright, Okla. received an hour-long overview of the materials during a June workshop.

Educational Video

As part of the original agreement, The Nature Conservancy had requested a video that would accompany the teacher materials. Originally, video work was scheduled to begin in May. However, this portion of the work was set aside for later. The delay was caused by extra work resulting from text expansion and video company scheduling conflicts (Stegman/Sere Productions).

In October 1994, it was decided that the existing two videos (already created for The Nature Conservancy) did not provide adequate footage for use in the educational

video. Video clips were not present which could be used in Topics Two (Habitat), Three (Water) and Four (Soil). Uncut footage of the related TNC Preserves was available at Stegman/Sere, producer of the original TNC television videos. After receiving a list of needed footage in October 1994, Stegman-Sere created a numbered tape of uncut footage. From this tape, clips could be selected for the teachers' video. This tape was available in January 1995. Review of the footage, selection of the clips and sequencing for the video followed. Some clips from the existing, already-produced videos could be used. A suggested sequence was provided to Stegman-Sere in February. Stegman/Sere then produced the teacher video using the suggested footage clips. The video was completed in March 1995.

The completed version of the educational video includes an introduction by Brita Cantrell, executive director of the Oklahoma Chapter of The Nature Conservancy. The final version of the video tape progresses in order from one topic unit to another. Each topic is separated by a pause and introductory screen for the next topic unit. Most topic segments are from four to seven minutes in length. However, the Tallgrass Prairie Section (Units 5-8) is nearly twenty minutes in length, as it covers four complete topic units. Scenes in the video that have no narration feature background music. The videos were available for the March 1995 workshop offered through Education Extension, and were provided (once available) to teachers who participated in the November 1994 workshop.

Evaluation of Materials

The creation of a pre-test/post-test to be used with the workshops was originally considered as a way to see if the materials taught students the desired concepts. The

original pre-test/post-test included 25 multiple-choice questions. At least one question was selected from the ecology background/content information of each activity. The first three questions related to information about the work of The Nature Conservancy in Oklahoma. The first question was a short answer question which asked the locations of The Nature Conservancy sites in Oklahoma. A response which included at least four correct locations of Preserves was considered a "good" answer. There are sixteen preserves in Oklahoma. The second short answer question asked the participant to state the mission of The Nature Conservancy. Most of the participants had a general idea about the mission, that it involved protection and conservation. The third survey question was a multiple choice which asked how The Nature Conservancy accomplished its work. Most participants successfully answered this question on the pre-test.

This pre-test/post-test was first used with teachers at the initial teachers' workshop. A review of the results after the first use produced the information in Table IV. This information does not include Survey Questions 1-3. The questions were analyzed to determine the pre-workshop knowledge of the participant. Questions appear in ascending order, beginning with those which were most successfully answered in the pre-test.

TABLE IV
COMPARISON OF PRE-TEST/POST-TEST
WORKSHOP 1 - NOVEMBER 1994

Question	Correct Answers #1 Pre-Test (n= 19)	Correct Answers #1 Post-Test (n= 16)
23. Songbird Migration	19	16
8. Habitat components	17	16
4. Ecosystem components	15	14
19. Grassland requirements	15	11
16. Rhizomes definition	14	16
11. Functions of wetlands	13	15
22. Effects of fire- animals	12	14
20. Extinction	12	13
21. Effects of fire- plants	12	11
5. Primary energy source	11	15
13. Erosion and soil type	10	8
6. Biodiversity definition	9	14
25. How birds migrate	9	13
10. Water cycle definition	8	10
24. Migration problems	8	7
7. Cave nutrients and fish	7	13
9. Ecol. niche definition	7	9
14. Climate and biomes	5	16
17. Food chains, first link	5	9
15. Big Four grasses	4	13
12. Soil horizons	4	3
18. Prairie nutrient cycle	2	3

After examining the results of the test, several inferences can be made: (1) some questions may have been unclear; (2) Test questions were factual in focus; and (3) the pre/post-test scores also reflected to some degree how inadequately the range of factual material had been covered in the workshop. The third inference is drawn from the observed lack of time required to teach all the ecological concepts. The ten units would require at least twenty-five hours of class time, plus a field trip to a prairie location. The OSU Extension workshops are too short (16 hours) to complete all activities or even adequately cover all of the major background concepts. Time was unavailable for unit evaluations, which the teacher would do with an actual class. Some concepts received more coverage than others because interest was high. Other concepts were neglected because time was short and it was imperative that all ten topic units had some coverage during the workshop.

In evaluating pre-workshop knowledge, the test revealed a familiarity with the general concepts of habitat and ecosystem. Questions most often missed were those concerning climate and biomes, food chains, Big Four grasses, soil horizons and composition, and the prairie nutrient cycle. This information gives direction as to what content should be emphasized in future workshops, and, perhaps, in environmental education materials in general.

Although the pre-test/post-test was not an effective means of evaluating the actual materials in this situation, the pre-test/post-test was used again in March 1995, primarily to evaluate teachers' pre-workshop knowledge and the effectiveness of concept

presentation. Some questions were rewritten for clarity. The results revealed that in the area of soil horizons, students still were not getting the facts straight. Prairie ecology (grass/fire/grazing interactions) still was not completely understood by most of the workshop participants. However, there was some improvement in other areas.

More effective in assessing the effectiveness of the materials were the assignments that were required of each workshop participant who took the class for graduate credit. Participants were asked to perform two activities with a class of students and evaluate how many of their students learned how much and how they felt about it.

Thirty-four participants in the first two OSU Extension Workshops pursued the graduate credit option and evaluated activities with students. The results of these class assignments reveal that many students, even some younger than the designated 4th - 8th grade levels, effectively learned environmental concepts with the "Spirit of the Last Great Places" activities. Five of the activities were not selected for use in these assignments: Activity 4A, a lab-type activity exploring soil samples; Activity 6A, a creative writing exercise investigating food chains; Activity 10A, a lengthy activity which simulates community decision-making, and Unit 8 Activities. Table 5 shows Use of Activities.

TABLE V

USE OF ACTIVITIES AS OUTSIDE ASSIGNMENTS
WORKSHOPS 1 and 2 (November 1994, March 1995)

Name of Activity	Number of Uses

TABLE V

USE OF ACTIVITIES AS OUTSIDE ASSIGNMENTS
WORKSHOPS 1 and 2 (November 1994, March 1995)

Name of Activity	Number of Uses
1A - Ecosystem Webs	5
1B - Oklahoma Ecosystems and Biodiversity	2
2A - Go Bats!	9
2B - What's Your Niche?	2
3A - Water Moves	2
3B - Water/Wetland Investigations	2
4A - Exploring Soil	0
4B - Looking at Erosion	1
5A - Rainfall on the Prairie	1
5B - Make a Grass	3
6A - On Some Other Prairie	0
6B - Prairie Food Web	2
7A - Bison Tick-Tac-Toe	1
7B - How Many Whatzits Can Live Here?	1
8A - Fire!	0
8B - Prairie Hi-Lo	0
9A - Migration Station	1
9B - A View from the Air	1
10A - A Land-Use Case Study	0
10B - Personal Views and Action	1
Total Uses of all Activities	34

By far, the most popular activity was "Go Bats!" This activity was conducted with different ages within the target range of 4th through 8th grade. One first grade group especially enjoyed the activity. Comments showed that the activity successfully provoked environmental awareness even in six or seven-year-olds.

Only Unit 8, which considered the effects of fire and grazing on grasses, and

variations within a prairie environment, was not used in these assignments. This unit was designed as a Field Trip activity, and required an actual visit to an outdoors site by either class or teacher. The information covered in this topic unit is a major focus of the complete supplement, but was not selected for use when only small bits of the material could be used. Some comments from teachers and their students about the most popular activities follow. Please refer to the "Spirit of the Last Great Places," Appendix A, for a complete description of the activity and procedure.

1A and B: "Ecosystem Webs" and "Oklahoma Biodiversity". One teacher adapted these materials to involve students in a study of local ecosystems. A simulated field trip (played with the fact cards provided with the materials) served as an ecosystem visit. Some comments from one teacher were: "the students learned a lot of new vocabulary. The students thoroughly enjoyed the video, much discussion followed." Another said, "the students enjoyed this activity and voiced their delight in forming the web." Another teacher, working with several grade levels (1st, 2nd and 4th) said, "You have no idea how exciting it is to have these lessons about our ecosystem that are ready to use and easy to teach."

Activity 2A: "Go Bats!" was the most popular activity. Following an active simulation, students graph the "bat" population increases and decreases over time. Comments included: "the graphing activity is especially worthwhile." Another teacher who used this activity, said, "This is an excellent activity for 5th grade students." A student who tried it with four and five year-olds, said, "This activity went extremely well. All children gained knowledge of a habitat, a bat, and human effect. This activity was

extremely effective with this age group in increasing their awareness." A seventh grade teacher noted that peer pressure affects the success of the activity at this age level. "This seemed to be directly related to the overall maturity of the group. They saw it as a game to 'win' and never got the point that it was a simulation. Three of my five classes were able to play correctly and understood the premise of simulating events." Another student who selected this activity said, "I really like this activity because it is easy to track/record the effects of conditions, which the players are experiencing directly. They also get the emotional component...how they feel about not having what they need to live." A first grade teacher said, "I really enjoyed this activity. I was thrilled to see the lesson had a carry over effect to home."

Activity 2B: "What's Your Niche?" requires the students to keep a journal and discover their personal niche. Comments were: "the journal sheet was a great idea but would not work well with our group because we meet only once a week..." "The students came away from this lesson with a new respect for bats and their role in the big scheme of things."

Activity 3A: " Water Moves" is a simulation of the water cycle. One fourth grade teacher said: I felt this activity went well and is a great way for students to really learn the water cycle."

Activity 3B: "Water/Wetland Investigations," uses a lab station setup and group investigations. Comments: "This activity was very beneficial to all involved...all the kids seemed to enjoy the projects and they definitely grew from the experiments." Another teacher who selected the activity said, "I plan to include this lesson each year in my plans

because it is so well written and very informative. Thank you for including this wetland unit."

Although only used by one student, valuable suggestions were made on ways to simplify the activity in 4B, "Looking at Erosion." The activity focused on erosion by water; the student suggested some ways to also demonstrate erosion by wind. Although erosion was mentioned as a natural process, the student mentioned feeling that the materials conveyed that erosion is always bad.

Activity 5A: "Make a Grass" allows individual students to become individual grass parts. It illustrates how much of the grass plant is located below the surface. This underground growth allows the plant to continue to grow in spite of mild grazing or a fast-moving prairie fire. Comments: "this is a good activity, but requires at least one instructor per 12 students or close management of the class."

Activity 7A: "Bison Tic-Tac-Toe" has students playing a game after learning facts about bison. Comments from one teacher, who used the activity with a mixed group of first and fifth graders, were: "All students really learned much about the bison with this fun game. I was very surprised how excited the young children got when playing this game."

Activity 7B: "How Many Whatzits?" provides students with a "what if" situation and has them consider the effects this might have on their favorite "wild" animal. Comments from one teacher were: "Students seemed self-motivated with this activity...the overall impact was a success, although the concepts of carrying capacity and limiting factors were hard for third graders."

Some changes to the curriculum supplement have been made because of comments

from teachers. Most of these suggestions have been procedural. It is likely that when these activities have seen more classroom exposure, more changes will be suggested. As with any text, changes and improvements are an ongoing process.

Only when this curriculum supplement is used in its entirety will it be possible to assess how adequately the supplement teaches concepts or increases environmental awareness. The fact that each topic unit stands alone is both a help to teachers and yet a hindrance to the goal of providing a curriculum supplement that teachers will use as a whole (all ten-units taught sequentially in a nine-week period).

DISCUSSION

The purpose of this study was to address seven questions concerning the development of the "Spirit of the Last Great Places" environmental science curriculum materials. This involved analyzing the process of creating environmental education supplements for middle school grades; creating a middle school curriculum based on Nature Conservancy Preserves (Spirit of the Last Great Places); and evaluating and surveying the anecdotal data provided by teachers trained to use the materials in a workshop situation.

First, how does a curriculum writer decide what concepts are important when writing a supplement for a particular agency? If the agency has developed other materials, a review of those materials, focusing on the key concepts which they include, should offer some help on the agency's mission and important issues. Curriculum development then follows certain logical steps depending upon philosophy and mission of the sponsoring agency. A topical outline and basic philosophical guidelines should be developed. Sample lesson plans can then be developed from the topical outline, and "fleshed out" in a way that meets the desired goals of the requesting agency.

Second, what types of activities are most successful in teaching these concepts? An intense review of existing curriculum supplements should offer some suggestions on activities which teach these concepts. These successfully tested existing activities can be adapted with permission. However, the success of each activity can initially only be supposed. Field testing is the only way to determine the actual success of each activity.

Third, what key persons should have input into the process? The advice of experts

in the field, including teachers and others who have worked with environmental education activities is helpful when deciding the format and activity procedures. An advisory panel can provide invaluable assistance to the writer as he/she steps through the process of formatting and writing. They should be given an opportunity to approve the final curriculum.

Fourth, how are the varying viewpoints of sponsoring entities balanced so that the resulting product is acceptable to all? If there are several entities serving as sponsors, their input is essential as the curriculum is developed. Care must be taken not to make offending or offhand statements anywhere in the materials. A constant awareness of the general tone of the materials must be maintained.

Early on, the curriculum developer should construct a recommended timeline, and, if the project is being funded, a budget for the project. Sponsors and advisory panel should be aware of the timeline and approve any changes which are necessary as the project unfolds. One or two revisions of the timeline can be expected, due to the need to address panel and sponsor concerns. The review process also takes considerable turn-around time. The amount of time required may be more than originally planned.

Fifth, once the curriculum has been completed and printed, the task of offering that curriculum to teachers and school systems remains. To be used, teachers must attach a value to the curriculum, i.e., they should feel that they have an investment in the curriculum and will therefore use it. Simply handing or mailing out the curriculum does not foster implementation. This investment may be emotional, if teachers personally attach great value to the subject matter; or it may be financial, if they have had to "pay"

for the materials, either with time invested in "teacher education" or with money required for purchase. The latter two investments require that the materials be marketed so that the inherent value and usability of the materials are obvious to the teacher or user. An example of such curriculum marketing is a workshop format. This is provided at a cost to the participant, but also meets the need for continuing education or college credit.

Sixth, how should the product be evaluated? The evaluation of the materials through use of a pre-test, post-test instrument at the introductory teachers' workshop is ineffective because it evaluates the effectiveness of the presenters and not the materials. A short workshop does not allow time for complete review of all necessary concepts or completion of topic unit evaluations. Pre/post testing is best accomplished by evaluating the middle-school pupils' gain in concept understanding and change of attitude. Only when the materials are used in full, in a classroom, with background materials adequately covered and evaluation opportunities used, can such an instrument (pre-test, post-test) be an effective measurement for classroom materials. In this situation, it may also be possible to test for student attitude change.

Seventh, can specific environmental science curriculum supplements be created which link a local environment to environmental concepts, personalizing the learning experience? "Spirit of the Last Great Places" is this type of curriculum supplement. The workshop assignments appear to indicate that these materials do successfully personalize environmental concepts into the daily lives of students by connecting these concepts to Nature Conservancy Preserves in Oklahoma.

It is hoped that the development of the "Spirit of the Last Great Places"

curriculum, and this descriptive study will provide baseline data for future investigations. The author suggests that an experimental design be used to test the effectiveness of the curricula on middle school students' understanding of concepts and environmental attitudes. An experimental design might also be used to test the effectiveness of the teacher training model.

The development of these materials was a wonderful learning experience. The author learned a great deal of information about Oklahoma and this state's many and varied ecosystems. It is exciting to imagine that study of these materials will provide a similar learning experience for students in grades 4-6.

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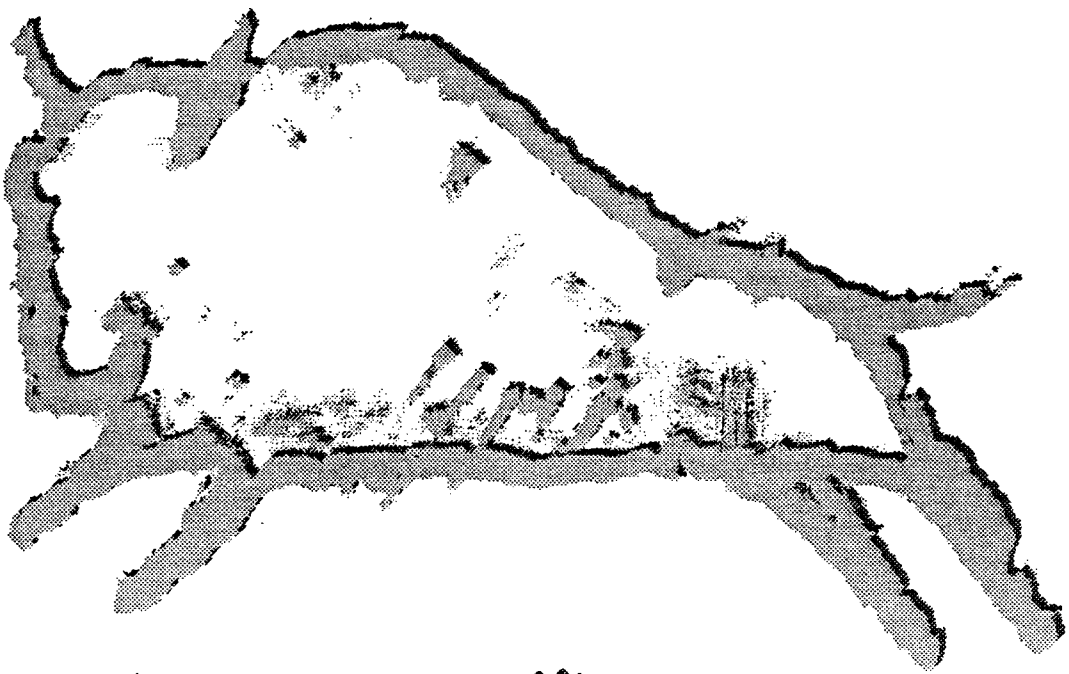
APPENDIX

The attached document, "Spirit of the Last Great Places" Teachers' Guide, appears in the form in which it is regularly printed. This document contains all worksheets necessary to complete the lessons, and also includes a Glossary and Reference section.

Spirit of the Last Great Places

A Teacher's Guide



The Nature Conservancy

"The Spirit of the Last Great Places"

An environmental studies curriculum supplement for Oklahoma students in grades 4 - 8.

A cooperative project of the
Oklahoma Chapter of The Nature Conservancy
and Oklahoma State University

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Introduction

There is a need for the preservation and restoration of unique biomes or "great places" on the planet Earth. We know this at an intuitive level as well as through application of our science or logical rationale. We also know that these "great places" represent more than just the sum of their parts. The wildlife, prairie grasses, water, flowers, trees, atmosphere, soil and bedrock interact to create their own "spirit" within and between all of these "great places".

The purpose of the "Spirit of the Last Great Places" instructional activities is to assist teachers of grades four through eight to teach the next generation about the ecology and beauty of natural systems within the state of Oklahoma. To achieve this end, lessons are related to the unique biomes represented by the Oklahoma Nature Conservancy preserves. The instructional cycle which has been utilized involves an initial experience with the concept, followed by vocabulary and then an extrapolation to personal experience, such as a Nature Conservancy preserve. The teacher may also wish to find a site of local interest which corresponds to the ecosystem emphasized in the Topic.

Organization of Topics

The major concepts covered in this instructional material are taken from the Nature Conservancy's award winning public television program, "The Spirit of the Last Great Places in Oklahoma."

The printed material is organized into ten general Topics. Each of the ten general Topics is supported by a video tape which includes footage taken from that TV program. This video may be used as an introduction to the materials included in each topic, or as a reinforcement of the presented concepts. Each individual Topic unit is divided into three parts, two activities and a Nature Conservancy Highlight.

The first section of each Topic includes the first activity and supporting background information. This activity introduces the major Topic concepts to the student. The second section of each Topic includes the second activity and supporting background information. This second activity allows the student to experience how that general concept applies to a specific Nature Conservancy location, and perhaps, to themselves. Most activities are designed for completion within one hour of classroom time.

The third section of each Topic, the Nature Conservancy Highlight, is a written description of the basic ecology of an appropriate Oklahoma Nature Conservancy Preserve. This information has been provided by the Nature Conservancy. Actual information sheets from each Preserve are included in the Appendix section. These information sheets may include a map (if appropriate) as well as instructions on receiving more information about the site.

The intent of the "Spirit" instructional materials is to offer teachers and their pupils the opportunity for real "hands on" experiences as well as a visual experience (video tape) and written text. Many of the activities are to be completed in cooperative learning groups. Many of them require use of the five senses, and creativity. Many require movement within or outside of the classroom.

The first topic, Ecosystems, was designed to assist the student in developing a holistic view of the planet. Topics 2-9 allow them to focus on specific ideas and concepts. Topic 10 was designed to encourage contemplation of the holistic view again, and develop some understanding of the many differing viewpoints and priorities which affect environmental decision-making or environmental action.

Each of the two lesson activities of each Topic contains:
(1) the objectives of the activity;
(2) a list of the main ideas to be taught (vocabulary);
(3) teacher notes regarding teaching the activity;
(4) background information for teacher and student;
(5) materials list, preparations for the activity and activity setting;
(6) activity procedure;
(7) evaluation; and,
(8) enrichment suggestions.

For each activity, the instructional material may be modified to suit the specific needs of children as determined by their teacher. Some of the activities in these materials were adapted from Project WILD, Project Learning Tree or additional sources (see Reference section). Other activities are original, and copyrighted within this publication.

Following the Nature Conservancy Highlight in each Topic, teachers will find an additional listing of Suggested Variation/Expansion Activities found in other curriculum supplements. These supplements include Project WILD, Aquatic Project WILD and Project Learning Tree. Additional resources which may be helpful to the teacher are also included. Additional pages of each Topic Section include original materials which the teacher will be utilizing for the topic activities: Information Cards, Worksheets, etc.

The final sections of this supplement include: a Glossary section listing all vocabulary words introduced in all ten topics; a Reference section noting all source material used in preparing background information and activities for each topic; and an Appendix of Nature Conservancy materials and information used in more than one of the supplement's activities.

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Acknowledgments

Several sources were drawn on time and again for information as well as inspiration during the writing of this supplement. Some activities included in "The Spirit of the Last Great Places" materials were drawn from those sources or adapted to fit specific topics. Those sources are acknowledged in the reference section.

Without the assistance of my advisory panel, completion of this curriculum supplement would not have been possible. The following persons spent many hours assisting in conceptualizing, formatting, and editing the supplement. Gracious thanks to:

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Sara Wilson, The Nature Conservancy, Oklahoma Chapter, Tulsa
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Mark Moseley, Soil Conservation Service, Stillwater
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Topic One

This Great State Where We Live: Ecosystems

Topic Overview: Students study ecosystems and their components. In Activity 1A, teachers introduce sensory awareness techniques, students write Cinquain (5-line) poetry and then develop an ecosystem web with the subjects of their poems. In Activity 1B, students compile information and then compare the components of four types of Oklahoma ecosystems.

Activity 1A: Ecosystem Webs

Objectives: Students will be able to:
(1) define an ecosystem and its components;
(2) state the relationships between several objects in an ecosystem; and,
(3) orally state how interfering with a relationship between objects in an ecosystem affects all objects in the ecosystem.

Main Ideas: Ecosystem, biotic, abiotic, energy, kinetic energy, chemical (food) energy, radiant energy, guano.

Teacher Note: This activity sets the stage for the curriculum's focus on biodiversity in Oklahoma. The learners have the opportunity to use their powers of observation, be creative and have some fun while they are learning about the connectedness of life on Earth.

Background Information:

An ecosystem can be as big as Earth or as small as an abandoned mussel shell. It is any place where there are living elements (biotic), nonliving elements (abiotic) and some source of energy. These ecosystem components interact in various ways.

Living things grow, eat, live, reproduce and die in certain ways because of the energy available to them, and because of nonliving elements (temperature, altitude, rocks, water). Similarly, the amount of energy available in the ecosystem increases or decreases depending on the living elements. Finally, the nonliving elements increase and decrease because of both living elements and energy. These components become an ECOSYSTEM full of connections, or interrelationships. If any of these interrelationships are altered, the system is altered, and all components of the ecosystem (living, nonliving and energy) may be affected.

The living elements in any ecosystem include bacteria, protists, molds, fungi, plants and animals. The nonliving elements include matter such as rocks, minerals, gasses and liquids.

The primary source of energy of any ecosystem is the sun. Through the process of photosynthesis, plants create

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food from the sun's energy. This plant food is the base of all food chains. In some ecosystems, tracing energy back to the sun follows a circuitous route. In subterranean systems, certain inhabitants (such as bats) may leave their home environs to find food outside, but return and deposit food waste (guano) which provides food energy for other subterranean inhabitants.

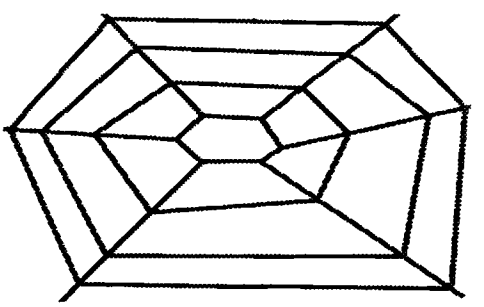
There are many relationships between objects in an ecosystem. Sometimes, one living object provides food or shelter for another. Nonliving components may break down to form other nonliving components, or may serve as shelter or water for living inhabitants. The sun serves both as the primary source of energy to create food, and as a weathering agent.

Energy is the driving force in all ecosystems. This energy takes on different forms. Kinetic energy is the energy created by motion. Chemical or food energy is the energy living organisms take in and utilize in life processes. Radiant energy is energy traveling in a wave motion (electromagnetic waves). Other energy types include electrical energy and sound energy.

Materials and Setting:

a. Materials:
- "Word" Cinquain poetry forms (Topic One materials)
- 5x8 index cards
- markers
- ball of yarn or string
- scissors.

b. Setting: School ground, local park or field trip site.



Procedure:

a. Introduce the students to the techniques of sensory awareness and also the procedure for writing "Word" Cinquain. The technique of sensory awareness includes isolating students and masking one of their senses, thus heightening their awareness of the other senses. Sensory awareness allows the students to become sensitive to their immediate environment. Students locate a spot on the school ground or in a nearby park where human influence is minimal. Students close their eyes and sit quietly for a few minutes, using the time to listen to the sounds around them, smell the outdoor scents, feel the sensations of the wind and sun. After a few minutes, they open their eyes and select a nearby animal, plant or mineral (not a man-made object) to be the subject of their "Word" Cinquain. (See Cinquain poetry form) Cinquain is a type of poetry written on five lines. The word itself is derived from the French and Spanish words for five. True Cinquain poetry is based on word syllables, but this exercise uses entire words rather than their syllables. Line 1 will be the name of the subject. Line 2 will be two words which describe Line 1. Line 3 is three words which tell what Line 1 is doing. Line 4 is four words which tell how the student feels about Line 1. Line 5 is a word that means the same thing as Line 1.

b. Distribute the Cinquain forms and then take the students outside. Direct students to find a place within an area designated by the teacher. Follow the procedures for Cinquain writing.

c. Return to the classroom.

"Word" Cinquain

The "Word " Cinquain is a 5-line poem!

The rules are simple:

Line 1: One word which names the object of the poem.
Line 2: Two words which describe that object.
Line 3: Three words that describe what the object is doing.
Line 4: Four words that tell how you feel about the object.
Line 5: Another name for that object.

Line 1 _____.

Line 2 _____, _____.

Line 3 _____, _____, _____.

Line 4 _____, _____, _____, _____.

Line 5 _____.

Activity 1B: Oklahoma Ecosystems and Biodiversity

Objectives:
Given a picture of a Nature Conservancy ecosystem, the student will be able to:
(1) match the picture with the name of an ecosystem;
(2) list four living and nonliving elements of that ecosystem;
(3) list three influences of nonliving elements in the ecosystem on the living elements; and,
(4) discuss biodiversity of ecosystems in Oklahoma.

Main Ideas: Ecosystems (representative ecosystems are: wetlands, subterranean, tallgrass prairie grassland, forest/woodland), biodiversity, guano

Teacher Note: In addition to the stated objectives, it is hoped that the students will reach the goal of understanding that: (1) there is a great diversity of ecosystems in Oklahoma; (2) that diversity of ecosystems and their inhabitants is necessary, and (3) how the nonliving elements of the ecosystem (water, temperature, light, and energy) affect the living elements.

This group activity involves classroom sharing and discussion using Information Cards which describe four of Oklahoma's many ecosystem types.

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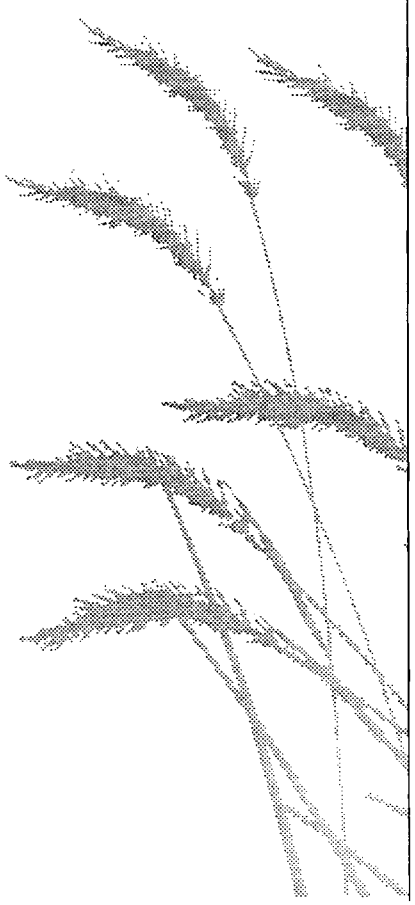


Background Information:

Many different ecosystems can be found in Oklahoma, making it one of the most unique states in the nation, and a state known for great biodiversity. Biodiversity is a term meaning biological variety. This term can be applied to the number of ecosystems present, or to the number of different living species found within a specific ecosystem.

Oklahoma has great biodiversity of both ecosystems and species because of the state's geographic location. Traveling from northwest to southeast across the state, the elevation and rainfall change considerably. The elevation decreases from 4,973 feet above sea level in the northwest to 287 feet above sea level in the southeast. That's a change of 4,686 feet, or 4/5 of a mile! The rainfall in Oklahoma changes from 16" per year in the northwest to 54" per year in the southeast. Some of Oklahoma's ecosystems are unique, inhabited by plants and animals that are seldom found elsewhere.

Depending on the source questioned, Oklahoma has eight to ten ecosystems represented across the state. Representative systems which will be studied in this activity include: subterranean, tallgrass prairie grasslands, deciduous forest/woodlands and wetlands.

Many different ecosystems can be found in Oklahoma, making it one of the most unique states in the nation, and a state known for great biodiversity.

Materials, Preparation and Setting:

a. Materials:
   Four (4) Ecosystem Information Card Sets (Topic One materials).
   Nature Conservancy ecosystem pictures (included with manual).
   Discussion Question Sheets (to be prepared as preferred by teacher, see Preparation).

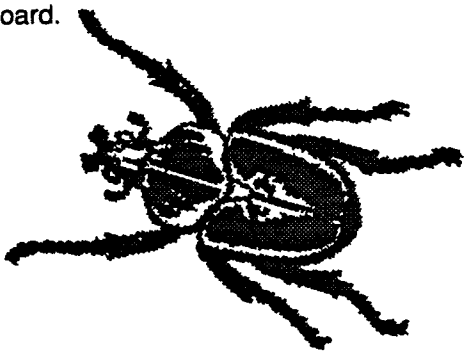
b. Preparation: Students may create their own discussion question sheets from questions given in Procedure b. This information may either be written by the teacher on a transparency or on the chalk board, or the teacher may prefer to type this list and make copies to distribute.

c. Setting: The classroom.

Procedure:

a. Divide the class into four groups and distribute one set of Ecosystem Information Cards and one picture of a Nature Conservancy site to each student group. Within their groups, have each student take one card and study the information. If possible, be sure that each group is given a different ecosystem.

b. Distribute the Discussion Question sheets as prepared by the teacher, or have the students copy the following questions from transparency or blackboard.



   List the names of living things found in this place.
   List the names of nonliving things found in this place.
   Discuss the temperature in summer.
   Discuss the temperature in winter.
   Discuss the rainfall in summer.
   Discuss the rainfall in winter.
   Discuss the wind. Does the wind blow in this place?
   How might the wind affect the living things here?
   How might the wind affect the nonliving things?
   What do you think the soil might be like?
   Which of the following kinds of energy do you think might be found here: radiant, kinetic, chemical (food)?
   What is the primary energy source found here?

c. Within groups, have the students compile the information found on their Information Cards to complete the Discussion Question Sheets.

d. Have a representative from each group share their ecosystem with the class, giving their responses to the various questions. Allow the other groups to add responses if they desire.

e. Once all groups have shared their ecosystems, discuss the following questions with the class:
   The most living things were found in which ecosystem?
   Among the ecosystems, which had the highest temperature? Lowest? Most constant?
   In what ways might the temperature affect the number of living things found there?
   In what ways might temperature affect the nonliving material?
   How do rainfall amounts differ among the ecosystems?
   How might rainfall affect the kind of living things found there?
   How might the wind affect the living things in these ecosystems?
   Which ecosystem do you believe has the greatest amount of wind? Why?
   How might rainfall affect the nonliving material?
   What source of energy was the same in all systems?
   How might the amount of this energy affect the living elements of the ecosystem?

Do we need to have a variety of ecosystems on earth? Why?
Where do you want to live? Why?

f. Share Nature Conservancy Preserve information from Section C with the students and discuss the ecosystems.

Evaluation:

Distribute one picture of a Nature Conservancy Preserve site to each student. Ask the student to:

(1) identify the basic ecosystem pictured;
(2) list four living and four nonliving elements, and the types of energy present;
(3) list three influences of nonliving elements in the ecosystem on the living elements, and;
(4) write a short paragraph discussing the variety of ecosystems in Oklahoma and what might cause such biodiversity in the state.

Enrichment:

a. Energy Study: Ask the students to diagram, starting with the sun, the pathways of how energy flows in one of the Nature Conservancy Preserve ecosystems. This diagram may be as simple or as complex as the student desires.

b. Provide students with temperature and/or rainfall maps of Oklahoma to use with Procedure (f) to show how the temperature and rainfall change, and how this affects Oklahoma ecosystems. These maps are located in the Appendix Section.

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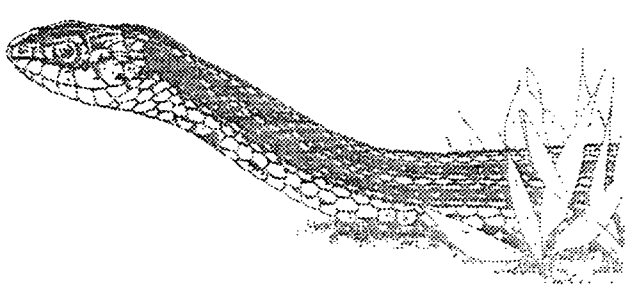


Nature Conservancy Highlight:

The Nature Conservancy owns numerous preserves in Oklahoma. These projects criss-cross the state from the Black Mesa Preserve in the northwest corner to Boehler Seeps and Sandhills Preserve in the southeast, representing the biological diversity of Oklahoma and the Conservancy's dedication to the preservation of these diverse ecosystems. For additional information on each of the following, see the Appendix.

Black Mesa, Cimarron Co., OK. - four ecosystems -**shortgrass prairie, juniper/pinon woodlands, mixed grass prairie, riparian**; 31 rare species, at either the easternmost or westernmost portions of their range. Managed by Oklahoma Department of Tourism and Recreation.

E.C. Springer Prairie Preserve, Garfield Co., OK - Big Bluestem and Switchgrass, **tallgrass prairie** remnant.

Canadian River Least Tern Preserve, Cleveland Co., OK. - **Streambed Ecosystem.** Endangered Least Tern nesting sites occupied from May through August, on 16 miles of the Canadian River.

Tallgrass Prairie Preserve, Osage Co., OK - **Tallgrass prairie.**

Redbud Valley Nature Preserve, Tulsa Co., OK - **Crosstimber woodlands and mixed grass prairie,** adjacent to Bird Creek. Operated by Oxley Nature Center.

Arkansas River Least Tern Preserve, Tulsa Co., OK - **Streambed Ecosystem.** 1,400 acres along 9 miles of river where endangered Least Terns nest on islands in the Arkansas River, early May through late August.

White Oak Prairie Preserve, Craig Co., OK - **Tallgrass prairie** remnant.

Twin Cave Preserve, Delaware Co., OK. - **Subterranean** - Limestone cave, underground stream with rare bats and endangered aquatic species.

Boehler Seeps and Sandhills Preserve, Atoka Co., OK - **Oak/hickory/pine forest, wetlands.** Upland sandhill woodland, hillside seep, two globally rare ecosystems and 26 rare plant species.

Suggested Variations/Expansion Activities

Project Learning Tree: Field, Forest and Stream; School Yard Safari; Are Vacant Lots Vacant?
Project WILD: Microtrek Treasure Hunt; Animal Poetry; Web of Life; Learning To Look, Looking to See.

Additional Resources

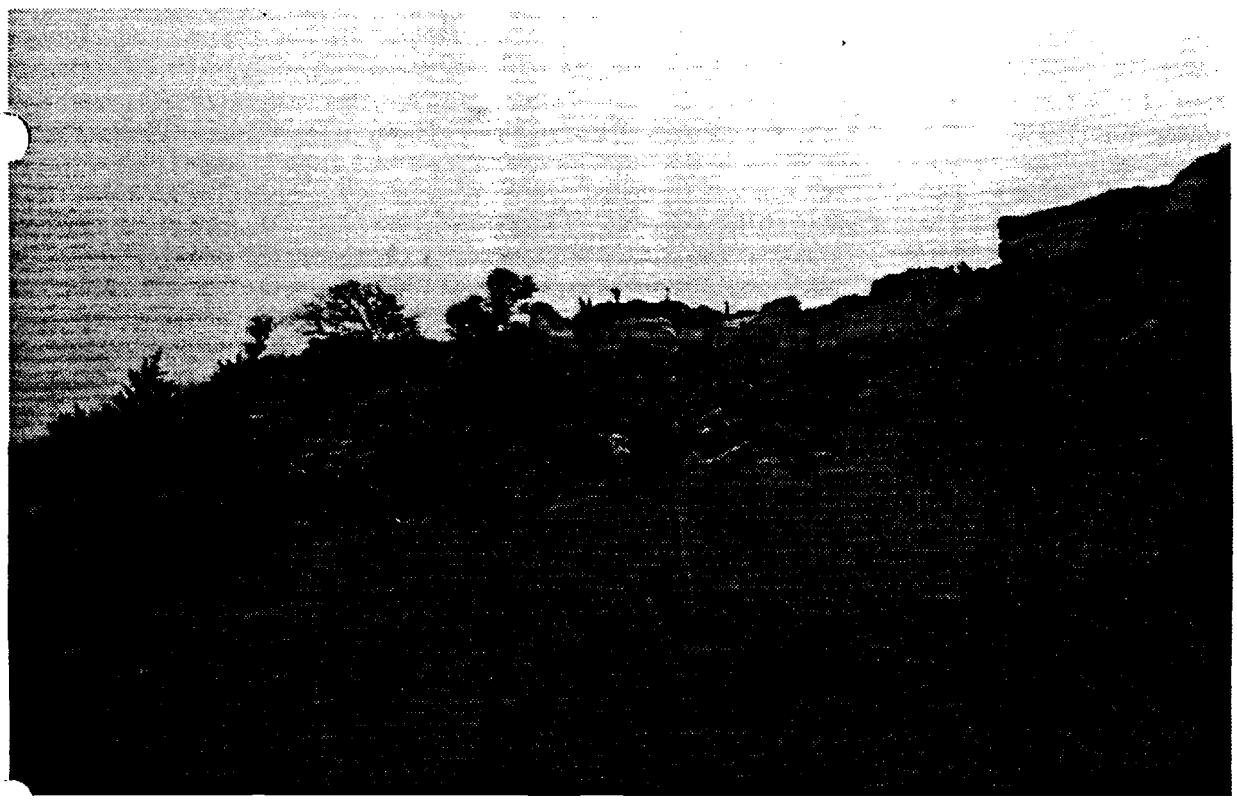
Rainfall and Temperature Maps of Oklahoma

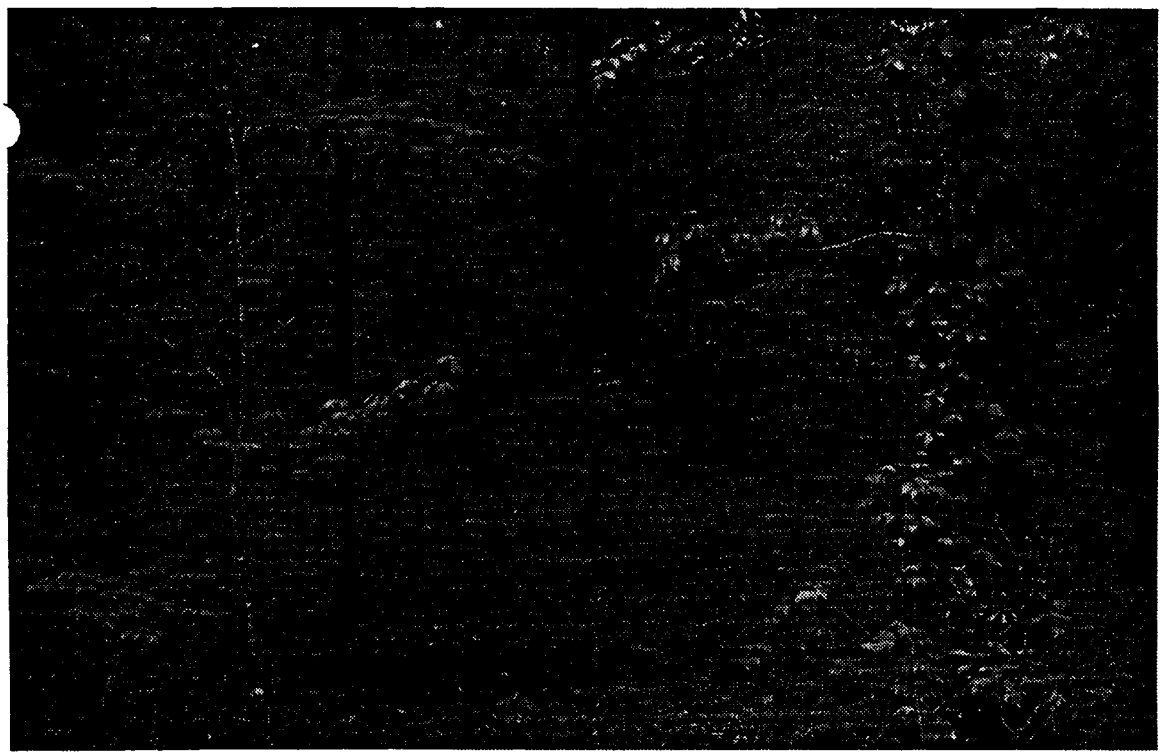
1. **Subterranean** (Twin Cave Preserve) Limestone Cave, largest room is 450 feet long and 100 feet wide - the King Room. The cave includes an underground stream and "lake".	2. **Subterranean** (Twin Cave Preserve) The Twin Cave environment is dangerous. It has hazards such as falling rocks, slippery/unsure footing, and narrow passageways.
3. **Subterranean** (Twin Cave Preserve) Temperature: fairly constant at 60 degrees (about 10 degrees colder than your home).	4. **Subterranean** (Twin Cave Preserve) The air is very moist, as if it is going to rain anytime. (Relative humidity of 95%)
5. **Subterranean** (Twin Cave Preserve) Cave has three Zones: twilight - varying light and temperature; middle - varying temperature, complete dark; deep interior - constant temp, complete dark.	6. **Subterranean** (Twin Cave Preserve) Bat guano provides an important source of outside nutrients (energy) to replenish the cavefish's food (chemical energy) supply. Guano is found on the cave floor.
7. **Subterranean** (Twin Cave Preserve) Cave formations found there are covered with a layer of quartz or mica crystals.	8. **Subterranean** (Twin Cave Preserve) The Gray Bat feeds on night-flying insects which they find by echolocation. They live in caves all year, but migrate to Missouri caves to spend the winter. The Gray Bat has been on the Federally Endangered List since 1976.
9. **Subterranean** (Twin Cave Preserve) The Ozark Cavefish is a small, two inch long pinkish-white blind fish with a flattened head. It only exists in a cave environment in clear, cold undisturbed pools within the total darkness region. Its presence indicates healthy water quality. This fish has been on the Federal list of Threatened Species since 1984.	10. **Subterranean** (Twin Cave Preserve) The Cave Crayfish is blind, and looks white or translucent. It has small first legs and very long antennae used for feeling around in the dark. It is found in clear, cold undisturbed pools within the total darkness region. This crayfish is threatened by destruction of habitat and disturbance from careless cave explorers.

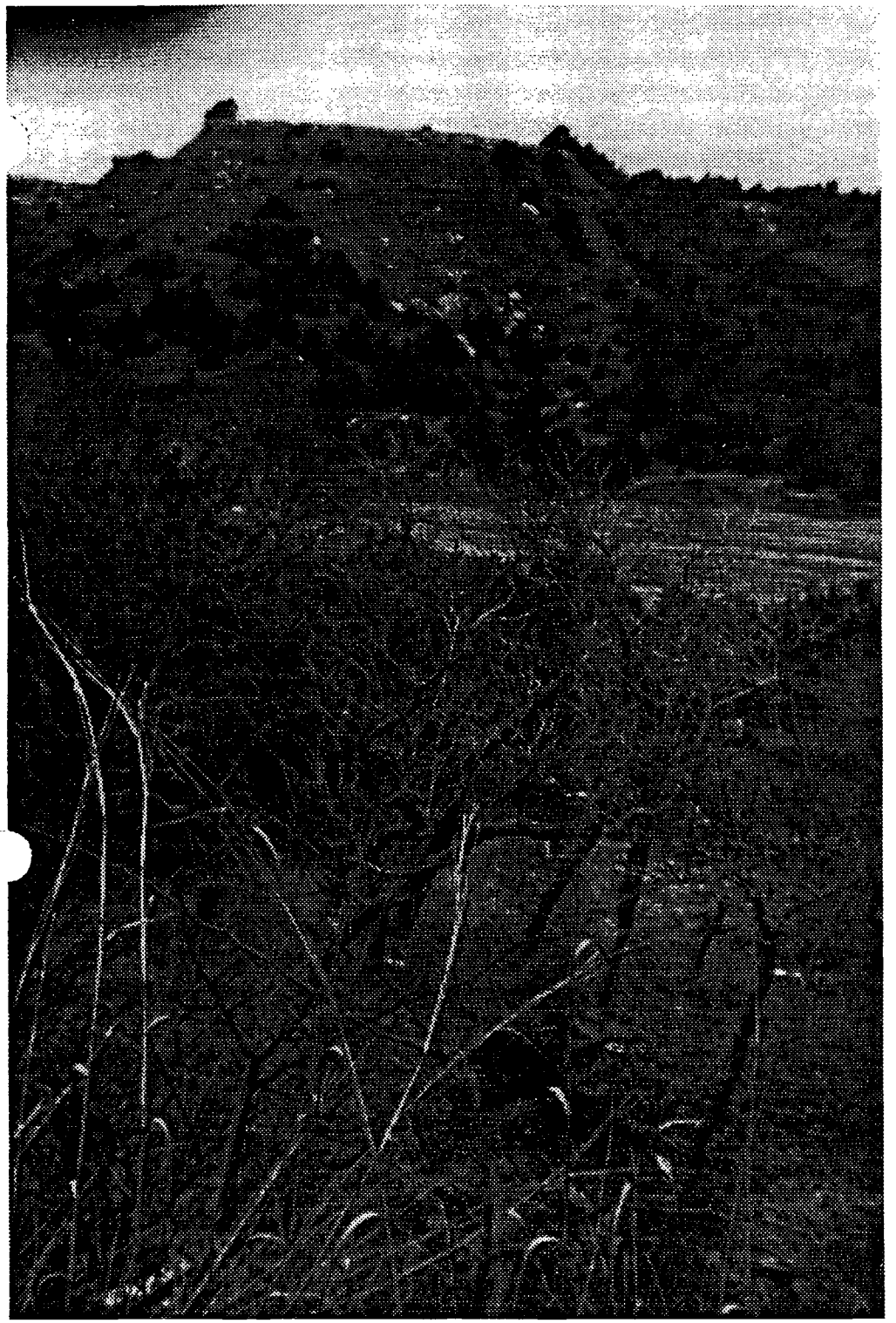
1. **Grassland** (Tallgrass Prairie Preserve) Grasslands are characterized by the dominance of grasses over other types of vegetation. Trees and shrubs may be present in areas where there is more water, and along stream banks.	2. **Grassland** (Tallgrass Prairie Preserve) The soil is deep and rich on the tallgrass prairie, making this ecosystem prime land for agricultural purposes. The native grasses have been plowed under so crops can be grown. Most tallgrass prairie ecosystems around the world have been destroyed.
3. **Grassland** (Tallgrass Prairie Preserve) Temperatures on the prairie vary greatly from winter to summer. On Oklahoma's Tallgrass Prairie, the average temp. in January is 30-32 degrees F. The average temp. in July is 80 to 82 degrees F.	4. **Grassland** (Tallgrass Prairie Preserve) Moisture is the key to the type of grass which grows on the prairie. Tallgrasses require the most moisture of the grasslands. Areas with tallgrass prairie receive from 25 to 39 inches of rain per year.
5. **Grassland** (Tallgrass Prairie Preserve) Grasses which are predominant on the Tallgrass Prairie include: Big Bluestem - (up to 8' tall) Switchgrass - (up to 6' tall) Indian grass - (up to 8' tall) Little Bluestem - (up to 5' tall)	6. **Grassland** (Tallgrass Prairie Preserve) Prairie grasses are fire resistant because of their deep root systems. In fact, prairie fires are necessary to maintain grasslands. Fire reduces the litter of dead grass stems and leaves, turning it into nutrient ash which becomes a part of the prairie soil.
7. **Grassland** (Tallgrass Prairie Preserve) Prairie grasses typically have many deep fibrous roots which allow the plant to obtain water and nutrients when rainfall is slight. These roots also anchor the grasses, preventing the plant from being blown over by the wind, or pulled up when grazed by animals.	8. **Grassland** (Tallgrass Prairie Preserve) Grazing is also important to maintaining a grassland. Removal of the top part of the plant allows the lower leaves to receive more sun, increasing food production (photosynthesis) by the plant. The grazing animals also help redistribute nutrients on the prairie through manure deposits.
9. **Grassland** (Tallgrass Prairie Preserve) Many burrowing animals live on the prairie. These include: Plains Pocket Gophers, badgers, Franklin's ground squirrels and voles.	10. **Grassland** (Tallgrass Prairie Preserve) The grasslands provide food for animals which graze, also known as herbivores. These animals include bison, cattle, horses, sheep, and deer.

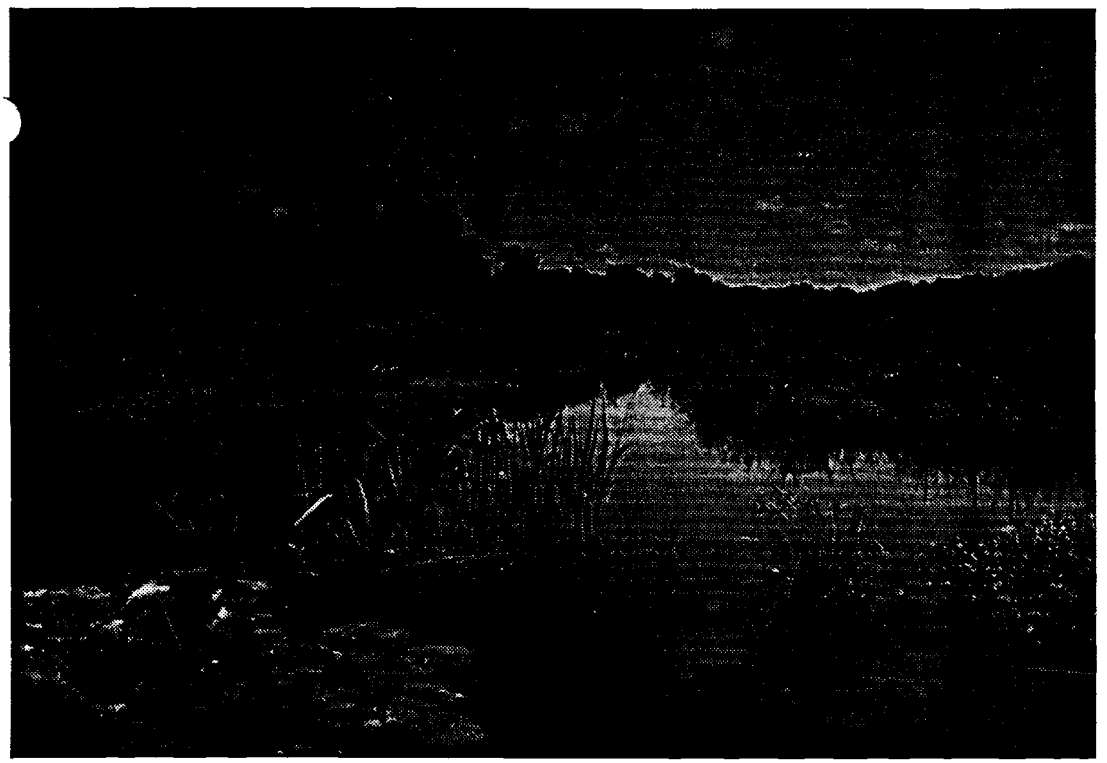
1. **Wetlands** (Boehler Seeps and Sandhills) The term wetlands describes many ecosystems, including freshwater and saltwater marshes, swamps, bogs, and lagoons. There is an abundance of water , making wetlands a preferred place for many plants and animals to live.	2. **Wetlands** (Boehler Seeps and Sandhills) Marshes and other wetland areas often provide breeding or resting habitats for birds that migrate each winter and spring. Some bird species breed in the same wetland each year, traveling several hundred miles to reach that same spot .
3. **Wetlands** (Boehler Seeps and Sandhills) Wetlands serve as a filter for the earth's water supply. Silt settles out in wetlands, and harmful substances like sewage are broken down and made harmless. Wetland vegetation absorbs nutrients which might otherwise wash away, and returns them to a food web cycle.	4. **Wetlands** (Boehler Seeps and Sandhills) Boehler Seeps is located in southwestern Oklahoma. The average annual rainfall is between 42 and 44 inches of rain per year. Temperatures range from an average of 38 degrees F in January to an average of 82 degrees F in July.
5. **Wetlands** (Boehler Seeps and Sandhills) Boehler Seeps includes two freshwater marshes, providing habitat for several state rare plants. An amazing variety of plants are found here, including poisonous mushrooms.	6. **Wetlands** (Boehler Seeps and Sandhills) The Seeps at Boehler form where the water table intersects the surface along the sides of small drainage areas in sandy soils. Luxurious mosses and liverworts are abundant in this area.
7. **Wetlands** (Boehler Seeps and Sandhills) The Dwarf Pipewort grows here. This rare plant, which is 2 to 4 inches tall, has thin, pale green leaves that appear to grow directly out of the ground. It grows in moist to wet, sandy soils of upland seeps and bogs.	8. **Wetlands** (Boehler Seeps and Sandhills) Water draws a variety of creatures who prefer this habitat. Some of the more dangerous ones who make their homes here include the pygmy rattlesnake, cottonmouths and copperheads.
9. **Wetlands** (Boehler Seeps and Sandhills) Another group of animals common to wetlands are amphibians. These include the Green Treefrog, and various other frogs and salamanders. Turtles are common, as are clams and crayfish, water insects and water snakes.	10. **Wetlands** (Boehler Seeps and Sandhills) Mammals have an important part in wetlands, too. A beaver, by making a dam, can assure that a wetland stays a wetland. Otters, and muskrats are two more species that frequent wetland areas.

1. **Forest** (Cucumber Creek) This Oklahoma forest is part of a temperate deciduous forest (trees that lose their leaves in winter). It rains throughout the year, with the average annual rainfall being about 54 inches of rain per year.	2. **Forest** (Cucumber Creek) Temperatures at Cucumber Creek vary from an average winter temperature of 38 degrees F. in January to an average summer temperature of 80 degrees F. in July.
3. **Forest** (Cucumber Creek) Forests actually have three regions. The canopy is the upper part of the trees, their limbs and leaves. The understory is smaller trees, and then shrubs below them. Finally, the herbs, low-growing, non-woody species such as ferns and ground-growing mosses.	4. **Forest** (Cucumber Creek) The large trees found at Cucumber Creek include Blackgum, Sycamore, Shagbark hickory, and the Cucumber Tree (a tree found in only a few Oklahoma sites). A mixture of oaks, hickories, beeches and maples is found here as well. Short-leaf pine is one evergreen found in this area.
5. **Forest** (Cucumber Creek) Sixteen rare plants have been found in the Cucumber Creek area, including four which were originally found and grow only in the Ouachita Forest where Cucumber Creek is located.	6. **Forest** (Cucumber Creek) The creekbed itself in this preserve is home to a rare salamander. The creekbed consists of well-drained loamy soil with cobblestone underlayers. The surrounding slopes have deep, well-drained, stony soil.
7. **Forest** (Cucumber Creek) The soil in most temperate forests is rich in minerals and organic matter, but not as thick as that of grasslands. In this region of Oklahoma, the soil is formed over bedrock of shale and sandstone.	8. **Forest** (Cucumber Creek) The tree canopy acts as a light filter. The canopy itself absorbs 40 percent of the light reaching it. The understory absorbs another 50 percent, leaving only 5 percent for the shrubs and 5 percent for the mosses below.









Topic Two

That Special Great Place: Habitat and Niche

Topic Overview: Students study habitat and ecological niches. In Activity A, students play a game called "Go Bats!" and learn about the essential components of habitat. In Activity B, they learn about ecological niches of bats and humans and keep a 24-hour activity journal.

Activity 2A: Go Bats!!

Objectives:
Students will be able to:
(1) define habitat;
(2) list several factors which might have a negative or positive effect on the habitat;
(3) draw a graph representing a typical population over a period of time; and,
(4) state in writing how human activity influences the habitat of the Gray Bat.

Main Ideas: Habitat, limiting factor, carrying capacity, adapt, echolocation.

Teacher Note: This activity requires lots of room because there is lots of movement! In "Go Bats!" the learners will simulate a bat as it searches for food, water and shelter.

Background Information:

A habitat is the place where an animal or organism lives. It includes the components of shelter, water, food and space of that place. These components must be arranged in a way that the animal is able to successfully survive there. Successful survival means that the creature's needs are met so that it can live and reproduce. Many different animals may live in the same individual habitat. In fact, humans share their "habitats" with many other creatures.

Habitats can be destroyed and altered in ways that may force some species to adapt, move or die. Any habitat component can become a limiting factor. The numbers of surviving members of any species depends on the quantity of an individual habitat component. The number of members that can survive successfully is the carrying capacity of that habitat. In a given situation, this might be either the amount of food, water, shelter, or space available for each member of the population.

People can adapt to habitats in ways animals cannot. People transport necessary food and water, or build another apartment complex for housing. They can continue to live in areas even as the habitat around them is deteriorating. Eventually, however, the quality of life is lessened, and finally, even humans will lose the ability to survive in that habitat.

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The Gray Bat is an example of a species with specific habitat needs. A resident of Twin Cave Preserve, this bat has been listed as a Federally Endangered Species since 1976. An insect eater, the Gray Bat finds its food by echolocation. Sounds of varied length, frequency and intensity are produced in its larynx. The bat's highly sensitive ears then detect the location of objects from the sound waves which bounce back to them, just like sonar and radar equipment.

Materials and Setting:

a. Materials:

Nature Conservancy materials about Twin Cave Preserve (see appendix and/or Subterranean Cards from **Topic One** as well as **C: Nature Conservancy Highlight)**
graphing materials

b. Setting: A large area, gym or playground, where "bats" are able to "fly."

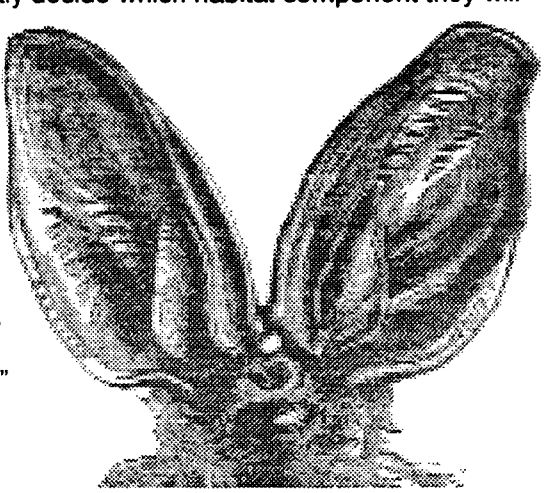
Procedure:

a. Identify for the students the necessary components of habitat (water, food, space and shelter) and review the Twin Cave materials from the Nature Conservancy.

b. Explain that students will play a simulation game, "Go Bats!", in which some of them will represent bats and others will represent the habitat components needed by the bats. Explain to the students that simulation is a popular method of learning, utilized as an instruction method for pilots, astronauts, truck drivers, etc. In this simulation, students will experience how the lives of bats (or any other species) may be influenced by changes in the availability of habitat components.

c. Have the students count off in fours. The ones will gather together at one side of the room or area. They will represent the gray bat. As the game is played, the bat will need to find the necessary components of its habitat to survive. It will be looking for food (insects); water; and shelter (cave). When looking for food, the bat will indicate that by mumbling "food, food"; when looking for water, it will mumble "drink, drink"; when looking for shelter, it will indicate that by mumbling, "safe place." The twos, threes and fours will be necessary components of the bat's habitat: food (insects); water; and shelter (cave). Habitat components will individually decide which habitat component they are as the game is played. The bats should line up opposite the habitat components.

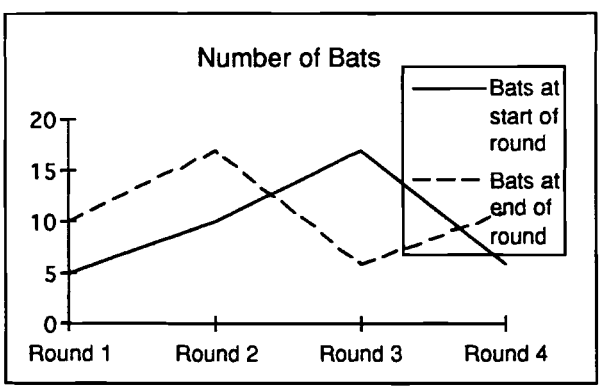
d. The first round begins when the teacher asks students to begin making their sounds. Prior to this announcement, the "bats" should independently decide which habitat component they will be looking for, and the "components" decide individually what they are. (Note: Neither bats nor components should change what they need or are after each round has begun. To do so would alter the accuracy of the results the class will obtain.) Those components that are shelter will say, "cool cave"; those that are water will say, "gurgle, gurgle" and those that are insects (food) will say, "buzz, buzz." Usually there will be a variety of each component. On the count of five, the "bats" and the components" should begin to make their sounds. The "bats" should begin to "fly" toward the components, listening carefully for the



sound which the component it needs is making. When it hears the sound, it should reach out for that component, and return with it to the bat's original line. When the bat has returned to the original line with its component, it is able to survive. Those bats unable to find what they need "die" and become a "habitat component (food, water shelter)" for the next round. Those components who accompany bats back to the original line become bats in the next round.

Bat Mumble	**Habitat Component Sound**
seeking food = "food, food"	(insect) = "buzz, buzz"
seeking water = "drink, drink"	(water) = "gurgle, gurgle"
seeking shelter = "safe place"	(cave) = "cool cave"

e. The game continues in this fashion for several rounds, with the teacher keeping track of how many bats there are at the start of each round, and at the end of each round. (Suggestion: For the final round, the teacher, unknown to the bat population, should restrict the habitat factor of shelter to demonstrate how lack of shelter is detrimental to the bat population.)
f. Discuss the population changes with the students.
g. Graph the results from the game play. (see graph below)



h. Discuss possible changes which may occur in the habitat:
   1. Humans disturb the cave repeatedly in a short time period.
   2. Pesticide use destroys many of the insects the bat feeds upon.
   3. The water flowing through the cave becomes polluted.
   4. A nearby bat cave is now unsuitable for bat habitation because of human interference. Those other bats begin to move into the "Go Bats!" habitat.

i. "Go Bats!" again, with the teacher limiting the amount of water or food or shelter available, as if the just discussed scenarios had occurred. Note the results and graph them so that the students can see the effect each change in habitat component has on the bat population.

Evaluation:

Ask the students to:

(1) define a habitat and name habitat components;
(2) list several factors which might have a negative or positive effect on the habitat;
(3) draw a graph line which represents a typical population over a period of time (noting how population numbers rise and fall each year rather than maintaining a constant value); and,
(4) state in writing how human activity influences the habitat of the Gray Bat.

Enrichment:

a. Ask the students to pick an animal other than the bat and write a brief essay about how changes in habitat might affect that animal. Have them share this with the class.
b. Ask the students to investigate an endangered species to discover what habitat alteration led to their endangered condition. Use a Federally Endangered Species Listing for suggestions. These lists may be obtained by contacting: Director, Office of Endangered Species, U.S. Fish and Wildlife Service, U.S. Department of Interior, Washington, D.C. 20204.

Notes:

Activity 2B: What's Your Niche?

Objectives:
The student will be able to:

(1) compare and contrast the components of the ecological niche filled by bats with the ecological niche filled by themselves; and

(2) identify habitat preservation as essential to the continued existence of all living things.

Main Ideas: Ecological niche, preservation, migration, nocturnal, diurnal

Teacher Note: This activity requires a homework assignment - a 24-hour journal in which the students make note of everything they do and how they interact with others (their niche!)

Background Information:

An ecological niche can be described as the activities which a particular species performs through the passage of a day/week/month/year/lifetime. It concerns both the timing of these activities and their relationship to other members of both that species and other animals. These activities include: eating; drinking; excreting; moving about; sleeping; seeking shelter, or companionship, or sunlight; avoiding shelter, or companionship, or sunlight; etc. Every living creature has an ecological niche.

Sometimes ecological niches are altered because of habitat changes. The more adaptable a living thing is, the more likely that it can continue to survive and successfully accomplish its environmental niche. Man is the most adaptable animal, and is able to accomplish his ecological niche in many different environments. Most animals have more specific ecological niches and are negatively affected by environmental disturbances.

In these situations, habitat preservation may be one way to insure that this species continues to survive. Preservation is the practice of managing an ecosystem in such a way that the species which live there have the necessary amounts and types of the habitat components that they require to successfully survive and reproduce.

The Gray Bat, an inhabitant of Twin Cave Preserve, has been listed as a Federally Endangered Species since 1976. It has a specific ecological niche. The bat is a nocturnal animal, meaning that it is most active at night. Man is a diurnal animal, naturally active during the day.

One part of the bat's niche (breeding requirements) requires that the bat migrate every winter. Migration means that the species must travel somewhere, usually annually, to another locale where it breeds, or spends the cold winter months.

Topic Nine deals further with the concept of migration, and how migration makes the species susceptible to environmental hazards and habitat destruction at both ends of their journey, as well as in-between destinations.

Notes:

Materials and Setting:

a. Materials:

Gray Bat Information Cards (Topic Two materials). Teacher will need one set of cards for each group.

Activity/Journal Sheets for Gray Bat/Human (Topic Two materials). Teacher will need two sheets per child.

b. Setting: Classroom.

Procedure:

DAY ONE

a. Divide the students into groups. Appoint a scribe or secretary, and a reporter for each group.
b. Distribute Gray Bat Information Cards, one set to each group.
c. Distribute Activity/Journal sheets, one per group. Ask each group to fill out an activity sheet for the Gray Bat, using the Gray Bat Information Cards. Each student should read their card, and share the information on that card when it could be helpful in filling out the activity/journal sheet.
d. After all the groups have individually completed the assignment, using the blackboard or overhead projector, fill out a master activity/journal sheet, as each group reporter supplies the information needed to complete the sheet.
e. Discuss "ecological niche" as the activities and relationships which an animal carries out in a specific period of time.
f. Distribute another journal sheet, one per student. Ask the students to keep a 24-hour journal, to be returned to class the next day at the same time. On that sheet, they will keep track of their activities, similar to those they discussed for the bat.

DAY TWO

a. When they return to class the next day, display the "ecological niche" information about the Gray Bat which you collected the previous day and ask the students to add it to the bat column on their own activity sheet.
b. Discuss with the students what their "ecological niche" is. Ask the students to share their journal activities with the class, and list these on the blackboard or use an overhead projector.
c. Review with the students how habitats and ecological niches can be affected by human activity (as discussed in "Go Bats!").
d. Discuss preservation, and how this practice can help maintain a habitat so that it is possible for an animal to successfully maintain its "ecological niche."

Evaluation:

(1) As each student reviews the activity sheet which he/she completed, ask the student to write a paragraph comparing the niche of the bat with his/her own niche;
(2) Ask the student to write (as previously discussed) in essay form, the importance of the practice of preservation in maintaining habitats.

Enrichment:

a. Have the students select an animal whose ecological niche they would like to fill. Have them investigate that niche and share it orally or visually with the class.
b. Have the students select an ecosystem we have not investigated (e.g. desert, aquatic, mountain, tropical rainforest, etc.) and investigate what specific animals and/or plants have their "ecological niche" in that ecosystem.

Notes:

Nature Conservancy Highlight:

Twin Cave Preserve is located in Delaware County. This preserve is a limestone cave, unimproved and **dangerous**. Access to the cave is restricted.

The underground lake room is home to the Ozark Cavefish and the bristly Cave Crayfish (threatened species). A third important resident of the cave is the Gray Bat, which has been on the Federal Endangered Species list since 1976.

The cave habitat is 60 degrees with a relative humidity of 95 percent. The cave has three zones: twilight (near entrance), a middle zone of complete darkness and variable temperature, and a zone of complete darkness and constant temperature in the deep interior.

The Ozark Cavefish and the Gray Bat have an important relationship; the guano of the bats provides an important source of outside nutrients to replenish the cavefish's food supply. The bats find their food (insects) outside of the cave on nightly flights. The Gray Bat lives in caves year round, and migrates from Oklahoma to Missouri in the winter. The Ozark Cavefish (which is blind) was listed as a threatened species by the federal government in 1984. It is found only in permanently dark pools of clear water cave streams. The habitat of the Cave Crayfish (which is also blind) is also limited to clear, cold undisturbed pools within the total darkness region of the cave. It is threatened by destruction of habitat and disturbance by explorers.

Because access is restricted, contact The Oklahoma Chapter of the Nature Conservancy in Tulsa at 1-918-585-1117 to find out about scheduling a field trip.

Suggested Variations/Expansion Activities

Project Learning Tree:	Habitat Pen Pals
Project WILD:	Habitrekking, Oh Deer!, Which Niche? Who Fits Here? Habitat Lap Sit, Habitracks, Habitat Rummy, What's That, Habitat? Classroom Carrying Capacity, Carrying Capacity; How Many Bears Can Live in This Forest?
Aquatic Project WILD:	Blue Ribbon Niche, Riparian Retreat, Designing a Habitat

Additional Resources

Federal Endangered Species List (request from):

Director, Office of Endangered Species
U.S. Fish and Wildlife Service
U.S. Department of Interior
Washington, D.C. 20204

Daily Activity/Journal Sheet

(Contrast and Compare **where, when, how often**)

Activity	**Bat**	**Human**
1. Ingestion (eating)		
2. Digestion		
3. Excretion		
4. Play		
5. Work		
6. Travel		
7. Energy Used		
8. Sought shade		
9. Sought sun		
10. Sought temperature change		
11. Sought company of		
.....peers		
.....family		
12. Moved away from		
.....peers		
.....family		

1. **Gray Bat Information** The Gray Bat eats insects, and may eat from one-fourth to one-half of its body weight each day in insects caught over bodies of water. Mayflies make up the major part of the Gray Bat's diet.	2. **Gray Bat Information** The Gray Bat finds its food by echolocation, a kind of radar using sounds produced in the bat's larynx. These sounds vary in how long they are, how strong they are and how often they are made.
3. **Gray Bat Information** Gray Bats, like most other bats, spend the day in their cave, in a state similar to sleeping. Their body temperature drops so that energy and water are conserved. Gray Bats prefer limestone caves which are located in four northeastern OK counties.	4. **Gray Bat Information** The Gray Bat flies and feeds during the night, from twilight to just before dawn. They range at least 12 miles from their cave colony to feed over bodies of water.
5. **Gray Bat Information** The gray bat migrates to Missouri in September, where it mates. The bats then winter there, often in the same hibernation cave every year. A hibernation cave can contain as many as one million individual bats. The bat returns to its Oklahoma cave in the spring.	6. **Gray Bat Information** The gray bat has few natural predators (other creatures who eat the bat for food). Usually bats are caught by chance, rather than on purpose. Some of those living things which eat bats are: owls, opossums, skunks, hawks, snakes, cats, and other bats.
7. **Gray Bat Information** On average, gray bats, like other bats, live to be seven or eight years old. About half of those born each year die before they are a year old. The oldest known bats are about thirty years old.	8. **Gray Bat Information** Bats are often killed because of changes in their environment, such as severe cold spells, or changes in the temperature and air movement in their cave. Human disturbance is especially harmful to the bats. Other threats include pesticides and loss of habitat.
9. **Gray Bat Information** Bats are the largest and most widely distributed group of mammals, and have 950 living types or species. They are the only mammal which can fly. Their wings are actually webbed fingers!	10. **Gray Bat Information** Gray bats, like other bats, have a body covering of hair, produce milk for their young, have three ear bones, loose baby teeth and grow adult teeth, can maintain a constant body temperature, and give live birth to their young.

Topic Three

A Great Liquid: Water

Topic Overview: Students study the water cycle, water properties, and important aquatic environments. In Activity 3A, students study the water cycle in a simulated field trip. In Activity 3B, students study aquatic environments and wetlands in relation to the Boehler Seeps Preserve.

Activity 3A: Water Moves

Objectives:
The student will be able to:
(1) diagram a water cycle;
(2) explain what happens during evaporation, condensation and precipitation; and
(3) name four types of precipitation.

Main Ideas: Water (hydrologic) cycle, evaporation, condensation, clouds, precipitation, aquifers.

Teacher Note: During this quiet classroom activity, the learners will have the opportunity to consider different forms of water and the lengthy travels of one water molecule.

Background Information:

Water is the most precious resource on earth. Every living thing is dependent on it for survival. Water cycles through our daily lives. Its uses are varied and many: washing ourselves and our dishes, drinking, watering the plants and the lawn, washing clothes, cooking foods, cooling the house, and so on.

The water that we use daily moves through what is known as the hydrologic cycle. As a molecule of water moves through the cycle, it will first be heated by the sun's energy. Through the process of evaporation, the molecule rises into the air in the form of steam. These water molecules will cool as they rise higher, and condense to form water droplets. These droplets congregate as clouds. Eventually the droplets fall to earth as precipitation in the form of rain, hail, snow, and sleet, or condense on the ground as dew. Once back on earth, the water may soak through the earth into aquifers (underground layers of porous or water permeable stone) where the water is temporarily stored. It may also run into streams and rivers, winding its way into lakes and eventually the ocean. Meanwhile, it may be used in a variety of ways by people - industrial, agricultural, municipal and private uses.

All plants and animals require water. Some of it passes through their systems and back out again into the soil or the air,

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where it rejoins the cycle.

Seventy percent of the earth's surface is covered by water, but 97 percent of that water is salt water. Of the 3 percent that is freshwater, most of it is locked up in glaciers, the polar ice caps, the atmosphere and the soil. Still more of it is so severely polluted that it is untreatable - and unusable.

Water makes up 80 to 90 percent of the weight of most plants. Woody plants like trees are 50 percent water.The human body is 65 to 75 percent water. Humans can go without water for only four to seven days before dying. We can go without adequate space, shelter, or even food much longer.

There is roughly about the same amount of water on the earth now as there always has been. Water is a molecule formed by two hydrogen atoms and one oxygen atom. These molecules are constantly being broken apart and created by natural processes.

The total quantity of water on the earth is limited, but human usage of water has increased dramatically. During the last fifty years, usage per person has increased by 350 percent. Since 1950, water use around the world has tripled. Indeed, water may be human's limiting factor on earth.

Materials and Setting:

a. Materials:

Water Cycle Simulated Field Trip (Topic Three materials)
Paper and pencil
Soft, soothing background music (taped)

b. Setting: Classroom.

Procedure:

a. Ask the students to clear their desks of all objects and settle comfortably in their seats. (The teacher may prefer to ask the students to close their eyes.)
b. Slowly read the simulated field trip to the students.
c. Ask the students to take out a pencil or pen and a piece of paper, and draw the water cycle which they just experienced through the reading.
d. Discuss the following questions:

1. As the water molecules warmed and broke away to rise up in the air, they were changing from one state to another. The water in the air is still water, but in a different form. What is the term for the process that the water molecule went through? (evaporation)
2. As the water molecules in the air cooled and slowed, they went through another change of state. What is the term for that transformation? (condensation)
3. As the water returned to earth in the form of rain, sleet, hail or snow, it went through the condensation process, but is given a new name. What is the general term for water falling from the atmosphere to the earth? (precipitation)

Evaluation:

Ask the student to:

(1) diagram a simplified water cycle;
(2) explain in writing what happens during evaporation and condensation, and;
(3) name and illustrate the four types of precipitation.

Enrichment:

a. Expand the water cycle simulated field trip, including the concepts of plant transpiration, animal respiration, and water percolation through the soil into aquifers.

b. Keep a Water Journal. Make an entry every day, noting if there was evidence of precipitation or condensation overnight, or during the day. At the end of a seven-day period, make a bar graph of the results, comparing how many times it rained (or snowed, hailed or sleeted) and how many times condensation was visible (dew or frost).

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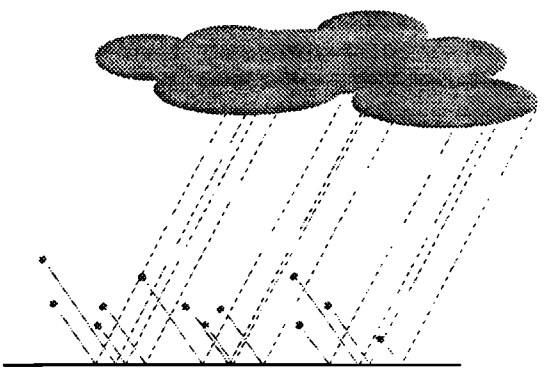

Water Cycle Simulated Field Trip

Take a deep, easy breath...now another...and prepare to leave this room in your mind's eye. Imagine you are sitting among the trees and grass by a lake or pond that you know. Take a moment to notice the bank of the lake or pond. What does its soil look like? What does it feel like? Does it crumble in your fingers? Take a look at the plants growing around you. Smell the leaves or needles of the trees. Look at the colors of the grasses.

Imagine that the wind is blowing. Listen to the wind in the trees. Feel the wind in your hair, on your face. Watch the plants in the breeze. The wind is blowing across the water, too. Dangle your feet in the water. Is it warm or cool? Can you see your feet under the water? The wind blows harder and the waves come up higher on your ankles. Listen to the waves as they gently slosh against the shore.

It is afternoon and the sun is bright. Turn so that you can see the water but so the sun is not directly in your eyes. There, it's not so hard on your eyes like that, is it? The sun is warming the water and tiny particles of water move faster and faster as they absorb the heat energy from the sun. The particles are so small that you could not see them, even with a microscope.

In your mind's eye, allow an image to present itself that represents those tiny particles, something you can imagine moving fast and freely, vibrating both in the pond or lake and in the air

above it. Trust the first image that comes to your mind for those very small vibrating bits of water. Now imagine those bits of water, the water molecules, moving very fast in the warming surface of the lake or pond. They vibrate faster and faster as they absorb the sun's heat energy, moving apart from each other. They continue to move apart as they vibrate faster, and some break away from the water surface and move up into the air. They move farther and farther apart, liquid water evaporating to form water vapor...going up, up, rising on the warm air. Now they are higher than the tallest tree...now above the highest hill. Watch them moving up to the height of the highest mountain you know.

Imagine following them. Watch them rise and travel on the wind until they are so high that the air is cooler. As they cool, the bits move more slowly. They move closer together. Watch them cluster together as a cloud forms, sailing in the sky. Imagine that you are traveling, following them for miles and miles, watching that cloud....

The bits of water (the water molecules) come closer and closer to each other, cooling....losing their heat energy...slowing down...and now they stay together to form drops so heavy that gravity pulls them to earth. They fall through the cool air. They have condensed to form liquid water.

Pick a place where your drops of water fall, on your head, on grass, or on a highway, on a tree, or the roof of your house. Listen to them falling. Smell the air now that it's raining.

Where are the drops going now? They roll along to a lower place, down the drainpipe or the gutter of a street. Perhaps they roll between tiny stones in the ground. Some will move through the soil to join other bits of water underground. Watch your water molecules moving through the ground, or follow them washing down a hill. They are joined by more and more bits in tiny streams which move faster and faster toward the creek. Now they flow around a rock and are carried into the stream, moving easily under bridges, past trees and houses.

Imagine someone standing on the bridge watching your water bits go by on their way to a new lake or pond. Here they come, out into the broad water of the lake, moving slower and slower, joining the water of the lake. If you'd prefer, your water molecules can flow into a bigger and bigger river, on a long journey to the ocean.

As you sit by the ocean, or this new lake or pond, notice that the rain has stopped. Feel the sun shining on your back. Look around again before we return to this classroom...and before you return, notice how you feel in this place by a lake or pond or ocean. Now come back to this room...and open your eyes.

Activity 3B: Water/Wetland Investigations

Objectives:
Students will be able to:
(1) describe physical characteristics of water by comparing pure water with soapy water and oil; and,
(2) list nine functions of a wetland.

Main Ideas: Wetland and aquatic.

Teacher Note: Using classroom stations, groups of learners move at their own pace, discovering: (1) the physical characteristics of water; (2) the many purposes served by wetlands; (3) wetland inhabitants; and (4) how nature's filtering system works. Teachers may want to be familiar with the many types of aquatic locations (lakes, ponds, aquifers) and how they differ. Sharing this information with students may help in comparing the importance and difference of wetlands to other aquatic habitats.

Background Information:

Oceans, lakes and rivers are aquatic habitats where animals and plant life are totally dependent upon the water. Wetlands are habitats which are also water dependent. They serve as a transition area between land and water. Common types of wetlands include marshes, seeps, lagoons, bogs, and swamps. The soil in these areas is saturated with water. This soil supports varieties of plant and animal life that cannot exist in drier places.

Wetlands can be located along the coast or inland. A wide variety of wildlife makes it's home in wetlands because of the abundance of vegetative growth and thus food for wildlife species.

Many bird species inhabit wetlands year round. Other residents are seasonal, migratory birds, which use the wetlands as breeding or nesting grounds in specific seasons.

Some species of fish use wetland areas near larger bodies of water for breeding. Other fish species spend their entire life in the wetland. Additional creatures which are abundant in wetlands include reptiles, amphibians, insects and crustaceans, like crayfish.

In fact, so many creatures besides fish use the wetlands to breed that wetlands are often called "wildlife nurseries".

Another very important function of a wetland is filtering water as it flows into a body of water. Many toxic substances which the water has picked up during its many uses are decomposed here. Sewage is neutralized, and silt is filtered out, so that the water is returned to its usual clarity. Both the plants and soil of the wetlands play a vital role in the earth's built-in filtering and purifying system.

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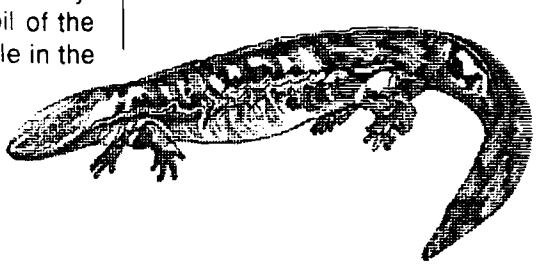
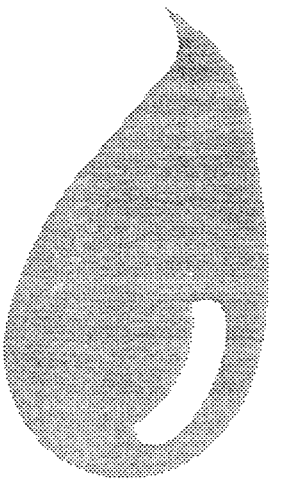


Materials, Preparation and Setting:

a. Materials:

Worksheets for stations 1-3 (enough for each group to have one sheet per station)
Worksheet for Water Filtering Activity
Station 1 materials:
- wax paper
- water
- soapy water
- cooking oil
- three glass beakers
- three eye droppers



Station 2:
- large kitchen sponge
- kitchen strainer or sieve
- coffee maker filters
- antacid tablets
- bar of soap
- box of cereal
- doll cradle
- small pillow
- hand mixer

Station 3:
- picture books or encyclopedias with information about wetlands and the animals which live there. (Wetland Species/Boehler Seeps list provided, Topic 3 materials)

Teacher Station:
- clean sand
- clean gravel
- clean pebbles or small rocks
- absorbent cotton
- clean 2-liter pop bottle (preferably clear) or other plastic bottle with bottom removed
- clear water pitcher or cup
- water
- soil, including leaf litter and organic matter from surface

b. Preparation and Setting: Set the classroom up in three stations, with materials in each area as described above. Students will be working in three groups, with the groups rotating through the stations. Worksheets should be completed at each work station. A fourth station should be prepared for the teacher.

Station 1: cut enough wax paper squares (about 5" x 5") that each class member can have three. Place water in one beaker, labeled A, with one eye dropper. Place oil in second beaker, labeled B, with one eye dropper. Place soapy water in third beaker, labeled C, with one eye dropper.

Station 2: arrange the materials in two rows and label them from 1-9.

Station 3: arrange books on table and provide chairs enough for each member of the group.

Teacher Station: place the materials in the upside-down pop bottle as follows: cotton in the neck, then about two inches of pebbles, then two inches of gravel, then two inches of sand, or similar proportions. Leave room at the top to pour muddy water into the filter. Mix two to three spoonfuls of the soil (including organic matter) into the pitcher of water. Teacher will perform this activity for the class after they have completed the three stations independently.

Procedure:

a. Divide the class into three groups. Tell the students that they will be moving from station 1 through Station 3 in this activity, with about ten minutes at each station.
b. Distribute worksheets for the three stations. Have all group members place their names on the group worksheet.
c. Have the students pass through the three stations, completing a group worksheet for each station.
d. After all students have completed the three stations, allow a few minutes for the group to complete their worksheets if extra time is needed.
e. Distribute the Water Filtering Worksheet, one per student.
f. Perform the filtering demonstration for the class. Pour the dirty water into the bottle after placing the bottle neck-first into a beaker or glass where the students can observe the filtered water. Have each student complete the worksheet as you discuss with them what happened.
g. Discuss the worksheets and the information the students have gathered.

Evaluation:

Ask the students to:

(1) Write a paragraph or make a chart/poster, comparing the characteristics of water, oil and soapy water.

(2) Write a paragraph or make a chart/poster, describing the nine functions of a wetland by using a metaphor: (1) absorb water (sponge); (2) filter out impurities (coffee filter); (3) settle or strain out silt and debris (strainer or sieve); (4) add needed nutrients and oxygen to the water (mixer); (5) neutralize toxic substances (antacid); (6) provide nutritious wildlife food (cereal); (7) serve as nursery for the newborn of many species (doll cradle); (8) serve as resting place for migratory birds (pillow) and, (9) clean the environment (soap).

Alternate Evaluation: Grade the students as a group, using the completed worksheet of each group to make your assessment. Check for the above listed information.

Enrichment:

a. Obtain permission and visit a local wetland area. Have the students observe and list the creatures which they see there. Have them take photographs of these creatures. Then ask them to make a poster or give an oral report about what they observed.
b. Ask the students to interview a water quality expert in your area, and ask him/her questions about wetlands and their importance. Have them tape or make a video of the interview and share the most important points with the class.

Notes:

Nature Conservancy Highlight:

Boehler Seeps and Sandhills Preserve is located in Atoka County. Two distinct community types are represented in the Preserve: Bluejack Oak Woodland community and the Acid Hillside Seep community. Two freshwater marshes provide habitat for several state rare plants, as well as many amphibians. A beaver dam helps maintain some of the preserve's wetland characteristics.

Seeps have formed where the water table intersects the surface, usually along the sides of small drainages in sandy soils. Critically imperiled Dwarf Pipewort occurs in the preserve in moist to wet, sandy soils of upland seeps and bogs.

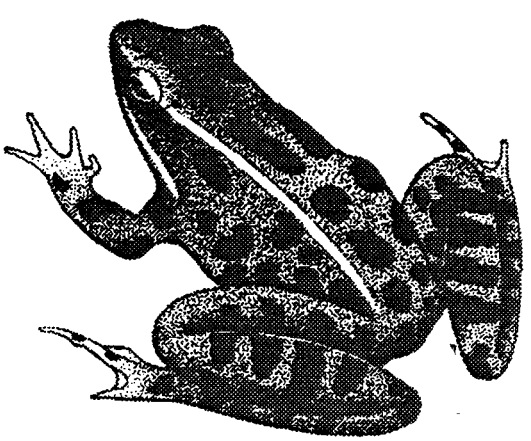
Suggested Variations/Expansion Activities

Project Learning Tree:	Water Wonders; Every Drop Counts; Watch on Wetlands
Project WILD:	Water's Going On?
Aquatic Project WILD:	Aqua Words; Water Wings; How Wet Is Our Planet?; Wetland Metaphors

Additional Resources

from the Atlas of Oklahoma (or similar sources)

- Oklahoma Rivers and Lakes
- Oklahoma Groundwater
- Oklahoma Water Usage Maps



WORKSHEET - Station 1
Characteristics of Water

Three beakers of liquid are at this station, labeled A, B and C. Follow the steps below.

Step 1: Each group member should take one piece of wax paper.
Step 2: Place one drop of liquid from beaker A on that wax paper.
Step 3: Observe the drop on the paper and fill in the chart section for substance A.
Step 4: Each group member should take another piece of wax paper.
Step 5: Place one drop of liquid from beaker B on that wax paper.
Step 6: Observe the drop on the paper and fill in the chart section for substance B.
Step 7: Each group member should take another piece of wax paper.
Step 8: Place one drop of liquid from beaker C on that wax paper.
Step 9: Observe the drop on the paper and fill in the chart section for substance C.
Step 10. Answer the questions at the bottom of the page, below the chart.

	Substance A	**Substance B**	**Substance C**
What is the shape of the drop? (top view and side view)			
How does the liquid smell?			
What color is the liquid?			
Name three other things you observe about the drop.			
How does the drop move across the wax paper?			

1. Which of the three substances would win the race if you tilt the paper so that the drops "race" across the wax paper surface?

2. What do you think the three substances were, and why?

Substance A:_____ Why?_____

_____

Substance B:_____ Why?_____

_____

Substance C:_____ Why?_____

WORKSHEET - Station 2
Wetland Metaphors

Study the objects on the table top. Beside the number which has been given to each object, complete the chart. In the first column, name the object. In the second column, list how that object is used. In the third column, write how the wetland has that same purpose.

Name	Used for	Wetland Function
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

WORKSHEET - Station 3
Wetland Animal Species

Using the information provided at this station, for each category of wildlife, find one to three species which would live at least part of the year in a wetland area.

Birds
1. _____
2. _____
3. _____

Fish
1. _____
2. _____
3. _____

Reptiles
1. _____
2. _____
3. _____

Amphibians
1. _____
2. _____
3. _____

Crustaceans
1. _____
2. _____
3. _____

Insects
1. _____
2. _____
3. _____

Mammals
1. _____
2. _____
3. _____

WETLAND SPECIES
Oklahoma - Boehler Seeps

The following species may be found at Boehler Seeps in southeastern Oklahoma. They are typical wetland species found in Oklahoma.

BIRDS

Surface feeding ducks
- Mallards
- Pintails
- Wood Ducks
- American Widgeon

Shore birds -
- Great Blue Heron
- Green Heron
- Killdeer

FISH
- Chubs
- Shiners
- Darters
- Bass
- Catfish

REPTILES

Snakes -
- Western Cottonmouths
- Western Pygmy rattlesnake

Turtles -
- Snapping Turtle
- Pond slider
- Painted Turtle

AMPHIBIANS

Frogs -
- Green Tree Frog
- Spring Peeper
- Bullfrog
- Leopard Frog

Toads
- Spadefoot Toad

Salamanders
- Mud Salamander
- Spotted Salamander

CRUSTACEANS
- Crayfish
- Scuds
- Water Fleas

INSECTS
- Mosquitos
- Chiggers
- Wasps - Yellowjackets
- Dragonflies, damsel flies, mayflies, water striders

MAMMALS
- Beaver
- Racoons
- White-tailed deer

WATER FILTERING WORKSHEET

Questions:

1. Describe the appearance of the water before it is poured through the filter.

2. Describe the appearance of the water after it has been poured through the filter.

3. What do you think happened to the dirt in the water?

4. How do you think wetlands serve as a filtering system for water?

Topic Four

A Great Substance: Soil

Topic Overview: Students study the composition of soil, the creation of soil, and erosion. In Activity 3A, students study the composition of soil and the types of soil particles. In Activity 3B, students study erosion and how erosion shapes the topography of the earth.

Activity 4A: Exploring Soil

Objectives:
Students will be able to:

(1) describe the process of weathering;
(2) list the four components of soil;
(3) list the three scientific classifications of soil; and,
(4) compare the size of the soil particles and explain how water reacts when it meets each soil type.

Main Ideas: Weathering, clay, silt, sand, organic matter, chemical weathering, mechanical weathering, soil horizons, litter, O horizon, A horizon, B horizon, C horizon, parent rock (bedrock), loam, silt-loam.

Teacher Note: This soil exploration asks the learners to explore soil layering and soil composition in a lab-type activity. When collecting soil "cores" in preparation for the activity, the teacher might wish to collect soil samples that are not primarily clay.

Background Information:

All soil originally comes from rock. This rock is broken down through processes of weathering. Physical weathering is caused by temperature changes that cause the rock to break apart or by mechanical actions from water, wind and ice. Chemical weathering is caused by acids which attack the rock and break it down. These acids are formed in two ways: (1) the process of oxidation of iron in the rock, and (2) the combination of various gases in the atmosphere with water vapor. Soil is formed very slowly.

Soil is made up of layers, called horizons, which are sometimes visible in the banks of streams, roadbeds or eroded areas. The top layer of the soil is usually made up of litter, dead leaves and other plant material which has not yet decayed, and animal material, such as feces. This is called the O horizon, and decomposition is occurring there. The next layer, or A horizon, is the topsoil. This layer is composed of organic matter from plants and animals living in the same area as the soil. This matter also includes the billions of small organisms which live in the soil. Farther down into the

Notes:

Notes:

soil, the organic matter is even more altered in form. The next major layer is the subsoil, or B horizon, and is primarily made up of minerals and materials which have disintegrated through the top soil. The next layer, or C horizon, contains even more minerals as well as larger pieces of disintegrated rock from the parent rock (bedrock) which underlies the area. It is a transition zone.

Soils are classified as clay, silt or sand, depending upon the type of parent material. All soils contain a mixture of these particles in different proportions. Clay particles are the smallest, less than 0.002 millimeters in diameter. (1.0 millimeter is about the thickness of a dime.) Silt particles range from 0.002 to 0.05 millimeters in diameter. Sand ranges from 0.05 to 2.0 millimeters in diameter. Any particles larger than 2.0 millimeters are classified as gravel or stones.

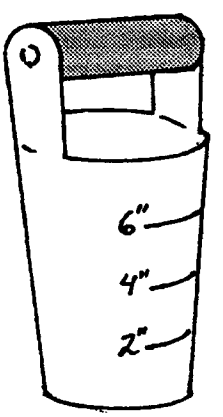
Depending on the percentage of clay, silt and sand, soils will vary in their ability to hold water and nutrients. Clay soils absorb water very slowly and release it very slowly. These soils are sticky to the touch. Sandy soils take in water quickly, and release it quickly. Water runs down and out of sandy soil, with little moisture held for use by plants in the area.

The best soils are called loam or silt loam. These soils have a proportion of sand, silt and clay which allows water to be absorbed or retained, yet easily releases water to the root systems of plants.

Materials, Preparation and Setting:

a. Materials:

- bulb planters (to take topsoil samples- see diagram)
- topsoil samples
- soil testing kits (pH test) or litmus paper
- wide-mouth jars
  (at least 5 inches tall) with lids (enough for each group to have two jars)
- water
- Soils Worksheets (one per student)
- trays for soil observation
- white plastic spoons



b. Preparation: Prior to doing these activities, collect some dry soil samples from several different areas by using the bulb planter. Insert the planter as deep into the soil as possible, removing a "core". (Very sandy soil will not stick together in a core.) Be sure to include any surface litter with the soil sample. Carefully place this sample in a jar and label it according to where it was taken. Take as many samples as are needed so that after your class is divided into groups of no more than six, each group can have a sample.

c. Setting: Classroom with open surface areas for soil experimentation.

Procedure:

a. Divide the class into groups, preferably of no more than six students. Provide each group with one jar containing a soil sample, a tray, and a spoon, and a second empty jar with a lid.
b. Distribute Soil Worksheets to class members.
c. Ask each group to complete Part A of the worksheet as they study their soil sample.
d. Ask each group to scrape the very top portion of the sample into the tray. Have them inspect the organic matter and see if they can identify leaves, twigs and animal matter. Ask them to complete Part B of the worksheet.
e. Have the students set aside about three spoonfuls of soil to use for soil pH testing (Part C on worksheet) before they proceed with (f).
f. Have the students place the soil "core" in their empty jar , then fill the jar with water so that the jar is almost full. Tell them to screw the lid on tightly and then shake the jar vigorously so that the soil is dissolved into the water. The students should then leave the jar on the table and allow the soil to settle into layers.
g. Have the students follow the procedure for testing the soil sample pH. (Younger children may need to have instructions read to them step-by-step.) Have students complete Part C of the worksheet.
h. Most of the soil samples will have settled after 10-15 minutes, except for those with very small particles (clay). These may not completely settle out for another day or two if the sample is heavily clay. Have the students make a sketch of the way the layers appear in the jar (Part D of the worksheet). This can be done by holding the paper up against the jar and lightly marking the appropriate layer lines before filling them in with various shadings. At least three obvious layers should be apparent. The top layer is the clay, the second is the silt, and the third is the sand. There may be a fourth layer of very coarse sand at the very bottom.
i. Have the students estimate the percentages of each particle and complete the remaining section of Part D.
j. Ask each group to share what they learned about their sample with the class. As each group finishes have them consider the location of their sample. Can they suggest a reason why the soil might have been more acidic or basic, or have the highest percentages of sand, silt or clay?
k. Discuss soil formation with the class (weathering), as well as the influence which organic matter has on soil formation.

Evaluation:

Ask the student to:

(1) write a story, as if he/she is are telling the story about a rock which is slowly weathered to become part of the soil. He/she should include details of what happened (weathering details) to cause their "breakdown", and what three other types of things joined them as they became soil (organic matter, rocks and minerals, air and water); and,

(2) compare and contrast two lists, one a list of the three scientific classifications of soil (clay, silt, sand) from smallest particle size to largest, and the second list a list of soil particles from that particle with the greatest ability to hold water to that with the least ability to hold water. (The lists are the same.)

Enrichment:

a. Have the student take some soil samples from his/her yard (with parents' permission) and analyze them using the methods from class. Ask him/her to report his/her discovery in written or visual form to the class.
b. Have the student talk with a soil scientist about how his work helps farmers in the area. Report the results of this interview to the class in written or graphic form.
c. Have the student learn about the process of making soil using composting. Have him/her prepare a visual or written step-by-step guide to composting and share it with the class.

SOILS WORKSHEET

Original Location of Soil Sample_____

Part A - Observation/Soil Horizons

Your soil "core" probably has some very visible layers or "horizons." You may have noticed these previously in the soil of a stream bed or road cut. These layers represent the developing soil. They are known as horizons O, A, B and C.

O Horizon= organic horizon (composed of dead leaves and other plant and animal (organic) matter.

A Horizon= topsoil (composed of crumbled organic matter, dissolved minerals and nutrients).

B Horizon= subsoil (accumulated minerals, little organic matter).

C Horizon= transition area between soil and parent material (bedrock).

Horizon	Color (black, black-brown, brown, red, yellow, gray)	Feel (Texture) (loose, crumbly, chunky, slick, gritty, dense, won't crumble)	Organic Matter (high content, medium content, low content)
O Organic			
A Topsoil			
B Subsoil			
C Parent			

Part B - Organic Matter

What types of organic matter do you see in the scrapings?

Plant matter -
Leaves_____
Twigs_____
Stems_____

Living -
Roots_____
Moss_____
Plants_____

Animal matter -
Feces_____
Fur_____
Bones_____

Living animals -
Worms_____
Insects_____
Other _____

Where is the air and water located in your soil sample?_____
_____

Part C - pH Testing

The pH scale runs from 0 to 14, with neutral considered a pH of 7. A pH below 7 is considered acidic and a pH above 7 is alkaline.

Our Soil Sample pH was _____, making this soil (acidic, alkaline).

Part D - Soil Particles/Percentages

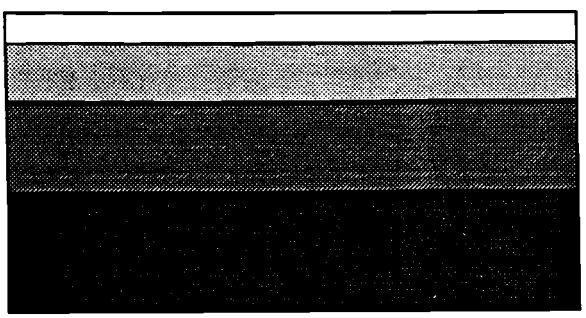
As your soil sample settles, it will divide into layers, determined by the size of the soil particles. The largest particles (sand) settle first, then silt and finally clay, the smallest particles, some particles may be so small that an ordinary microscope does not show them! Soils contain a mixture of these particles, with different proportions of each. The size of the soil particles determines how quickly water moves through the soil, and how much water the soil can hold.

A soil containing lots of clay takes in (absorbs) water very slowly, and gives it up just as slowly to plants. It feels sticky when wet.

A soil containing lots of sand allows water to pass through very quickly, and does not hold water for plants to use.

A soil containing lots of silt abosrbs and releases water at a rate which allows root development and plant growth. Silty soil is the best for raising plants.

Draw a chart of your soil, labeling the layers as shown in this example.



CLAY (10%)
SILT (20%)

FINE SAND (30%)

COARSE SAND (40%)

USE THIS SPACE FOR YOUR CHART

Activity 4B: Looking at Erosion

Objectives:
The student will be able to:
(1) define erosion and its three primary causes;
(2) describe how the presence of organic matter in soil affects erosion by water; and,
(3) describe the importance of vegetation in the prevention of water and wind erosion.

Main Ideas: Erosion, topography.

Teacher Note: This activity requires using school yard locations, so the teacher should review the activities and select appropriate locations prior to beginning the activity with the students. Ideally, the ground should be fairly dry when performing this activity.

Notes:

Background Information:

Erosion is the natural process by which water, wind and ice wear away rocks and soil. Over long periods of time, erosion can significantly change the way a landscape appears, carving out valleys, wearing down mountains and altering the course of a river. Over short periods of time, soil erosion can be responsible for changes in soil quality. Erosion of this type eliminates layers of earth which retain nutrients needed by plants. Once erosion has begun in an area, if it is allowed to continue, the bedrock below the original surface will eventually be uncovered.

The composition of soils is dependent upon the erosion of the original bedrock which forms soil, and on the living organisms that live upon and within the soil. It is also dependent upon the topography (surface configuration) of the area, and how susceptible the area is to erosion. The topography includes geological features such as mountains, hills, ravines, canyons and even flat areas which characterize an area.

Some soils erode faster than other soils. Vegetative cover is very helpful in preventing erosion. The plants and their roots help hold the soil together, preventing erosion from water and/or wind.

Water erosion is a problem on ground which slopes. Water can erode a gully into the side of a slope and eventually eat the soil away to form a canyon. Wind erosion is a problem in areas where few trees or hills block the flow of the wind. Soil blows when there is no vegetation to hold it in place, and no trees to decrease the speed of the wind.

The effects of wind erosion were felt during the Dust Bowl of the 1930's, when up to a foot of top soil was blown from farms across the Plains, making it impossible to raise crops.

Materials and Setting:

a. Materials:

Exercise 1: Two glass lamp chimneys or plastic water bottles, one filled with high organic matter soil and the second filled with low organic matter soil (see Preparation for locating these soil types).
Cheesecloth to cover the bottom end of the chimney to keep the soil from falling out.
A box with two holes cut in the top that will support the glass chimneys.
Two small, clear wide-mouthes jars to sit inside the box, with the chimneys inside them, to capture water.
Water.

Exercise 2: Two 3" diameter aluminum irrigation pipes cut 6" long.
Two 1 liter plastic soft drink containers.
A steel rod.
A wooden block or hammer (for pounding pipes into the ground).
Water.

Exercise 3: One empty coffee can with 5 nail holes punched in the bottom.
Pieces of 3 - inch string suspended through each of the holes helps direct the "rainfall."
Several pieces of white poster board approximately 1 foot square.
Water.

Exercise 4: Black Mesa information cards (Topic 4 materials).
Black Mesa Erosion Question sheet (Topic 4 materials).

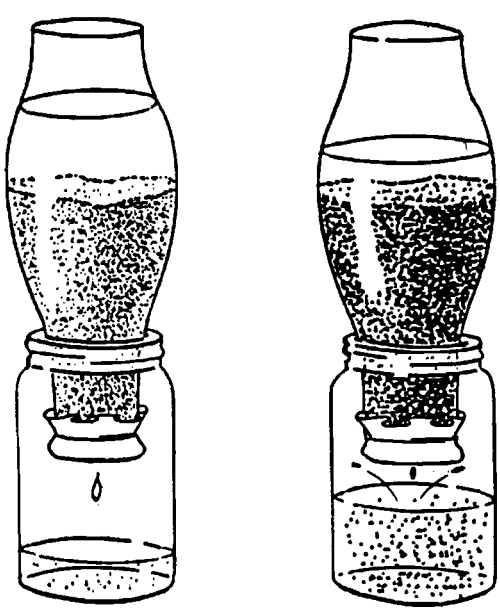
b. Preparation: Locate and collect samples of high and low organic soil for Exercise One. High organic matter soil can be found in grasslands or under trees. Low organic matter soils can be found in a plowed farm field or barren earth which has little visible vegetative matter.

c. Setting: Classroom (exercises 1 and 4), grassy and barren soil surfaces near the school (exercises 2 and 3).

Procedure:

Exercise 1:

a. Let the students observe the two types of soil. Make a list on the board of the differences they observe.
b. Fill one lamp chimney about 2/3 full of high organic matter soil, and the other 2/3 full of low organic matter soil.
c. Place the chimneys into the box stand so that they rest in the small glass jars.
d. Add water to the top of the chimney until it is full. Wait several minutes as the water passes through the chimneys.
e. Compare the color of the two waters, and the contents.
f. Discuss why these two soils transport water in different ways, considering the differences which were listed on the board in (a).



Exercise 2:

a. Take the class to an outside area and find a location with bare ground, and also ground with heavy ground cover, preferably a bunch grass.
b. Drive the two 3-foot irrigation pipes into the ground about 1 inch. (A block of wood on top of the tube will prevent damage.) Place one pipe in bare ground and one pipe in grass.
c. Fill the soft drink containers with water and place them upside down onto the pipes.
d. Have the students observe air bubbling in the bottles as the water is released into the soil. Is the rate different? Which bottle has the fastest bubble rate? From which bottle is the water running the fastest?
e. After 5 to 10 minutes, remove the containers and the pipes, and insert a steel rod into the wet spot. Measure the depth of the water infiltration.
f. At which spot did the water penetrate the farthest? At which spot is run off water the most evident?

Exercise 3:

a. Take the class to an outside area and find a location with bare ground, and also ground with either plant litter or growing plants.
b. Place the plastic lids on the bottom of the coffee cans and fill the cans 1/2 full of water.
c. Position one can over the bare soil area about 3 feet above the ground.
d. Have a student hold the white cardboard upright next to where the falling water will impact the soil.
e. Remove the plastic lid on the can and begin simulating rainfall with a rapid drip of water. Soil will splash on the posterboard.
f. Position one can over the vegetative area about 3 feet above the ground.
g. Repeat steps (c) and (d) at this location.
h. Compare the two cardboards. At which site was there more soil splashed onto the cardboard? How does this relate to water erosion? How does vegetative cover prevent erosion? The soil on the cardboard represents soil which would be washed away from the area.

Exercise 4:

a. Return to the classroom.
b. Distribute the Black Mesa Information Sheets
c. Distribute the Black Mesa Erosion Question Sheets
d. Divide the class into groups and allow ten minutes for the groups to fill in the question sheets, using the information on the sheets to provide information.
e. Discuss the question sheets with the class.

Evaluation:

Ask the student to:

(1) create a poster or display showing erosion, its three primary causes and how the presence of organic matter in soil affects its erosion by water;
(2) summarize the drainpipe exercise performed by the teacher, describing the importance of vegetation in preventing water and wind erosion.

Enrichment:

a. Ask the student to take photographs showing examples of erosion near his/her home or in his/her neighborhood. Label the photographs according to what caused the erosion, and make a display for the class.
b. Have the student study the Dust Bowl of the 1930s. If possible, have him/her interview someone in his/her family or community who remembers that time. After talking with him/her, the student should write a narrative describing that person's experience and share it with the class.

Nature Conservancy Highlight:

Black Mesa Nature Preserve - The Black Mesa is a basalt-capped plateau formed by the flow of an ancient volcano. The highest point in Oklahoma is located on this plateau, 4,973 feet above sea level. The plateau is forty five miles long extending from Colorado through New Mexico to just inside the northwest tip of the Oklahoma panhandle. Dakota sandstone underlies the basalt. Both rocks erode vertically, resulting in steep talus strewn slopes which merge abruptly with the plains below.

Extreme climatic fluctuations occur in the area. Precipitation averages about 13.5 inches annually, but can vary from 8 to 38 inches per year. The Black Mesa area supports thirty one state rare species (twenty three plants and eight animals) and four community types. Many species are at the easternmost or westernmost portions of their range. Vegetation on top of the nearly flat mesa is bluestem-grama shortgrass community. The mesa's talus slopes support a oneseed juniper-shrub oak woodland, while neighboring buttes have a oneseed juniper-pinon woodland. Both are eastern extensions of Rocky Mountain Foothills vegetation. Plains below the mesa support a blue grama-buffalograss, galleta grassland and a bluestem-grama grassland.

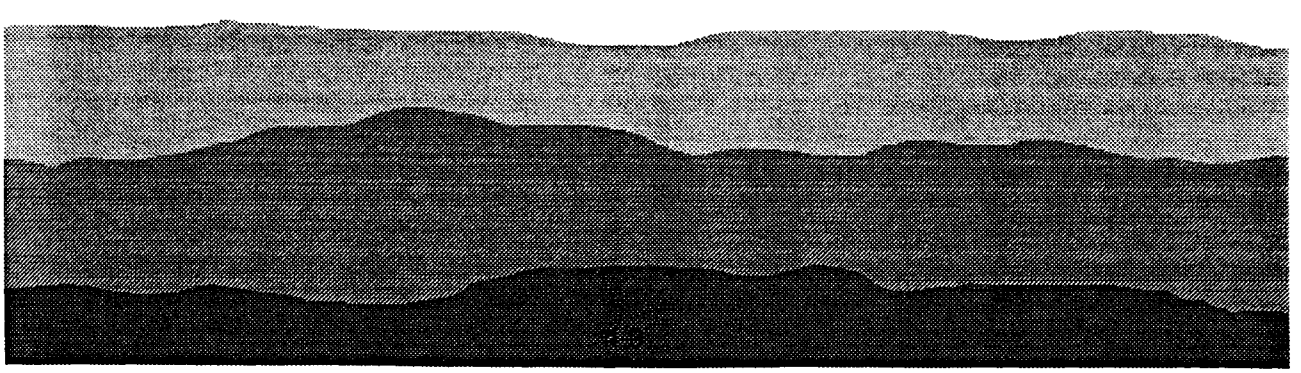
Suggested Variations/Expansion Activities

Project Learning Tree: Nature's Recyclers; Soil Stories
Project WILD: Eco-Enrichers

Additional Resources

Soil Maps of Oklahoma
Oklahoma Mineral Production, Mineral Resource Map

Notes:



BLACK MESA EROSION QUESTION SHEET

1. What natural action probably created Black Mesa and nearby buttes?

2. What facts about the climate of the Black Mesa area make continued erosion likely?

3. What plants are found on the slopes of the Black Mesa?

4. Is the soil on the slopes of the Black Mesa likely to be high in organic content?

5. Which Black Mesa vegetative community is least likely to suffer from erosion?

6. Is wind erosion likely at Black Mesa? Why or why not?

7. If erosion is a problem at a location like Black Mesa, how could people help stop the erosion?

BLACK MESA INFORMATION SHEET

Black Mesa 1. Precipitation averages about 13.5 inches annually, but can vary from 8 to 38 inches in a single year. Most precipitation falls during heavy thundershowers in the summer.	**Black Mesa** 2. Temperatures at Black Mesa vary from -30 degrees F in the winter to 112 degrees F in the summer.
Black Mesa 3. The Black Mesa area is where the Rocky Mountains meet the shortgrass prairie. It is unique in that it represents an area where many species are at the easternmost or westernmost portions of their range.	**Black Mesa** 4. Black Mesa is a basalt-capped plateau, formed by the flow of an ancient volcano. It is 45 miles long and extends from Colorado through New Mexico to just inside the northwest tip of the Oklahoma panhandle.
Black Mesa 5. Vegetation on top of the nearly-flat mesa is a shortgrass community (bluestem and grama grass.)	**Black Mesa** 6. Dakota sandstone underlies the basalt at Black Mesa. Both types of rock erode vertically, resulting in steep, rocky slopes, which merge abruptly with the plains below.
Black Mesa 7. The slopes of Black Mesa support a juniper-shrub oak woodland community.	**Black Mesa** 8. The plains below the mesa support a blue grama-buffalograss and bluestem-grama grassland.
Black Mesa 9. Black Mesa is a birder's paradise all year. Birds which may be observed there include Golden Eagles, scaled quail, black-billed magpies and pinon jays.	**Black Mesa** 10. Animals which live in the Mesa area include black bears, bobcats, mule deer, antelopes. Rattlesnakes may be active, especially mornings and afternoons during cool weather.

Topic Five

One Great Biome: Grassland

Topic Overview: Students study the grassland biome, and the structure of grasses. In Activity 5A, they study how rainfall and elevation amounts determine the locations of specific vegetation types. In Activity 5B, students "build" a grass and learn the structure of a grass. They also learn to recognize the seedheads of the Big Four Tallgrass Prairie grasses.

Activity 5A: Rainfall on the Prairie

Objectives:
Students will be able to:
(1) locate the general area of Oklahoma's three types of prairies;
(2) state the average annual rainfall of each area; and,
(3) state other nonliving factors besides rainfall which may affect the vegetation found in an area.

Main Ideas: Biome, climate, shortgrass prairie, mixed grass prairie, tallgrass prairie.

Teacher Note: In this activity, the learner uses state rainfall and highways maps to plot the differences in rainfall across the state and to consider elevation changes. These factors have combined to make Oklahoma a state rich in biodiversity of both ecosystems and of species.

Background Information:

A biome is a geographic area which, over time, has a somewhat uniform climate (temperature, precipitation and wind velocity). Wherever a particular climate is found, the same types of plant and animal life will be found. Most of central and western Oklahoma is a "grassland biome."

There is no single grassland climate. Interactions which allow grasses to remain the dominant vegetation type are complex. Those things which interact include soil, rainfall, temperature, available nutrients, sunlight, fire and grazing.

Elevation affects these interactions as well. This is apparent in Oklahoma, where the elevation decreases from 4,973 feet above sea level in the northwest corner of the state to 287 feet above sea level in the southeast.

Grasslands usually develop with a variety of large herbivores. These animals partially regulate the extent of grassland vegetation by grazing. Grasses will remain healthy as long as half the growing leaf is intact. Over 6,000 types of grasses have been identified in the world. On a small acreage, as many as 75 to 100 different types of grasses may be found.

Fire is a necessary action in natural grasslands. Fire acts

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Notes:

as an alternative nutrient recycling pathway. In the absence of fire, grasslands often become forests or brushlands. The major pathway for energy and nutrient flow through the grassland is through the grazing food web, rather than the detritus (decay) food web as in most other terrestrial ecosystems.

Water is another fundamental regulator of energy in grasslands. In a grassland biome, there is usually not enough moisture to support forests. Shrubs and trees occur along streams and rivers.

As much as 45 percent of the earth's terrestrial surface may have once been covered with natural grassland. The grassland biome is said to have suffered more complete destruction than any other biome in North America. It is estimated that 90 percent of the natural grasslands have been destroyed.

In grasslands, the soil is thick and rich with nutrients because of the large amount of dead plant material which is recycled when the leaves, stalk and roots die. About one-third of the roots of each grass plant die naturally each year. The rich soil makes grasslands prime land for agricultural and ranching purposes.

Three common prairies are: shortgrass prairie, mixed grass prairie and tallgrass prairie. **Shortgrass prairie** grasses are usually less than 2 feet tall at maturity and grow in areas receiving less than 20 inches of rainfall per year. The Panhandle and some western portions of Oklahoma is shortgrass prairie. The **mixed grass prairie** is as the name implies, a mix of short and tall grasses, with stalk height at plant maturity varying from 2 to 4 feet. Up to 28 inches of rain fall in that area each year. Most of central and western Oklahoma is mixed grass prairie. The Dust Bowl of the 1930s included this area, along with western Kansas, Nebraska, South and North Dakota. Remnants of the **tallgrass prairie** can still be found in east-central and eastern Oklahoma. Here, between 28 and 40 inches of rain fall each year. These grasses can grow as tall as eight feet and taller.

Materials and Setting:

a. Materials:

- Oklahoma Annual Precipitation Maps (Appendix 1)
- Oklahoma Vegetation Maps (Appendix 2)
- Oklahoma County map (Topic 5 materials)
- Oklahoma Town Rainfall/Elevation fact sheet (Topic 5 materials)
- Oklahoma highway maps (available from the Department of Transportation, 200 N.E. 21st St., Oklahoma City, OK 73105.)
- "Natural history for the naturally curious" (Topic 5 materials)
- crayons or markers

b. Setting: The classroom.

Procedure:

a. Divide students into teams of two. Give each group an Oklahoma Town Rainfall/Elevation fact sheet as well as four crayons (yellow, orange, red and green).

b. Using the fact sheet, have the students make a check mark in yellow beside all cities with an average annual rainfall amount of less than 20 inches. Have the students make a check mark in orange beside all cities which have an average rainfall amount of between 21 and 28 inches per year. Have the students make a check mark in red beside all cities which have an annual rainfall amount of between 29 and 40 inches. Have the students make a check mark in green beside all cities whose rainfall amount is greater than 41 inches per year.

c. Distribute the Oklahoma County map and the Oklahoma State Map.

d. Ask the students to make a yellow dot on the county map at the approximate location of each city from the Oklahoma Town Rainfall/Elevation fact sheet that has a yellow check beside it. Have them do the same for the orange, red, and green checked cities. They do not need to write the names of the towns on the county map. (This will take some time, as students will be locating the cities on the Highway map and then relocating them on the county map. Encourage them to use the map locator key to find the cities.)

e. Have the students divide the state into rainfall areas moving from the northwest corner to the southeast corner. First, they should connect the dots which are of the same color and then lightly shade each area with the same color as the town dots in that area. Be sure town dots are still visible.

f. Pass out Oklahoma Vegetation maps to each student group.

g. Have the students compare the rainfall amounts to the location of the various vegetation types. How much rainfall appears to be needed for shortgrass prairie? mixed grass prairie? tallgrass prairie? forest? Determine and list rainfall amounts for each vegetative community.

h. Next, have the students consider elevation across the state. Ask them to take the Oklahoma Town Rainfall/Elevation fact sheet and circle in yellow the elevation of the yellow-checked cities. Use the space at the bottom of the fact sheet to write down a range in elevation of these cities, from highest to lowest elevation.

i. Have the students follow this same procedure for orange-checked cities, then red-checked cities; and finally green-checked cities. After completing each section, have them write the elevation range at the bottom of their fact sheet. How does elevation change across Oklahoma?

j. Distribute the Oklahoma Annual Precipitation Map.

k. Ask the students to compare this map to the elevation ranges they have found for the cities. Discuss elevation. Does there seem to be a connection between elevation and rainfall? If so, what is it?

l. Open the discussion to include both rainfall and elevation. Discuss rainfall in your area. Where does the rain come from? What influences rainfall patterns in your state? Does elevation influence rainfall? Why? Can you find two cities or towns that are at almost the same elevation, yet receive very different amounts of rain? Why is this? Would these rainfall/vegetative patterns be similar in other parts of the world? Would similar influences function all over the world?

m. Distribute the "Natural history for the naturally curious" sheet to the class, and allow time for the students to read this and ask questions.

Evaluation:

Given a blank outline of Oklahoma, ask the students to:

(1) indicate on the map, with three different colors of markers, the general area of Oklahoma's three types of prairies;

(2) write on the map the average amount of rainfall which occurs in each prairie area; and.

(3) state the nonliving factors besides rainfall which may affect vegetation in a particular area (nonliving factors include: temperature, wind, elevation, fire, grazing, soil, nutrients and light).

Enrichment:

a. Using a United States or World Atlas, with vegetation maps included, ask the students to identify another state or country which has grassland. Have them investigate that country or state, considering elevation and annual rainfall. Ask them to compare this information to what they have learned about Oklahoma. Create a visual display with this information and share it with the class.

b. Have the student select an animal which calls the prairie home (e.g. prairie dogs, swift fox, jackrabbit, etc. A list is included with Topic 6 materials. The bison will be studied in Topic 7, so other prairie species should be used here.) Ask the student to investigate how that animal is able to live on the prairie, then write an essay or create a poster to explain what they discovered.

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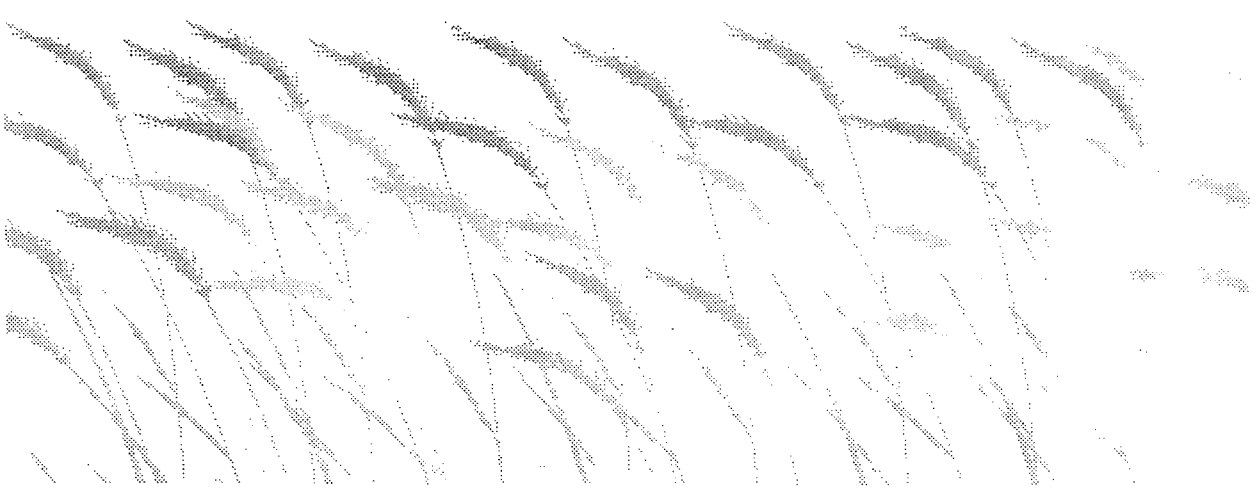
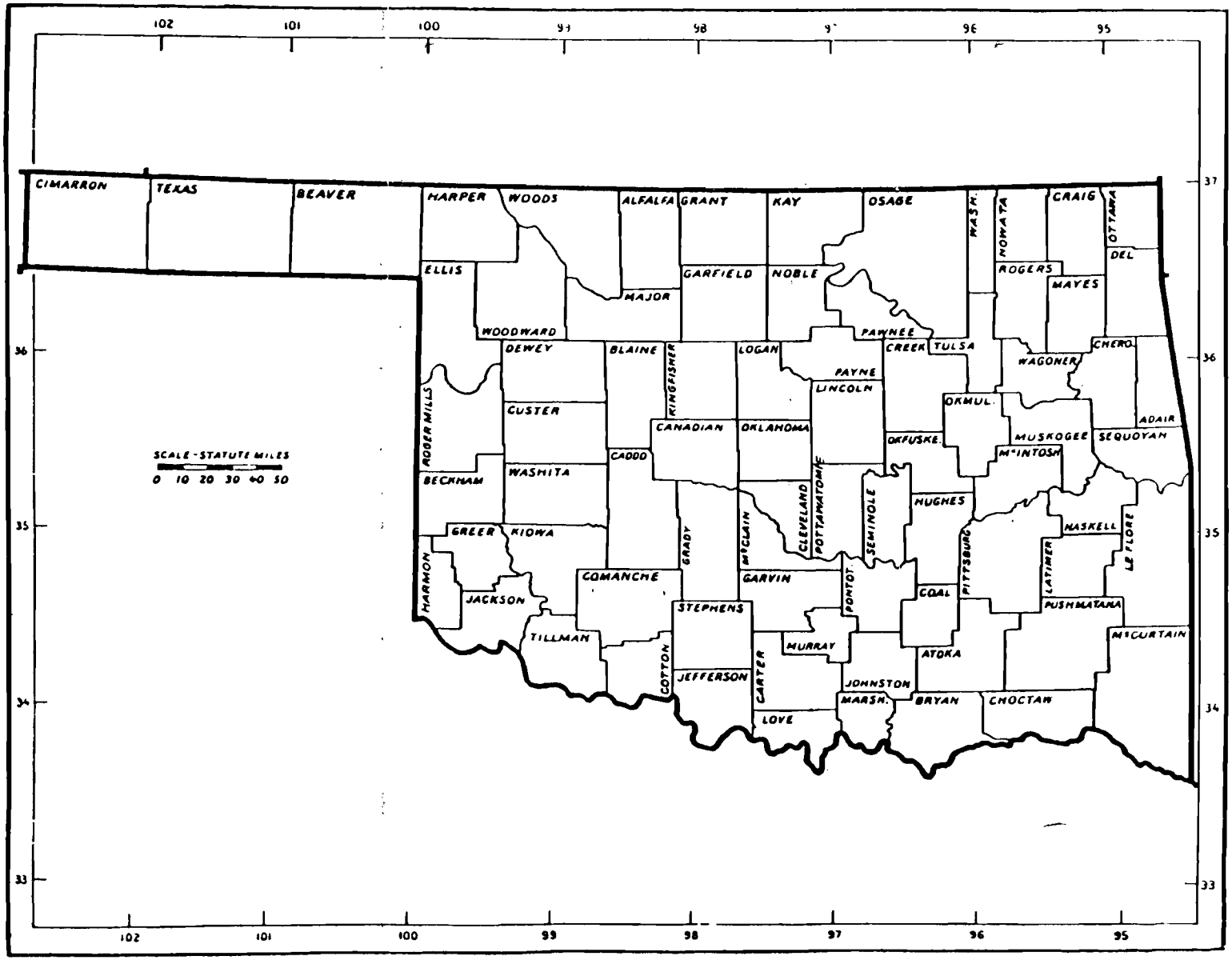


Oklahoma Town Rainfall/Elevation Fact Sheet

Town	County	Rainfall	Elevation
1. Ada	Pontotoc	40"	1,058'
2. Altus	Jackson	26"	1,389'
3. Alva	Woods	26"	1,351'
4. Antlers	Pushmataha	46"	504'
5. Ardmore	Carter	38"	886'
6. Bartlesville	Washington	38"	715'
7. Beaver	Beaver	20"	2,500'
* 8. Broken Bow	McCurtain	46"	488'
9. Buffalo	Harper	25"	1,791'
10. Chickasha	Grady	30"	1,095'
11. Duncan	Stephens	32"	1,126'
12. Durant	Bryan	40"	657'
*13. Enid	Garfield	32"	1,246'
*14. Grove	Delaware	46"	801'
15. Guthrie	Logan	34"	977'
16. Guymon	Texas	16"	3,126'
*17. Hugo	Choctaw	46"	547'
*18. Heavener	LeFlore	46"	497'
*19. Kenton	Cimarron	16"	4,600'
20. Kingfisher	Kingfisher	30"	1,056'
21. Lawton	Comanche	30"	1,117'
22. McAlester	Pittsburg	48"	740'
*23. Muskogee	Muskogee	41"	605'
24. Newkirk	Kay	34"	1,154'
*25. Norman	Cleveland	33"	1,170'
26. Okmulgee	Okmulgee	40"	670'
*27. Pawhuska	Osage	36"	879'
28. Sayre	Beckham	26"	1,816'
29. Stillwater	Payne	34"	913'
*30. Stilwell	Adair	43"	1,112'
*31. Tulsa	Tulsa	38"	744'
*32. Vinita	Craig	43"	700'
33. Watonga	Blaine	28"	1,515'
34. Weatherford	Custer	26"	1,669'
35. Woodward	Woodward	22"	1,906'

* Indicates location of Nature Conservancy preserve

OKLAHOMA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KINGFISHER
LOGAN
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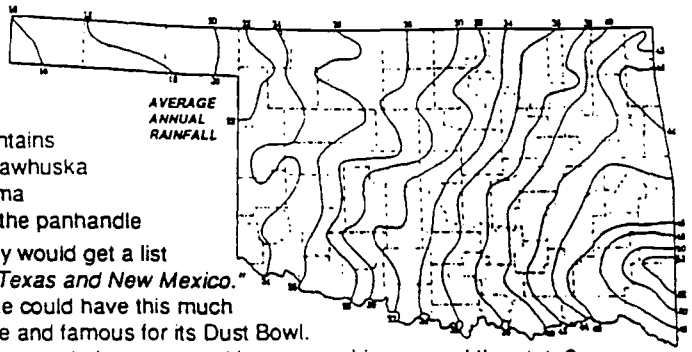


Imagine showing the following photos to a person who has never been to Oklahoma:

- The cypress swamps of McCurtain County in the southeast corner of the state
- The rugged, pine forests of the Kiamichi Mountains
- The tallgrass prairie of the Osage hills near Pawhuska
- The mesquite plains of southwestern Oklahoma
- The cactus filled landscape of Black Mesa in the panhandle

Ask where the photos were taken, and you likely would get a list something like *". . . Louisiana, Arkansas, Kansas, Texas and New Mexico."* Few people would ever imagine that any single state could have this much diversity, especially a state less than 500 miles wide and famous for its Dust Bowl. So why is it that there is such a great change in the natural plant communities as you drive around the state?

Let's consider what factors most influence whether or not a plant can thrive in a particular environment. Of the many factors, such as amount of sunlight and soil composition, the most important are temperature and rainfall.

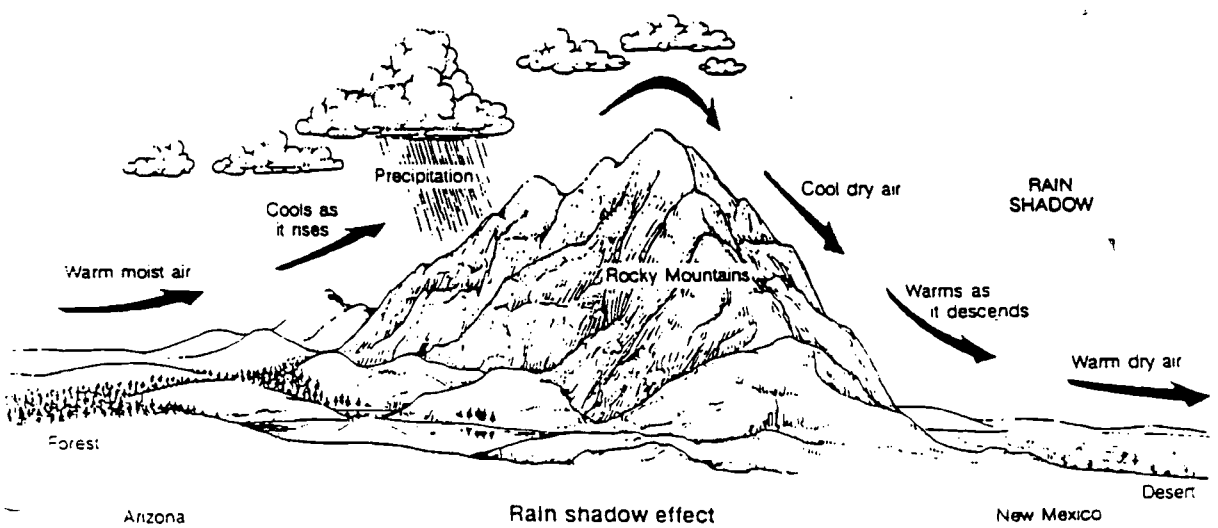
Temperature We know from the weather maps on television that any time of year it is usually cooler in the panhandle than the southeastern part of the state. While the small difference in latitude may account for some of this, it is the difference in altitude which should get the credit. The warmer southeast corner of the state has an elevation of just 300', while the tip of the panhandle is almost a mile high at 4,793'! This tilt is the result of tremendous geologic forces which lifted the western edges of Oklahoma, Kansas and Nebraska as the Rocky Mountains were formed.

Rainfall Here we have the main answer to the diversity riddle. As you can see on the rainfall map above, the average annual precipitation ranges from 16" to 52", creating vastly different ecosystems. During the growing season from April through September the average rainfall ranges from 12" in the west to 28" in the east.

Two things account for these differences. First of all, the western part of the state is in a "rain shadow", a phenomenon due to the fact that cool air can't hold as much moisture as warm air. Because of this natural law, as the moist clouds go up and over the Rockies they are forced to unload their moisture, yielding dry clear skies over eastern New Mexico, northwestern Texas and western Oklahoma. The second factor is that eastern Oklahoma (along with Louisiana, eastern Texas, Arkansas, and other states) is in the unblocked path of moist warm air moving up from the Gulf of Mexico.

For those of us who enjoy native wildflowers, Oklahoma has it all: delicate, blue wild hyacinth in low moist soils of southeastern counties, big, red barrel cactus flowers in the southwest, and a panorama of hundreds of different flowers native to the woodlands and prairies.

Tom Chilton



Rain shadow effect

Map reprinted from *Historical Atlas of Oklahoma*
Illustration reprinted from *Living in the Environment*

The Gaillardia

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Activity 5B: Make A Grass

Objectives:
Students will be able to:
(1) define an annual, biennial, and perennial plant;
(2) list the seven primary parts of a grass; and,
(3) sketch and name the seedheads of each of the Big Four Tallgrass Prairie Grasses.

Main Ideas: Grasses, Big Bluestem, Switchgrass, Indiangrass, Little Bluestem, annual, biennial, perennial, forage, fibrous roots, rhizome, stolon, stem, meristems, herbs, forbs.

Teacher Note: Students "become" a part of a grass plant in this fun activity involving simulation. Provide lots of room! Some students will be lying on the floor, and all of them will be speaking and moving at the same time, so be prepared! Prior to working with the students on this topic, the teacher should become familiar with the parts of a grass and grass reproduction. The teacher should also review the Big Four prairie grasses, their appearances, similarities and differences.

Background Information:

There are over 6,000 different grasses in the world. As many as 75 to 100 different types may grow side by side in any given grassland area. A large portion of each grass plant is located below the ground (the root system). This root system enables most grasses to survive both grazing and fire. Fibrous roots grow deep into the soil, taking in water and nutrients and anchoring the grass and soil. Grasses spread either by seed, by rhizomes (underground stems) or by stolons or tillers (aboveground runners). Shoots grow up from either rhizomes or stolons.

The above ground portion of the grass is the stem or stalk. Water travels upward through the plant's vascular system. The grass has strong joints, providing stability in the wind. Leaves are attached at nodes and alternate on each side of the stem. The flowering part of the grass, which produces seeds, is the seed head.

In grasses, some meristems (tissues which produce new cells responsible for plant growth) are located at the base of the stem (as opposed to the tip of stems or limbs as it is in trees). Additional meristems are located at root tips and bases of leaves. These special stem-base meristems allow grasses to continue growth after grazing, mowing or fire.

Grasses share the prairie with other types of plants, including broadleaf herbs or forbs. A herb is a plant with a soft, not woody stem that dies to the ground in winter. A forb is a low-growing annual or perennial herbaceous (not woody) plant. Both grasses and forbs may be annual (one year life cycle), biennial (life cycle complete in two years with flowering and seed production the second year); or perennial (life cycle of more than two years).

The four dominant grasses of the Tallgrass Prairie are Big Bluestem, Switchgrass, Indiangrass and Little Bluestem.

Big Bluestem prefers moist

Notes:

but not wet soil and is found in broad valleys and on lower slopes. It has many fibrous roots which may be as deep as 12 feet. The seed stalks of this grass appear in late August to October and may grow to be 8 feet tall. This grass grows in large clumps or bunches and is very leafy.

Indiangrass (the state grass of Oklahoma) is more drought-tolerant than Big Bluestem, can occupy bare soil and is excellent forage, (plants which herbivores like cattle or bison prefer). This grass has golden-brown plume-like seed heads which bloom in September and October, and may be as long as 12 inches. Its seed stalk can grow to be as tall as 8 feet.

Switchgrass is less shade tolerant than the others, and can grow in the dry soil on the upper edges of salt marshes. It is a sod-forming grass with very vigorous roots. Its seed stalks may be as tall as 6 feet.

Little Bluestem is only 3 to 5 feet tall and grows as a bunch grass rather than a sod grass. The most abundant grass in mid-America, it is also found in mixed and shortgrass prairie. It has very dense roots which may be as deep as 8 feet. It grows very well in soil types ranging from sandy and shallow to rocky or deep.

Notes:

Materials, Preparation and Setting:

a. Materials:

Drawing of the Primary Parts of a Grass, one per student (Topic Five materials)
Slips of paper with grass parts written on them (see Preparation below)
Paper Sack
Several bandannas
Sketches of Seed Heads of the Big Four Tallgrass Prairie Grasses, one per student (Topic Five materials)
Sketch pads or paper for each student
Drawing pencil or marker for each student

b. Preparation: Write the following parts of a grass on separate slips of paper and put them in the sack. The number of slips to be marked with an individual grass part name is indicated in the parenthesis. The suggested numbers are for a class of 24. Numbers may be adjusted depending on size of class.

Fibrous roots (8)
Stem(3)
Leaves (2)
Seed head (1)
Stolons (4)
Rhizomes (4)
Shoots (2)

c. Setting: The classroom, or outside. A large area is needed where students can role play as grasses, and where noise will not disturb others.

Procedure:

a. Distribute drawing of the Primary Parts of a Grass, one per student.

b. Tell the students that they are going to "become" a grass plant. Have the students take a slip of paper from the sack (prepared earlier) to see what part of the grass they will be. Take students to an area where they have room to move around, and noise will not disturb others.

c. Ask the students what part of the grass anchors the plant and draws in nutrients and water. Then have those students who are fibrous roots lay down with their feet as close together as possible in a wagon-wheel shape. From this position, they should repeat softly, "Sip water, Sip nutrients". Their arms should be moving continually as if they are searching for water in the soil. Allow them to practice their part, and then ask them to be quiet as the rest of the grass is assembled (Repeat this procedure with each grass part.)

d. Next, ask the students what part of the grass is most visible above ground. Then ask those students who are parts of the stem to come forward. Have one student squat where the feet of the "fibrous roots" come together and hold their arms straight up. Have the second student kneel behind the first, also holding their arms straight up. The third student should stand behind the other two, bending over them slightly with hands resting on knees for support. The "stems" will repeat, "straight and tall, straight and tall."

e. Ask the students what part of the grass makes food for the plant. Have those students who are leaves stand on either side of the stem and "attach" themselves with the bandannas to parts of the "stem." Leaves connect to the stem at the nodes which separate the stem sections. The bandannas can be held by one stem member and attached to the arm or belt of a "leaf." Have these leaf blades repeat "sun for food, sun for food" with one arm raised and waving up toward the sun.

f. Ask what part of the plant is "underground" and which enables the plant to reproduce without seeds. Students who are rhizomes should come forward. Have them lie down on the ground in a line, arms extended above their heads to touch the feet of another rhizome. The rhizome line should extend off to one side of the stem, with the first student's feet touching the stem. Have these students repeat "Rhizomes spread, rhizomes spread" as they stretch toward the other rhizomes.

g. Ask what "above ground" way, similar to rhizomes, enables grasses to spread. Students who are stolons should lay on the ground, head to foot, pointing in the opposite direction from the rhizomes. Have these students repeat, "runners spread, runners spread" as they reach out to the side with their arms.

h. Ask the students about the purpose of rhizomes and stolons. Then have the shoots come forward and have one stand somewhere along the line of rhizomes and the other somewhere along the line of the stolons. They should repeat, "rising shoots, rising shoots" as they reach their arms toward the sun.

i. Ask what third way a grass can be spread. Have the seed head come forward and stand behind the "stem", arms lifted high above head and waving. This student will repeat, "seeds spread, seeds spread."

j. Now that the grass plant is together, have all parts of the grass repeat their lines at the same time. Encourage participation! One grass part can not survive without the others!

k. To conclude the activity, illustrate what happens to the grass when:

(1) The grass is grazed. (Remove the seed head and upper portion of stem and grass blade. The main portion of the plant is still alive, so new stem and leaves will be produced.)

(2) Fire burns over the area. (Remove the seed head, all stem and grass blade portions as well as the stolon. The underground portion of the plant remains and produces new stem, leaves and stolons.) Make a new plant.

(3) The grass is plowed under and the land is used for agricultural purposes. (Remove all parts of the grass.)

l. Distribute the sketches of the Seed Heads of the Big Four Tallgrass Prairie grasses. Distribute sketch pads or paper. Have the students take a few minutes to sketch the Big Four seedheads in preparation for the evaluation.

m. As the students finish their drawing, review information from the overview about grasses and their structure with the students. Ask the students questions about how the grass gets water and nutrients. How did the water and nutrients get into the grass? How do the water and nutrients get to all parts of the grass? What keeps the grass from blowing over in the wind, or being pulled out when grazers eat the tops of the grass? How do grasses make their food?

Evaluation:

Ask the students to:

(1) define an annual, biennial, and perennial plant;

(2) list the seven primary parts of a grass and the function of each part (those parts which they "became" during the activity); and,

(3) sketch and label the seed head of each of the Big Four Tallgrass Prairie grasses.

Enrichment:

a. Ask the student to investigate what types of things (in addition to food goods) are made from grasses (could be clothing, fuels, baskets, types of shelters). Have him/her list these on a chart (illustrated if they'd like) and display it for the class.

b. Have the student investigate the contents of bread, cereals, etc., then make a display of these food grasses, including illustrations of the grain and its final food product. (Cereal grains are corn, wheat, oats, rice, barley, rye and buckwheat.)

c. Have the student investigate the many types of grasses which grow around his/her home. With the help of a parent, or a grasses field guide, have him/her identify these grasses, list them and share them with the class.

d. Have the student prepare dried samples of the Big Four Tallgrass Prairie grasses using a plant press.

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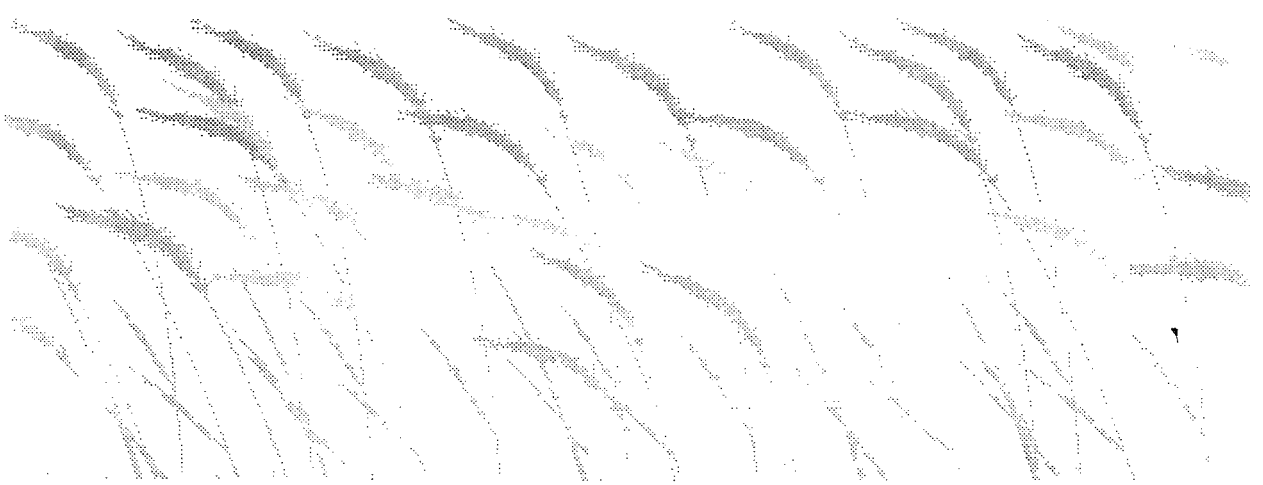


Nature Conservancy Highlight (Topics 5-8):

The 36,600 acre Tallgrass Prairie Preserve is located 17 miles north of Pawhuska, and approximately 10 miles east of the town of Foraker in Osage County, northeastern Oklahoma. The Preserve has been owned and managed by the Nature Conservancy since 1989. The unique beauty of the prairie varies from season to season, with different plants and grasses displaying vivid colors at different times of the year. Mid-May through mid-June finds wildflowers at their colorful peak. Grasses take the honors in Autumn as their seed heads reach heights of six to eight feet. Seed head colors vary from a deep gold to a rich reddish-purple.

There are more than 500 plant species on the Tallgrass Prairie Preserve, 250 bird and 80 mammal species. In October 1993, 300 bison were introduced to the Preserve. The bison, along with the use of fire as a natural management tool, will hopefully allow the prairie in this Preserve to return to a sustainable ecosystem. A sustainable system is one which is in a self-sustaining steady state. Eventually, it is hoped that the Preserve can support a projected limited population of 2,000 bison, reached through natural reproduction.

Additional Prairie Preserves:

Springer Prairie Preserve is a 40-acre tract of tallgrass prairie located in Garfield County, northeast of Enid. The tract was given to the Nature Conservancy in the 1980's. This prairie contains high quality, unplowed grass, dominated by Big Bluestem and Switchgrass. This Preserve is surrounded by winter wheat fields. 13 acres of the site were plowed historically and have been reseeded with the Big Four grasses and side-oats grama, another tallgrass species. Periodic controlled burning is used to maintain the area as prairie.

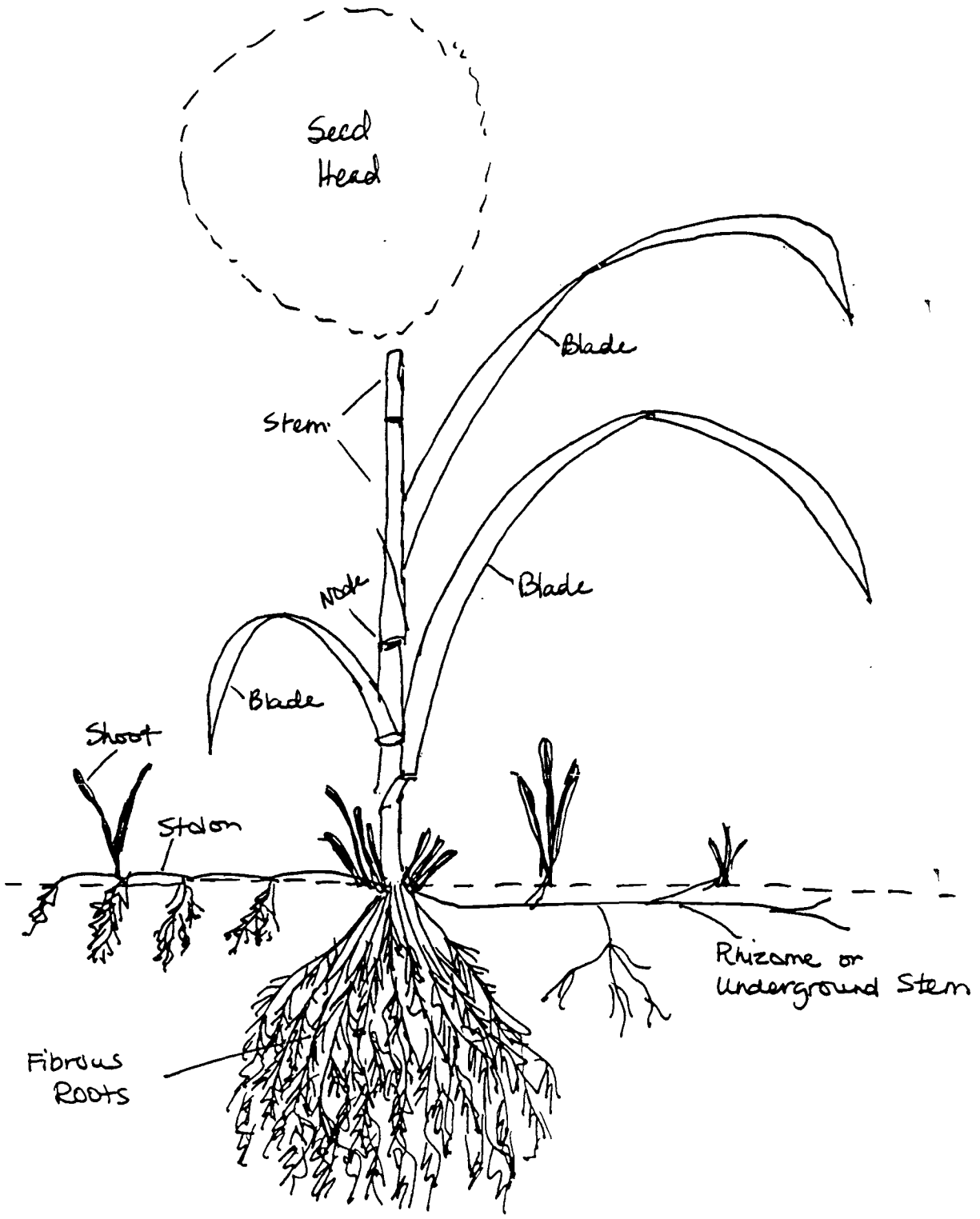
Suggested Variations/Expansion Activities

Project Learning Tree: Rain Reasons
Project WILD: Rainfall and the Forest

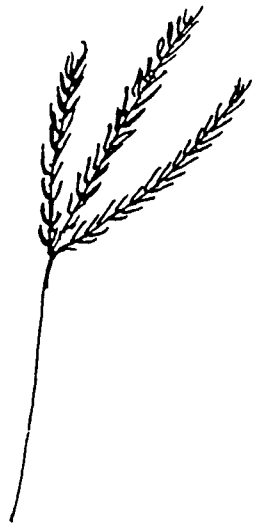
Additional Resources

Materials from the TallGrass Prairie Preserve including:
Self guided Nature Trail guide

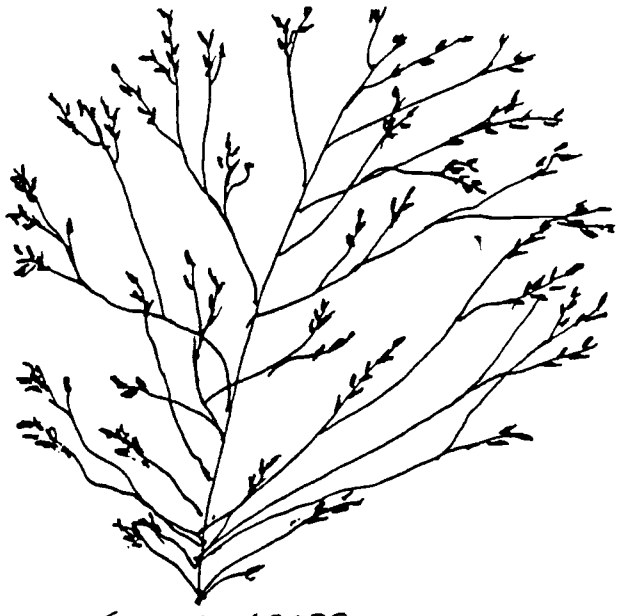
PRIMARY PARTS OF A GRASS



SEED HEADS OF THE BIG FOUR TALLGRASS PRAIRIE GRASSES



BIG BLUESTEM



SWITCHGRASS

LITTLE BLUESTEM

INDIAN GRASS

Topic Six

The Great Web of the Prairie: Food Chains and Food Webs

Topic Overview: Students study food chains and food webs, considering the prairie food web. In Activity 6A, students imagine plants and animals which make up food chains on another planet. In Activity 6B, students construct a prairie food web, using inhabitants of the Tallgrass Prairie.

Activity 6A: "On Some Other Prairie"

Objectives:
Students will be able to:
(1) define primary producer, primary consumer, secondary consumer, herbivore, carnivore, omnivore, decomposers; and,
(2) define and draw a simple food chain.

Main Ideas: Primary producer, primary consumer, secondary consumer, tertiary consumer, herbivore, omnivore, carnivore, food chain, decomposers.

Teacher Note: This activity requires the learner to listen as you describe another prairie-type ecosystem. They are then asked to imagine the plants and animals of that ecosystem, their appearance and food requirements. From their imaginings, the learners create a food chain. Encourage the learners to share their imagined plants and animals with each other. There are no incorrect answers!

Background Information:

A simple food chain is only one of many food energy pathways in an ecosystem. The first link of the chain is the plant, which produces proteins, fats and carboyhydrates using energy from the sun in the process we call photosynthesis. Plants are primary producers.

The second link in the food chain is made up of creatures which eat the plant. These creatures are known as herbivores, or plant-eaters. They are also called the primary (first) consumer.

The third link in the chain is made up of animals which eat the creatures which eat the plant. They are carnivores or meat-eaters, and are also called secondary (second) consumers.

An additional link in the chain is made up of those creatures which eat the carnivores. They are tertiary (third) consumers. Sometimes these creatures are omnivores, creatures that will eat both plants and animals.

The simple food chain is completed by the decomposers, bacteria, molds and fungi that feed on dead plant and animal material, bringing about the process of decay.

Notes:

Illustration: Rick Fry

10/31/94

On the prairie, as in other ecosystems, several omnivores may be present, utilizing food energy obtained from a variety of sources. These omnivores include coyotes, bobcats and foxes. Humans are naturally omnivores, although some choose to be herbivores (vegetarians).

Notes:

Materials and Setting:

a. Materials:
- Construction paper in blue, yellow, red and green; cut into small strips (about 1 inch wide by six inches long) to make chain links
- Scissors
- Stapler and Staples
- Paper and pencil
- "Ecosystem scenario" (Topic Six materials)

b. Setting: Classroom.

Procedure:

a. Have the students close their eyes. Ask them to listen carefully as you read the "Ecosystem scenario." Allow a few seconds of silence after you are finished reading.
b. Ask the students to take out a pencil and a piece of paper.
c. Invite the students to imagine. Have them name and describe a plant which they might find living in the ecosystem they just heard about. Tell them the plant may be a new, never-before-seen-on-earth plant because this ecosystem may be on another planet. Their description should include the color, size and shape of the plant, and whether it reproduces by seeds or by rhizomes and stolons or some other means. What do its leaves and flowers look like? Does it bear a fruit? Is the fruit edible by humans or animals? The students should write this information down on their paper and label it #1.
d. Next, ask the students to name and describe an animal which might eat this plant. Again, these may be new, never-before-seen-on-earth animals of any size. Have the students also tell how many plants and what plant parts the animal must eat each day to be healthy, and whether it eats these plants during the daytime or at night. Also, they should describe the animal. Does it have hair? What kind of teeth, eyes, nose, ears, feet does it have? Again, have the students write the information down and label it #2.
e. Next, ask the students to name and describe an animal which might eat the animal that ate the plant. Follow procedure (d) for requirements in describing this animal, then have them label it #3.
f. Finally, ask the students to name and describe an animal which might eat either the plants or the animals that eat the plants, depending on which is available. Follow requirements from procedure (d) when describing this animal. Students should label it #4.
g. Distribute the construction paper links, being sure that each student has one strip of each color.
h. Have the students write the name of their #1 plant on the green strip.
i. Have the students write the name of the #2 animal from (d) on the yellow strip.
j. Have the students write the name of the #3 animal from (e) on the blue strip.
k. Have the students write the name of the #4 animal which they created in (f) on the red strip.
l. Have the students staple the strips into links as they attach them together forming a chain. They should be attached in order: yellow to green, blue to yellow and red to blue.
m. The students have created a food chain. Explain the concepts of the plant as the primary producer, the first animal as the herbivore/primary consumer, the second animal as the carnivore/secondary consumer, and the third animal as the omnivore or tertiary consumer.

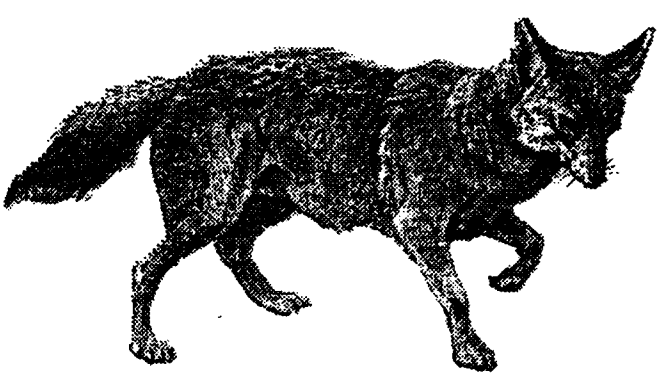
n. Ask for student volunteers to share their food chains with the class, describing the plants and animals that they have created.
o. Display the "chains."

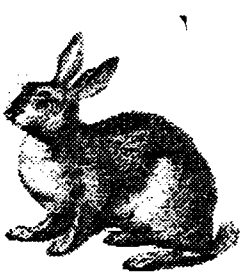
Evaluation:
Ask the student to:

(1) define primary producer, primary consumer, secondary consumer, herbivore, carnivore, omnivore, and food chain; and,
(2) give each student a list of plants and animals (identified as herbivores, carnivores, etc.) and ask him/her to make either a diorama or mobile illustrating a simple food chain.

Enrichment:
a. Have the students keep a record of what they eat during the day. Ask them to find out where each food item comes from. Then have them determine if they are a herbivore, carnivore, or omnivore.
b. Have the students expand the food chain they created in Activity 6A, using additional links which represent the other animals and plants they created. All "new links" must eat the ones to which they are attached.
c. Have the students complete their food chain by imagining a decomposer. Describe this creature, as well as how it recycles other plants or animals into soil to bring the nutrients back to the beginning of the food chain and the primary producers.

Notes:





Ecosystem Scenario
"On some other prairie..."

Close your eyes and sit back in your chair. Relax your arms and imagine that you are being pulled up into the sky, traveling through the earth's atmosphere, through the clouds and into space. Hours pass, but seem like only seconds as you flash through the universe. Suddenly, a planet is before you in space, and you are dropped down through that planet's atmosphere, and gently land on its surface.

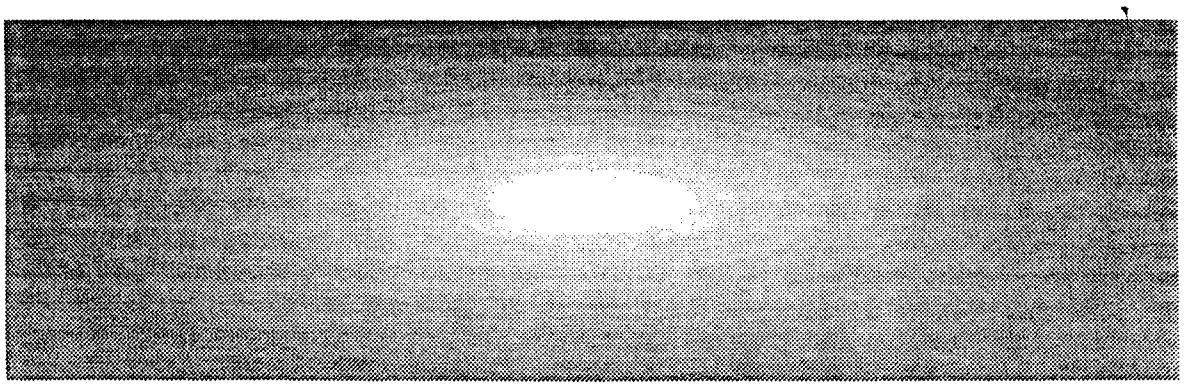
Imagine that you are lying on that soft, spongy surface, staring up at the blue-white sky. You have no idea where you are. But you can breathe normally and do not feel hot or cold. You lie still, and gradually your heart stops racing and slows to normal.

Huge purple clouds begin to race across the sky, and the wind whistles around your ears. Drops of water splatter down, but you lie still, letting the water slip down over your face and body to the surface below you. The surface begins to swell as the rain continues. You sink deeper into the spongy earth. You roll to your side, and struggle to get up. Once you are on your feet, you find walking is slow and tiring on the spongy surface. Slowly you make your way across a valley and over a hill.

The vegetation is unusual, like nothing you have seen at home. Some vegetation is low-growing, while other plants reach high into the sky. Water has collected in creases of the spongy earth. Now, after the rain, it streams down the creases and collects in deeper spots, forming small ponds.

The purple clouds race quickly off and disappear from the blue-white sky above you. It begins to get hot. Bright, hot light is beaming down. Steam begins to rise from the spongy surface. The water that surface has absorbed begins to evaporate into steam. The streams which had formed in the creases dry up before your eyes, and, as you watch, the lakes formed by the runoff water become shallower. Sweat begins to roll down your face. Most of all, you want to get out of the steam and find solid ground to walk upon.

Finally you reach shelter, a cabin with a hard wood floor. From its windows, you watch the animals of the ecosystem as they search and find "dinner" after the rainstorm.



Activity 6B: Prairie Food Web

Objectives:
Students will be able to:
(1) describe a food web; and,
(2) when given a list of prairie animal and plant species, create a simple food chain and a food web.

Main Ideas: Food web, grazing, herbivores, biomagnification.

Teacher Note: This activity is designed to be organized by the students! Expect some confusion as the students build their own prairie food web and discover the connectedness of animals and plants within the prairie ecosystem.

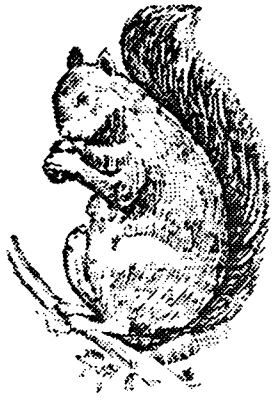
Background Information:

The food web of any ecosystem is an interlocking system of the food chains of individual animals. This web is the ecosystem's entire food energy transfer system. The primary food web of the tallgrass prairie is the grazing food web. In grassland ecosystems, much of the plant matter does not undergo decay. Instead, matter is eaten by plant-eating animals (herbivores).

In addition to the many large herbivores we always think of (cattle, bison, deer, sheep), there are many smaller, rarely seen herbivores which also graze in grasslands. These include rodents, rabbits and various insects such as grasshoppers and termites. Grazing is beneficial in grassland ecosystems. Grazing increases the photosynthetic rate. Less functional plant tissue (at the top of the plant) is removed and more light reaches the lower portions of the plant. Grazing also allows growth hormones to be redistributed within the plant. Soil water is conserved because there is less plant material, and nutrients are redistributed and recycled through herbivore excrement. This material is then recycled into soil, which, once again, nourishes plants.

Biomagnification is a process in which chemicals are accumulated in ever-increasing amounts when progressing up the food chain. These chemicals are found in fatty tissues and are passed on to the next consumer. Each successive consumer in the food chain receives more of the chemical than the consumer in the previous food chain level. An example is the magnification of DDT in the food chain. It is estimated that in the 1960s and 1970s the concentration of DDT magnified almost 7 million times as it passed through the food chain from plant life to various consumers, including fish and finally birds.

Notes:



Materials, Preparation and Setting:

a. Materials:

Part One: Selected Prairie Inhabitants list (Topic Six materials)

String (about ninety six-foot lengths - three hundred and sixty feet - for twenty students)

Scissors

Sheets of paper to make "name" signs, or 3x5 cards (one per student)

Markers or Pens

Part Two: plain black cotton cloth, cut or torn into at least eighty rags

b. Preparation: Using the Selected Prairie Inhabitants list, determine how to divide your students into groups. For a class of twenty, the group of prairie primary producers should have 10 members. The groups of prairie primary consumers (herbivores) should have six members. The group of secondary consumers (carnivores) should have two members. The group of omnivores should have two members. For other class sizes, adjust the numbers proportionately. Cut the string into six foot lengths, then tie three of the strings together with a common knot at one end. The string will represent a food web connection between those students holding the ends of the string.

c. Setting: Classroom or large open area, allowing ample space to build an ecosystem food web.

Procedure:

Part One:

a. Divide the students into groups and assign each group a name (primary producers, primary consumers/herbivores, secondary consumers/carnivores and omnivore).

b. Distribute the Selected Prairie Inhabitant list. Assign each student a role as one of the listed plants or animals from their assigned group. Have them print the name of that plant or animal on a piece of paper, and attach it to their clothing over their heart.

c. Give the primary producers three lengths of string, knotted at one end.

d. Ask the plants (primary producers) to gather at the front of the room.

e. Next, have the group of primary consumers/herbivores choose three plants that they would eat. They should take hold of one end of their selected "plant" student's strings, so that they hold three strings. Then ask them to step away from the "plants" so that all the strings are as taut as possible. (Teacher may need to adjust the lengths of some strings so that the web is tight.) For this exercise, each plant only has three strings, so only three herbivores may select that plant as food.

f. Next, have the secondary consumers/carnivores identify what four herbivores they would eat. Provide the herbivores with two sets of three strings, or six strings. Have the carnivores take the end of a string from each, again moving away so that the string is taut.

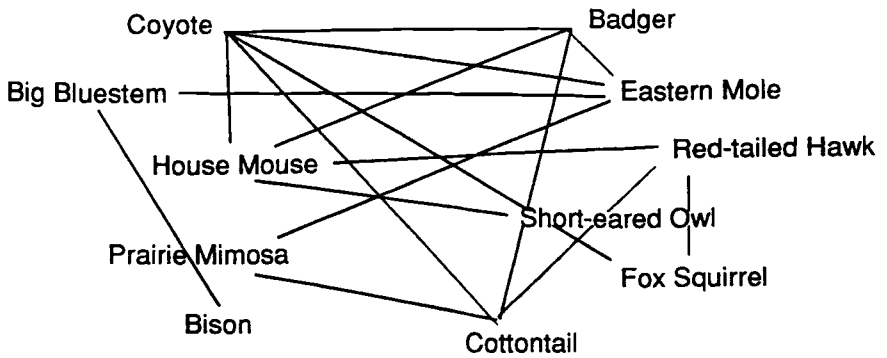
g. Finally, have the prairie omnivores identify what animals and/or plants they would eat. Provide the carnivores with two sets of three strings, or six strings. The omnivores should then select a total of six, and take the end of a string from each, moving away so that the strings are as taut as possible.

h. Ask the students if they think the web is complete. Then stand to one side of the group of primary producers and tell them that you are the missing part of the web. What are you? (The sun.)

i. The students have created a prairie food web.

j. Illustrate how that web would be weakened if any member of it disappeared (for example: the bison is removed). Take the "bison" student from the web, as well as other creatures/plants that depend on the bison, and watch the web disintegrate.

Prairie Web Diagram



Part Two:

a. Have the students form a "pyramid" according to their food web groups. The producers should form a straight line across the front of the class, the herbivores should form a second line, the carnivores a third, and the omnivores a fourth. Center each line with the one before it. For this exercise, all of the producers are a type of grass, all the herbivores are grasshoppers, all the carnivores are shrews and all the secondary consumers are hawks.
b. Place at least ten small black cloths over the shoulders of each "grass."
c. Ask each herbivore (grasshopper) to take two black cloths from the shoulders of each producer which they ate in Part 1.
d. Ask each carnivore (shrew) to take four black cloths from the shoulders of each herbivore they ate in Part 1. (Some rags may need to be torn in two so that all students can take what they need.)
e. Ask each secondary consumer (hawk) to take eight black cloths from the shoulders of each animal they ate in Part 1. (Again, some rags may need to be torn in two!) Have the "hawks" count how many black cloths they have.
f. Explain that the black cloths represent a pesticide such as DDT, that made its way into the water supply and into the producers. As the plants were eaten, this pesticide was passed up the food chain, stored in fatty tissues of animals, concentrating in ever increasing amounts as the consumers ate more and more in order to satisfy their energy needs. This is biomagnification. Eventually, the omnivores and tertiary consumers experience toxic effects of this chemical, even though originally it was not intended to harm them.

Evaluation:

Give each student a list of prairie plants and animals (identified as herbivore, carnivore, etc.), and ask the student to create a mobile which illustrates the prairie food web.

Enrichment:

a. Add decomposers to the food web. Provide a list of probable decomposers for the students to choose from.
b. Add the role of the sun to the food chain from the beginning of the activity. All plant members will be connected to the sun. (The teacher may want to set this up with the Sun as the center of the web, or hub of the wheel.)

Suggested Variations/Expansion Activities

Project WILD: What's for Dinner, Owl Pellets

Selected Prairie Inhabitants list

PLANTS	HERBIVORES	CARNIVORES	OMNIVORES
Big Bluestem	Bison	Badger	Coyote
Little Bluestem	White-tailed Deer	Ferruginous Hawk	Red Fox
Indian Grass	Black-tailed Jack Rabbit	Eastern Spotted Skunk	Gray Fox
Switchgrass	Eastern Cottontail	Long-tailed Weasel	Striped Skunk
Blackjack Oak	Prairie Vole	Least Shrew	Humans
Leadplant	House Mouse	Eastern Mole	Wild Turkey
Blazing Star	Fulvous Harvest Mouse	Upland Sandpiper	Greater Prairie Chicken
Butterfly Milkweed	Plains Pocket Gopher	Bobcat	Franklin's Ground Squirrel
Daisy Fleabane	Woodchuck	Red-tailed Hawk	Bobwhite Quail
Prairie Goldenrod	Fox Squirrel	American Kestrel	Three-toed Box Turtle
Prairie Mimosa	Grasshopper	Common Barn Owl	
Purple Prairie Clover	Monarch Butterfly	Prairie Rattlesnake	
Western Ironweed	Carolina Chickadee	Short-eared Owl	
Dotted Gayfeather	Eastern Wood Peewee	Burrowing Owl	

Topic Seven

A Great Prairie Species: The American Bison and Extinction

Topic Overview: Students study the American bison, its near extinction and relationship with the grassland. In Activity 7A, students learn bison facts in a unique way and then play a game. In Activity 7B, students study why species become endangered or extinct.

Activity 7A: Bison Tic-Tac-Toe

Objectives:
Student will be able to:
(1) name ways in which the Native American Indians used the bison in their culture;
(2) describe the migration patterns of the bison;
(3) describe the bison's appearance;
(4) describe the changes in bison populations from 1830 to 1990; and,
(5) explain how the bison and the grass depended on each other.

Main Ideas: Bison, dominant species, predator, competition, extinction, wallows.

Teacher Note: In Part One of this activity, the students "personalize" some facts about bison. Part Two calls for the class to play a fun game which tests what they remember about bison. You might like to expand their knowledge about bison and relationships in the prairie ecosystem and its inhabitants even further. Example: investigations into the brown-headed cowbird have shown that this species adapted so well to its relationship with the continually-moving bison that the cowbird stopped building nests of its own. Instead, it parasitizes other birds' nests. Further comments about this interesting bird can be found in Topic Nine.

Background Information:

(i) The American Bison is a large grass-eating mammal. It is commonly called the American buffalo although its species name is Bison bison. A male bison may be six and one half feet tall at the shoulder and weigh as much as 2,000 pounds (one ton). Female bison weigh about half that much and are four and one half to five and one half feet tall at the shoulder.

The front end of the bison's body is huge. A large hump behind its enormous head is covered with a shaggy mane of hair. A long beard hangs from its neck.

The bison's heavy fur coat begins to grow in October. The thick fur helps the bison to survive in the bitter cold, windy winters common on the prairie. The shaggy mane and beard provide additional protection. The bison begins to shed its winter coat in clumps during March. The bison uses its huge head and short, black horns to plow through snow to find grass during the winter months.

The bison was a dominant species on the prairie, meaning that it was a key organism

Notes:

Notes:

in the food chain, with a significant impact on the prairie and other species which lived there.

(ii) The lifestyle of the Native American Indian tribes who lived on the prairie centered around the bison. The bison was respected as a fellow inhabitant of the land, and was never killed needlessly. The Native American Indians utilized most parts of the bison's body: the hides were used for tepees and clothing; the meat was eaten both fresh and dried in pemmican; bladders were used to make pouches; and horns and other parts were used to make ceremonial items. The Native American Indians depended upon the bison for survival. The bison's survival depended on grass.

(iii) The grassland ecosystem can not maintain itself without fire. Fire serves to recycle nutrients trapped in the dead grass, adding the ash to the grassland soil. Fire also stops trees from invading the grassland. The Native American Indians would sometimes set prairie fires both to drive the bison to a place where they could be slaughtered, and to attract the bison with fresh growth of short, green grass. This cycle continued successfully for hundreds, perhaps thousands of years. Hunting by the Indians rarely, if ever, threatened the existence of the bison.

(iv) Bison rarely eat prairie herbs and forbs. They prefer specific types of prairie grasses. It is likely that at times the bison overgrazed these grasses. However, the herd would eventually move on to find more grass. This natural rest cycle allowed the grass to recover. Bison are believed to have traveled over 400 miles annually in a random migration to find food. It is believed that when the bison were moving southward, herds as large as a million animals would sometimes travel in single file, wearing ruts in the earth as deep as three feet. The bison grazed in the morning and evening, spending the mid-day hours resting at a watering area. Grasshoppers were their primary competition for food.

(v) Bison like to roll in the dust. This is an effective way to discourage mites and insects from bothering them. It also protects their skins from the hot summer sun. Areas where they rolled were often lower, wetter spots. The compaction of the soil caused depressions which remain on the prairie to this day and are known as buffalo wallows.

(vi) A frequent traveling companion of the bison is the brown-headed cowbird. This native prairie species feeds on the insects which surround the bison. Because the cowbirds travel with the bison, they do not build their own nests, but parasitize the nests of other songbirds on the prairie. This adaptation is believed to be a direct result of their relationship with the bison. Nest parasitism by the cowbird is now a major problem for other birds, as discussed in Topic Nine.

Predators of the bison, when it freely roamed the prairie, included cougars (mountain lions) and wolves (when they freely roamed the prairie.)

(vii) The arrival of the white man disrupted the fire/grass/buffalo cycle. The settlers brought in cattle which grazed most of the prairie plant species, leaving little fuel for prairie fires. Land was cleared or plowed so that it could be used for agricultural purposes. The plowed land also served as firebreaks, disrupting the cycle of fire necessary for this grass ecosystem.

(viii) The invading white men killed the bison for their hides, or for their hump and tongue. Bison were also eliminated in the 1860s and 1870s as part of governmental measures to bring the Native American Indians to dependence upon the government for food.

(ix) Prior to 1830, from 30 to 70 million bison existed in the prairie areas of North America. By 1870, those numbers were reduced to 5.5 million. By 1900, less than 1,000 remained, and two-thirds of those were in northcentral Canada. Extinction was near for the bison for several reasons. In addition to their dependency on grasses, bison congregate in herds, which are easily found; they did not perceive humans with rifles at a long distance to be dangerous; and they have low reproductive rates. In 1994, preserve and refuge bison populations nationwide

Notes:

Materials, Preparation and Setting:

a. Materials:

Topic 7A Background Information (one per student)
Bison Question/Answer Sheet for Tic-Tac-Toe (Topic 7 materials)
Paper and pencils
Classroom map of the United States
Chalk

b. Preparation: Draw Tic-Tac-Toe grid on blackboard. Designate square categories as drawn below. Categories are: Movement, Size, Characteristics, Food, Numbers, Uses, Extinction and General .

Movement	**Size**	**Characteristics**
Numbers	**Food**	**Extinction**
General	**Uses**	**Numbers**

c. Setting: Classroom, and "game show" set.

Procedure:

Part One:

a. Distribute a Topic Seven Background Information sheet to each student. Read through this sheet with the class, stopping at points listed below to expand the learner's knowledge.

b. After reading paragraph (i) expand the concept of the quantity "one ton/two-thousand pounds." Arbitrarily decide the average weight of a member of your class. (Examples: 4th-graders - 80 pounds; 5th graders - 90 pounds; 6th graders - 100 pounds; 7th graders - 110 pounds; 8th graders - 120 pounds). Tell students this average weight, then ask them to determine how many students in their class it would take to total 2,000 pounds, or one ton. By some quick division (example: 2,000 divided by 100= 20) determine how many students together weigh as much as one bison. Have twenty members of the class come to the front of the room and stand very close together. This group of students represents the weight of one full-grown, male bison.

c. After reading paragraph (ii) expand the idea of Native American uses of the bison. Ask the students to sketch an article of clothing that they would like to make from a bison hide, or how many bison hides it would take to create a teepee large enough for their family. Ask them to name a meat dish that they might make with bison meat (instead of beef, chicken or fish). Ask them what type of pouch, purse or bag they would make from the bison's bladder and how they might decorate it. Finally, ask them to design a decorative piece of ceremonial jewelry using the bison's horn or part of it.

d. After reading paragraph (iv) expand the concept of (1) the distance 400 miles, and the concept of (2) one million animals walking single file. For (1), using a state map, determine a city 100 miles from your home, then have the students think of a city they think would be four times that far. Then, give them the names of some places that actually are 400 miles from your home. Point them out on a classroom map of the United States. For (2) tell the students that the average length of a full-grown buffalo (standing 6 1/2 feet high and weighing nearly one ton or two thousand pounds) is eight feet. Ask them to calculate the following: if one million buffalo were standing nose to tail, with no spaces in between, how many feet long would the line of buffalo be? (8,000,000 feet) How many miles long? (1,515.5 miles). If the first bison were standing with you, where might the end of the line of bison be?

e. After reading paragraph (ix) expand the relationship of the quantities of 30 to 70 million, 5.5 million and 1,000 bison by having the students each create a bar graph to illustrate this comparison. Example: If 1,000 were 1/2 inches long on the graph, how many inches long would 30 millions be? 70 million? 5.5 million? Have them create one bar on the graph for each of these quantities. Students may choose to use a symbol instead of an inch measurement (i.e. one thousand bison might be one circle, star, cross, etc.)

f. Further expand the understanding of the time period by using the timeline, noting other historical occurrences from 1830, 1870, and 1900. (Presidents, U.S. states, etc.)

Part Two:

a. Divide the class into teams of no more than six members each.

b. Draw lots to determine which two teams will play "Bison Tic-Tac-Toe" first, and which of those two teams will start the game (as X).

c. Ask the first team to select a square and state the category of the question, then ask them a question from that category. Questions must be answered WITHOUT use of the fact sheet. If the question is answered correctly, place an "X" on that square on the chalkboard. If answered incorrectly, the space remains blank, and is available for either team to use in future play (with a different question).

d. Ask the second team to select a square and state the category, then ask the team a question from that category. If the question is answered correctly, place an "O" on that square of the chalkboard. If answered incorrectly, the space remains blank.
e. Continue this process until one of the teams scores three "X's" or "O's" in a row. The bison wins the game if neither team is able to complete three-in-a-row.
f. Have the winning team play again with a new competing team. Continue this procedure until all teams have played at least once. When the "Bison" wins the game, let two new teams play the game.

NOTE: While playing the game, the teacher should avoid asking the same question twice unless all questions in that category have previously been asked.

Evaluation:

Give each student one of the Word Search sheets (Topic Seven materials). Ask the student to:
(1) complete the Word Search, finding words which are related to the buffalo; and;
(2) complete the questions below the Word Search, filling in the blanks with the correct word.

Enrichment:

a. Ask the student to prepare an illustrated poster, displaying the many uses which the Native American Indian had for the bison.
b. Have the student learn more facts about the American bison and share them with the class. Example: Bison eat about 3 percent of their body weight per day. How many pounds of grass would a bison eat per year if it weighed 2,000 pounds?

Notes:

Bison Question/Answer Sheet for Tic-Tac-Toe

Movement

1. How many miles do we believe the bison traveled in its migration? *400 miles*
2. How often did the bison migrate? *Every year or annually*
3. How large might a herd of migrating bison have been? *One million animals*
4. Did the bison follow a typical migration route? *No. Migration was probably random*

Size

1. What was the average height at the shoulder of an adult male bison? *6 1/2 feet*
2. What was the average weight of an adult male bison? *2,000 pounds (one ton)*
3. In comparison to the adult male bison, how large was the adult female? *Half as big*

Characteristics

1. What physical characteristic of the bison offered protection against cold winters? *A heavy fur coat*
2. How did the bison manage to reach grass covered with snow? *He used his short horns and huge head to sweep snow away.*
3. Because the bison had a significant influence on the other species in his ecosystem, it is called? *Dominant species*

Food

1. What type of food did the bison prefer? *Grass*
2. What important prairie interaction is required to keep food available for the bison? *Fire*
3. Name one of the three ways that the white settler disrupted the grassland cycle? *They created firebreaks in three ways: (1) cleared land; (2) plowed land; (3) brought cattle in to graze.*

Numbers

1. How many bison are believed to have lived in N. America prior to 1830? *30 to 70 million*
2. How many bison are believed to have been living in N. America around 1870? *5.5 million*
3. How many bison existed in N. America in 1900? 1,000

Uses

1. Name two things bison hides were used for by the Native Americans. *Teepees/clothing*
2. What did the Native Americans use the bison bladder for? *Water pouches, toys*
3. What part of the bison body was used to make ceremonial items? *Horns, skulls*
4. Food made from dried bison meat and fat is called? *Pemmican*

General

1. Name the shallow depressions where bison rolled in the dirt. *Buffalo wallows*
2. What is the name of the bird which sometimes migrated with the bison? *Brown-headed cowbird*
3. Name one of the two animals (other than man) which were predators on the prairie in the 1800s ? *A cougar or mountain lion, a wolf*

Extinction

1. Name one of four possible reasons why the bison nearly became extinct. *Answers are: (1) dependency on grasses, (2) congregate in herds, (3) didn't see men with rifles at a great distance as a threat, and (4) low reproductive rates.*

WORD SEARCH

E S H O R T B L A C K H O R N S Z
A X L N D R F O U R H U N D R E D
P Y K E Q I Z H U G E H E A D V O
F B R T N C B E W F U R T O A E P
O C L O T H I N G O S U H K R N O
P E O N F O N E T H L U O A A T U
F R O W A L L O W P X F U N N Y C
I E A J B H C F F I R E S S D M H
V M G I Y I O O A U X O A T O I E
E O A R R N R M U Z R H N R M L S
M N W N A I F D V G M C D L I L N
I I T I X S E L O U A F O R R I B
L E F I R C S L A R C R A A E O D
L S A O T E E P E E S L R I T N S
I E P F O Y F O U R H U N D R E D
O S K U T D A N N U A L H U A C I
N D C L W D A S K U L L V M S O J

GRASS	SEVENTY MILLION	COWBIRD	PRAIRIE
WOLF	COUGAR	WALLOW	FIRE
ONE TON	ONE THOUSAND	FIVE MILLION	FOUR HUNDRED
FUR COAT	CLOTHING	ANNUAL	RANDOM
TEEPEES	FOOD	POUCHES	CEREMONIES
	SHORT BLACK HORNS	HUGE HEAD	

1. Estimated number of Bison in North America prior to 1830. _____
2. Estimated number of Bison in North America in 1870._____
3. Estimated number of Bison in North America in 1900._____
4. Estimated miles bison traveled in migrations._____
5. Timing of the bison's migration._____
6. Pattern of the bison's migration._____
7. Five ways the Native American Indian used the bison in their culture._____,
_____, _____, _____, _____.
8. Four physical characteristics of the bison. _____, _____,
_____, _____.
9. The bison's food. _____
10. A bird which sometimes accompanies the bison. _____
11. Where the bison roamed freely. _____
12. Two animals which ate bison (predators). _____
13. Depressions in the earth where the bison rolled in mud. _____
14. The natural event and prairie interaction which maintained the grasses for the bison. _____

WORD SEARCH KEY

E	**S**	**H**	**O**	**R**	**T**	**B**	**L**	**A**	**C**	**K**	**H**	**O**	**R**	**N**	**S**	Z
A	X	L	**N**	D	R	**F**	**O**	**U**	**R**	**H**	**U**	**N**	**D**	**R**	**E**	**D**
P	Y	K	**E**	Q	I	Z	**H**	**U**	**G**	**E**	**H**	**E**	**A**	**D**	**V**	O
F	B	R	**T**	N	C	B	E	**W**	F	U	R	**T**	O	A	**E**	**P**
O	**C**	**L**	**O**	**T**	**H**	**I**	**N**	**G**	**O**	S	U	**H**	K	**R**	**N**	**O**
P	**E**	**O**	**N**	F	O	N	E	T	H	**L**	U	**O**	A	**A**	**T**	**U**
F	**R**	O	**W**	**A**	**L**	**L**	**O**	**W**	P	X	**F**	**U**	N	**N**	**Y**	**C**
I	**E**	**A**	J	**B**	H	**C**	F	**F**	**I**	**R**	**E**	**S**	S	**D**	**M**	**H**
V	**M**	**G**	**I**	Y	**I**	O	**O**	A	**U**	X	O	**A**	T	**O**	**I**	**E**
E	**O**	A	**R**	**R**	N	**R**	M	**U**	Z	**R**	H	**N**	R	**M**	**L**	**S**
M	**N**	W	N	**A**	**I**	F	**D**	V	**G**	M	**C**	**D**	L	I	**L**	N
I	**I**	T	I	X	**S**	**E**	L	O	U	**A**	F	**O**	R	R	**I**	B
L	**E**	**F**	I	R	C	**S**	L	A	R	C	**R**	A	**A**	E	**O**	D
L	**S**	A	**O**	**T**	**E**	**E**	**P**	**E**	**E**	**S**	L	R	I	**T**	**N**	S
I	E	P	F	**O**	Y	**F**	**O**	**U**	**R**	**H**	**U**	**N**	**D**	**R**	**E**	**D**
O	S	K	U	T	**D**	**A**	**N**	**N**	**U**	**A**	**L**	H	U	A	C	I
N	D	C	L	W	D	A	S	K	U	L	L	V	M	S	O	J

GRASS	SEVENTY MILLION	COWBIRD	PRAIRIE
WOLF	COUGAR	WALLOW	FIRE
ONE TON	ONE THOUSAND	FIVE MILLION	FOUR HUNDRED
FUR COAT	CLOTHING	ANNUAL	RANDOM
TEEPEES	FOOD	POUCHES	CEREMONIES
	SHORT BLACK HORNS	HUGE HEAD	

1. Estimated number of Bison in North America prior to 1830. **seventy million**
2. Estimated number of Bison in North America in 1870. **five million**
3. Estimated number of Bison in North America in 1900. **one thousand**
4. Estimated miles bison traveled in migrations. **four hundred miles**
5. Timing of the bison's migration. **annual**
6. Pattern of the bison's migration. **random**
7. Five ways the Native American Indian used the bison in their culture. **teepees, food, clothing, pouches, ceremonies**
8. Four physical characteristics of the bison. **short black horns, huge head, one ton, fur coat**
9. The bison's food. **grass**
10. A bird which sometimes accompanied the bison. **cowbird**
11. Where the bison roamed freely. **prairie**
12. Two animals which ate bison (predators). **wolf, cougar**
13. Depressions in the earth where the bison rolled in mud. **wallow**
14. The natural event and prairie interaction which maintained the grasses for the bison. **fire**

Activity 7B: How Many Whatzits?

Objectives:
Student will be able to:
(1) define carrying capacity, and limiting factor;
(2) explain the difference between animals which are extinct and those which are endangered, giving two examples of each; and,
(3) list at least five things which might be limiting factors for a given species.

Main Ideas: Extinction, endangered species, threatened, rare, limiting factor, carrying capacity, range.

Teacher Note: In this activity the learner does a lot of supposing. Knowing actual numbers for limiting factors, etc., is much less important than understanding WHY anmal populations have natural limits. In order to anwer possible student questions, the teachers should have an understanding of the causes of extinction, including the fragility of ecosystems and the nonadaptability of many species.

Background Information:

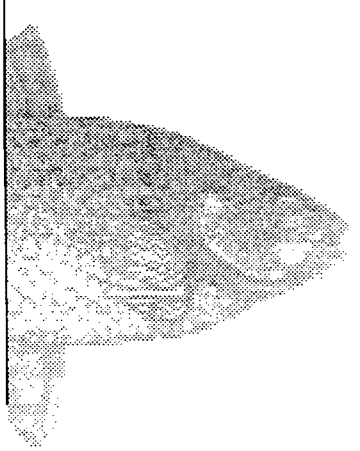
The American Bison successfully returned from near extinction in the 1890s. Extinction is when living individuals of that kind of animal no longer exist. In 1900, only about 1,000 bison remained. Public awareness of the bison's plight, and the foresight of several individuals who placed the animals on refuges, were responsible for saving the bison. Unfortunately, other species of plants and animals in North America have not been so lucky. Examples of species which have become extinct during the last century include: the Passenger Pigeon (before 1900), the Mission Blue Butterfly, and the Dusky Seaside Sparrow (since 1980).

Extinction is a natural process which usually occurs over long periods of time. Of the estimated 500 million species of plants and animals that have existed since life began on the earth, only about 2 to 4 million are alive today. Unfortunately, this natural process has been greatly accelerated by human activities, particularly over the last 400 years.

The Endangered Species Act of 1973 was the first legislation which successfully offered protection to species which were in danger of becoming extinct due to human activities. An Endangered species is any species of plant or animal which is in danger of extinction throughout all or a significant portion of its range (that area which the animal frequents to find food, water and shelter). Many other animals are listed as threatened. Threatened species are those likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Often, threatened animals are also described as rare. Worldwide, a rare species is any plant or animal that occurs in low numbers in its natural range.

In 1994, 1000 species have been recognized as endangered or threatened with extinction.

Notes:

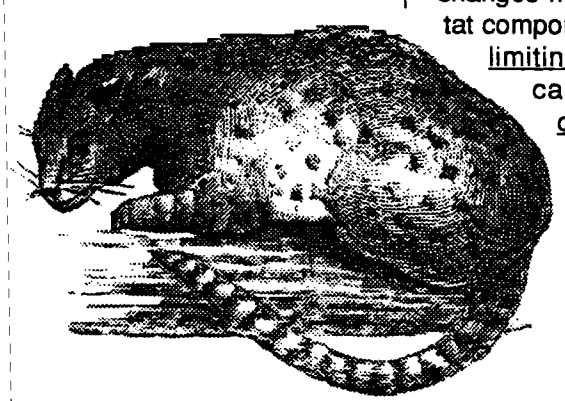


Notes:

Twenty of these are insects (mostly butterflies); ninety are fishes (mostly in the desert southwest); 120 are reptiles or amphibians; and 300 are mammals (including whales, many species of deer, many species of apes and monkeys, many large cat species, and other large land animals like the elephant). In the United States, species on the Endangered Species List include the Gray Wolf, the Florida Panther, and the Spotted Owl.

In Oklahoma, as of 1992, seventeen wildlife species (seven mammals, eight birds, one mussel and one insect) have been officially listed by the federal government as endangered. Two birds, three fish and one reptile species have been classified as threatened. Additionally, one freshwater mussel, one cave crayfish and one longnose darter species have been listed as state endangered and two fish as state threatened.

Extinction in most cases is caused by rapid and widespread environmental changes which don't allow the species the time needed to change or adapt. These changes may cause one habitat component to emerge as a limiting factor. This may cause the carrying capacity of the environment to change, so that not as many, if any, members of the species can survive. Historically, extinctions have been caused by climatic changes, the most drastic probably due to asteroids striking the earth. In the past 200 years, environmental changes are most often caused by human activities. These activities include poaching, destruction of wildlife habitats, draining of wetlands, pollution, and herbicide and pesticide use. An additional threat includes the introduction of an exotic species. This is a species which is not native to the area, and therefore has no natural predators or limiting factors in their introduced environment.



Why does it matter if species become extinct? It matters because that species occupied a unique niche in its habitat and ecosystem. As we have observed during our studies of ecosystems, including food chains and webs, the gap left by the disappearance of an animal or plant species will significantly affect other species. This is the ecological effect of extinction. In addition, these species have esthetic value in their beauty. They also may have educational, historical, economic and recreational values. Last, but not least, the species may have scientific value, found through research, that may provide medical or agricultural breakthroughs which can increase the quality of life for humans.

Materials and Setting:

a. Materials:

Imagination
Paper
"How Many Whatzits Can Live Here?" form (Topic 7 materials)
Habitat Change cards, copied and cut apart (Topic 7 materials)
List of Animals (your choice) written on blackboard or copied on paper
1994 Oklahoma Endangered Species List (Topic 7 materials)
1994 Selected Endangered Species List - USA and Oceania (Topic 7 materials)
Selected Extinct Animals list (Topic 7 materials)
Pencil

b. Setting: Classroom.

Procedure:

a. Have each student make a list of all the reasons that an animal might die. (too old, too cold, too hot, no food, no water, no shelter, no space, too many predators, disease, fire, flood, earthquake, not enough males or females, babies not born, etc). Compile this list on the blackboard or on a transparency.
b. Identify these things as possible "limiting factors" for a species. Note that for any given area, when the population reaches a certain number, there will not be enough food, water, shelter, etc. for any more animals to live. This number is called the carrying capacity of an area.
c. Distribute the form "How Many Whatzits Can Live Here?"
d. Distribute a List of Animals you have prepared (copies or blackboard).
e. Ask the students to select an animal from the List of Animals. It should be an animal that they are somewhat familiar with. Ask them to fill out the "Whatzit" form for that animal. NOTE: They may not know the exact numbers called for, and it is not necessary that the numbers be correct. They simply need a number to work with. This may take some time and thought on each student's part.
f. Once they have completed this section of the chart, have them select a Habitat Change Card. Under the proper column on the "Whatzit" form, have them note how the change will affect their chosen animal.
g. Have them answer the following questions:
    a. If this habitat change only lasted for a week, would the animals all die?
    b. If this habitat change lasted for a year, would the animals all die?
    c. If this habitat change took place very slowly, how might the animal change in order to continue to survive?
h. Distribute the 1994 Oklahoma Endangered Species List and 1994 Selected Endangered Species List (Topic 7 materials). Discuss the animals listed and the causes for their endangerment.
i. Distribute the Selected Extinct Animals list (Topic 7 materials). Discuss animals on the list and the reasons we believe they became extinct.

Evaluation:

(1) Ask the students to write an essay, newspaper article, scientific report, etc. dated A.D. 2020. They should select an animal from one of the Endangered Species lists and write as if this animal had become extinct. This may be written either as if the animal wrote it, or as if the student was the investigator assigned to tell the world how and why it happened. The information should include comments about the concepts of carrying capacity and limiting factor.

(2) Ask the students to explain the difference between animals which are extinct and those which are endangered. Give two examples of each.

(3) List at least five things which might be limiting factors for any given species and the habitat component which they affect.

Enrichment:

a. Have the student complete the "Whatzit" form and activity with homo sapiens (humans) as the animal.

b. Investigate one of the species on the Endangered Species List and accurately complete the "Whatzit" form for that species.

Suggested Variations/Expansion Activities

Project WILD Muskox Maneuvers; Here Today, Gone Tomorrow

Notes:

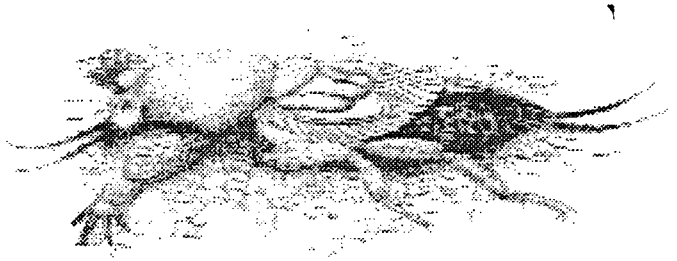


Illustration: James Lish

How Many Whatzits Can Live Here?

Name of Animal:

Characteristic	Estimated Fact	Habitat Change	Result
Usual life span (example: 5-10 yrs)			
Preferred temperature range (example: 32-95deg.)			
Food requirement per day (example: an owl might eat four mice/day)			
Water requirement per day (example: an owl might drink one quart of water per day)			
Habitat/Shelter requirement (examples: one cave, one oak tree, one hole in a mud bank)			
Space limits (examples: only four nests per tree, one bear den per cave)			
Age at which animal can first have babies: (example: six months, one year, two years)			
Number of young born at a time (example: litter of six, usually twins, or single births)			
How often an animal can give birth (examples: once per year, every two months, once in five years)			
Does this animal hibernate? If so, from what month to what month?			
Does this animal migrate? If so, how far each year and to where?			

Habitat Change Cards

Wildfire burns across area unchecked for two days.	Cloudburst drops 12 inches of rain in one hour. Rivers and creeks in area flood their banks and mudslides occur.
Earthquake strikes area, uprooting trees, causing cracks in the earth and avalanches.	Volcano erupts in area, lava spreads over the countryside.
An animal immigrant to the area brings in a disease which this group of animals is not immune to, and an epidemic begins.	Settlers to the area bring in domesticated animals which are allowed to feed in this animal's territory on the same food it prefers.
An asteroid strikes nearby.	An atomic bomb goes off somewhere nearby.
A disease kills half of the females in the group which are able to bear young.	Poachers enter the area and begin to destroy twenty animals per day for their hides & horns.
A cold front passes through, dropping temperatures 15 degrees below normal for about a week.	The summer is unnaturally hot, even though rainfall amounts are normal, temperatures are 20 to 30 degrees hotter.
A year-long drought occurs, with little or no rainfall for that period. Most streams, creeks and ponds dry up and major rivers have less water.	Winter snowfall is three times the normal amount. Thirty inches fall instead of ten, and cold temperatures keep the snow on the ground. No melting for six months.
Major housing development occurs. Forests are cut down for homes and grassland is plowed up and used for farming.	A large factory is built nearby, with land paved for parking lots, and daily air and water pollution occuring due to smokestacks.
A large shopping mall is built nearby, with land paved for parking lots and restaurants, and daily noise and air pollution from automobiles.	A national park is designated in the area. Camping sites are marked out, electricity installed, brick grills are built and roadways paved.

Habitat Change Cards

A local environmental group adopts this animal and begins to provide additional food and shelter to ensure its survival.	Forest lands which were previously clearcut are returned to a natural state by a new owner.
A state park where this animal lives changes usage options, and restricts use to hiking and primitive camping only.	The Nature Conservancy purchases land in the area where your animal lives and designates that land as a preserve.
Your animal is declared an endangered species and now is protected throughout the region.	Hunting restrictions are placed on your animal which restrict hunters to only one female killed per annual season.
Farmland adjacent to the area where your animal lives is allowed to return to its natural state.	Landowners whose nearby land had been set aside for a toxic waste dump loses their permit, and use of the land is halted pending results of a hearing.
A new housing development is being considered, but development is delayed for five years.	Mining company has stopped production and now must meet federal requirement to rehabilitate the land.

1994 Oklahoma Endangered Species List

Species	Reason for Endangerment
Gray Bat	Human disturbance, pesticides and loss of habitat due to flooding by man-made impoundments. Their habit of congregating in only a few caves makes them especially vulnerable to these factors.
Indiana Bat	Commercialization of their hibernating caves, pesticides and human disturbance. Changes in cave climate, caused by impeded airflow, have made many winter bat shelters unsuitable.
Ozark Big-Eared Bat	Loss of habitat, vandalism and human visitation to maternity roosts and hibernating caves.
American Peregrine Falcon and Arctic Peregrine Falcon	Pesticides, nest destruction and poaching.
Black-Capped Vireo	Nest parasitism by brown-headed cowbirds and loss of habitat due to urban development, mismanaged grazing, brush control and plant succession.
Whooping Crane	A migratory resident of west-central Oklahoma. Loss of wintering and breeding habitat, shooting, specimen-collecting and general human disturbance.
Interior Least Tern	Widespread loss and alteration of its nesting habitat.
Red-Cockaded Woodpecker	Forestry operations, widespread cutting of old growth timber, plant succession (change from pine savannah to regrowth oak).
Longnose Darter	Preferred habitat of this fish varies with the season. Loss of habitat due to reservoir construction and pesticides are major threats.
Cave Crayfish	Destruction of habitat. Species is entirely dependent upon living in subterranean streams and pools.
Ouachita Rock Pocketbook	A freshwater clam, pollutants become concentrated in their body tissues. Harmed by polluted and turbid waters (habitat).
American Burying Beetle	Habitat loss, disease and pesticides.
Neosho Mucket	A freshwater mussel which is disappearing, not abundant anywhere. Reasons unknown.

1994 Selected Endangered Species List
(USA and Oceania)

Species	Location	Reason for Endangerment
Spotted Owl	Pacific Northwest mature forests	Logging, habitat destruction.
Black-footed Ferret	Plains States	Specialized diet of prairie dogs only, prairie dog towns destroyed.
Attwater Prairie Chicken	Gulf Coast of Texas	Habitat destroyed by human development.
California Condor	California	Low reproductive potential, only one chick born every two years.
Kirtland's Warbler	Michigan's lower peninsula. Jack pines 5-8 years in age.	Habitat destroyed by development.
Peregrine Falcon	Open country, along rivers, near lakes and the coast, sometimes nests in urban areas on skyscrapers.	DDT caused thin-shelled eggs, embryos did not survive to be born.
Blue Whale Bowhead Whale Gray Whale Sperm Whale Sei Whale	Oceania	Excess fishing, pollution of habitat.
Hawaiian Birds	Hawaii destruction.)	Introduction of domestic dogs and cats by people who came there. Also rats, barn owls and mongooses. (Predation, habitat
Florida Panther	Florida	Habitat destroyed by man for development and for agricultural purposes.
Manatee	Florida Everglades	Habitat destroyed by man for development and for agricultural purposes.
Masked Bobwhite Quail	Arizona	Habitat damaged by overgrazing.

Selected Extinct Animals

Extinct before 1900

Mammals	Birds
Quagga (zebra-like) - South Africa	Great Auk - Newfoundland
Blaawbok (antelope) - South Africa	Dodo - Mauritius Island, Indian Ocean
Steller's Sea Cow - Bering Sea	Moa - New Zealand
Atlas Bear	Labrador Duck
Cape Lion	Spectacled Cormorant
Antarctic Wolf - Antarctica	Seychelles Green Parakeet

Extinct since 1900

Mammals	Birds
Barbary Lion	Passenger Pigeon - North America
Bubal Hartebeest	Carolina Parakeet - North America
Rufous Gazelle	Huia (crowlike) - New Zealand
Long-eared Kit Fox	Pink-headed Duck
Tasmanian Wolf (thylacine) - Tasmania	Auckland Island Merganser - Auckland Is.
White-tailed Rat	Dusky Seaside Sparrow

Topic Eight

Humanity and this Last Great Place: Prairie Ecology

Topic Overview: Students study the effects of fire and grazing on grassland, and how fire and grazing relate to prairie ecology. In Activity 8A, students compare burned and unburned grassland. In Activity 8B, students compare the variations in temperature, moisture, soil and vegetation which occur in different areas of the same grassland, and consider how those variations affect vegetation and wildlife.

Activity 8A: Fire!

Objectives:
Students will be able to:
(1) Compare and contrast the appearance of a recently burned grassy area and an unburned area; and,
(2) Explain why the appearance of the two grassy areas is different.

Main Ideas: Fire, grazing, herbivores, litter, woody plants, prescribed burns.

Teacher Note: Activities in this topic center around a field trip to the Tallgrass Prairie Preserve in Osage County, Oklahoma. Teachers who are unable to travel to the Tallgrass Prairie Preserve can successfully complete this activity by finding an area nearby which has been burned within the past year. Such a location may be found by contacting your local fire department or Soil Conservation Service office. The comparison visit may be made after the new grass has grown for two months or longer. If a field trip is not possible, the teacher could make the required observations and offer them for class discussion. Teachers should consider seasonal changes in prairie grasses when scheduling this activity, and also the presence of moisture (especially in the form of dew) at the field trip location. It is also suggested that the teacher have on hand several field guides which would assist interested students in identifying wildlife and plants at the site. See the Reference section for suggestions.

Background Information:

Section 1: Fire -

Fire is a natural part of a grassland ecosystem. It is one of the many interactions which allows grass to remain the dominant vegetation type. Without fire, the prairie might be invaded by shrubs and eventually trees. Such invasions are obvious throughout the former grasslands of central Oklahoma.

Fire modifies the grassland environment. It removes litter (dead, slightly decayed organic material on top of the soil surface). This allows more light to penetrate to the soil, thus causing an earlier warming of the soil in the spring. Nutrients released by burning accumulated dead plant material aid plant growth.

Because grasses and prairie forbs have extensive root systems, they regenerate

Notes:

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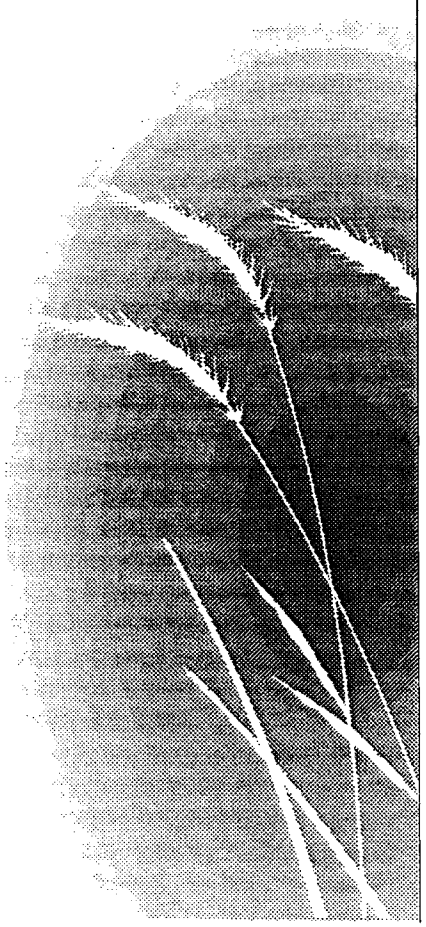

rapidly after a burn. Depending on what time of year the fire consumes the upper portion of the plant, the life cycle of the grass may be negatively or positively affected. Among the Big Four tallgrass prairie grasses, Little Bluestem should be burned while the plant is still dormant in early spring. Late spring burning favors Big Bluestem, Indiangrass and Switchgrass. Repeated burning favors Indiangrass.

Fire moves rapidly and soil is a good insulator, so the heat does not penetrate deeply into the earth. Soil temperatures increase very little a centimeter or less below the soil surface. However, woody plants may be heavily damaged by fire. These are higher plants like trees which have complex tissues and greater structural support. Fire stimulates seed production and germination, particularly of plants which are native to fire-prone areas.

Historically, prairie fires were started by lightning. Sometimes, Native Americans started fires for the purpose of later drawing bison to areas where the tender, young grass was growing. Ranchers discovered that fire assisted in nutrient recycling on grasslands, and instead of inhibiting its natural occurrence, fire became an important tool in managing grasslands. Fires set for ecological management reasons are known as prescribed burns.

Most prescribed burns are set during the dormant season (late March to early April) when conditions allow for fire control (high relative humidity, low wind speed and temperatures below 70 degrees). This is because: (1) the ground is cool and moist; (2) most plants are still dormant; (3) few birds have begun nesting; and (4) reptiles and amphibians are still hibernating.

Fires in summer do extensive damage to woody species. Grasses will burn to the ground thereby losing carbohydrate reserves. Some nutrients cycle back to the root systems when ashes return to the soil.

Preparation for a prescribed burn is a complex and time consuming task. Precautionary measures are taken to insure that the burn does not get out of control.

The fate of prairie animals is mixed in a fire. Burrowing animals take shelter in insulated, underground homes. Other species can run or fly away easily. However, snakes and small four-legged animals are sometimes killed, as are small birds, and larvae of butterflies and other insects. Most species which are native to grasslands have adapted to survive fires.

Section 2: Grazing -

Grazing - Grasses and many other prairie plants are designed to be grazed. Plants thrive as long as only a portion of the above ground plant is removed, preferably about half of the stem and leaf portion. Herbivores (animals which feed on plants) have several stomachs filled with bacteria

necessary to digest plant material.

Different species of grazing animals prefer different types of plants. They graze the plants which they desire and leave the others. Bison prefer grasses, while cattle will also feed upon forbs (broadleaf, nonwoody plants, such as compassplant) which grow among the grasses. If these grazing animals are restricted in the land they can graze, they will overgraze the plants they prefer. This prevents the grass from producing new stems and leaves. Eventually it will die.

When herds of grazing animals are being managed successfully, part of the management plan includes moving the herd from pasture to pasture as needed. This allows the recently grazed grasses and plants to recover.

Notes:

Materials and Setting:

a. Materials:

Burn Area Comparison Charts (Topic 9 materials)
Pens or pencils
Soil pH testing kits or Litmus paper

b. Setting: Outside. Grassland area or the Tallgrass Prairie Preserve.

Procedure:

a. Discuss fire with the students, making note of what they consider to be good and bad things about fire. Include discussion about the previous Prairie topics in this curricula which have mentioned the role of fire in prairie ecology.
b. Visit the prairie or a local grassland which has been burned. Fill in the related sections on the comparison chart and perform soil pH tests.
c. Visit another section of prairie or local grassland which has not been burned. Fill in the related section on the comparison chart and perform soil pH tests.
d. Conduct a comparison of the burned and non-burned sites, using the completed comparison chart.

Evaluation:

Ask the students to write a one-to-two page summary of what they discovered during this comparison. This should include:

(1) a comparison and contrast of the characteristics of a recently burned grassy area with that of an unburned area of grass, including vegetation present, wildlife present, and soil differences;
(2) an explanation of why the appearance of the two grassy areas differs; and,
(3) comments about how the fire might have affected plant growth, animals, birds, and insects in the area.

Enrichment:

Ask the student to research periodicals to discover the current state of vegetation and wildlife in Yellowstone National Park following the extensive fire of 1988. Have him/her prepare a report and present it to the class either orally or visually.

Burn Area Comparison Chart

	Burned Area	Non-burned Area
Soil Color/Appearance pH		
Vegetation Present a. Trees b. Shrubs c. Grasses	Height # Seed Heads	Height # Seed Heads
Wildlife/Wildlife Evidence Present (includes tracks) a. Animals b. Birds C. Insects		

Activity 8B: Prairie Hi-Lo

Objectives:
Students will be able to:
(1) compare and contrast the habitat variances in four sites located in one section of grassland; and,
(2) explain how differences in light, soil, water and temperature might affect the amount and types of vegetation and wildlife present.

Main Ideas: Prairie mosaic, humidity, soil pH.

Teacher Note: Prior to this activity, the teacher should locate a grassland site with variations in vegetation and elevation. If it is not possible for the class to visit the site together, the teacher should collect the necessary information and provide it to the students as they perform the comparison in the classroom. The comments made in the Teacher Note for Activity 8A also apply here.

Background Information:

The Tallgrass Prairie is a very diverse ecosystem, with a great variety of plants and animals. On the Tallgrass Prairie Preserve, more than 900 types of plants have to date been identified. These plants include grasses, shrubs, forbs, and herbs. Wildlife species include 300 identified species of birds, 80 identified species of mammals and uncounted species of reptiles, amphibians and insects.

The diversity found in the prairie is due to the subtle changes in habitats. These various habitats are the prairie mosaic, caused by fires blown about by the wind, and by uneven grazing. The grasses across the prairie are not of uniform height or thickness, and neither is the soil, or the availability of water and light. All these differences allow for an immense variety of plant and animal species which make up this diverse ecosystem.

Some differences which can be discovered include temperature, humidity (the amount of water vapor in the atmosphere), soil pH (degree of acidity or alkalinity of the soil), types of vegetation, quantity and types of birds, quantity and types of mammals, presence and amount of water, as well as light intensity. Each of these factors interacts with the others to provide specific habitats and niches which are filled by the many prairie species.

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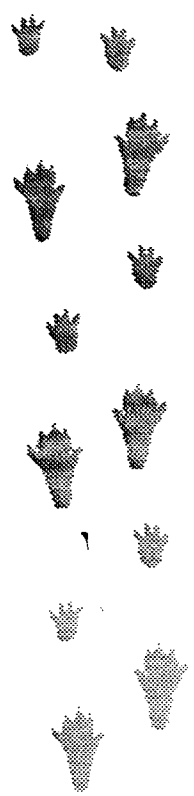

Materials and Setting:
a. Materials:
Habitat Variance Survey (Topic 8 materials)
Thermometer
Soil pH test kits or Litmus paper

b. Setting: Outside. Grassland area or The Tallgrass Prairie Preserve.

Procedures:

a. Visit the prairie or a local grassland area.
b. Select four different locations at the grassland site. This exercise works best if there is a variety in vegetation and/or elevation at the four locations. Example: Select one site at a flat, open area; second site halfway up a grass covered hill, north slope; third site at the top of a grass covered hill, facing south; and fourth site beside a tree-shaded stream.
c. Perform Soil pH tests at each site using pH testing kits or Litmus paper.
d. Take air and soil temperatures at each site.
e. Perform soil, water, wind, slope and wildlife observations at each site.
f. Estimate the height of grasses, trees and forbs at each site while completing vegetation observations.
g. Discuss the variations in the sites with the students and consider the following questions:
   Which area has the highest air temperature? the lowest?
   Which area has the highest soil temperature? the lowest?
   What might cause the variety of temperatures among the sites?
   Which area has the most acidic soil? the most alkaline soil?
   What might cause the variety in soil pH among the sites?
   Which area had the most visible water present? the most evidence of water?
   How did the wind speed vary in the different locations? Can you guess why?
   Estimate the area which had the greatest slope. The least slope.
   Estimate the area with the most sunshine. The least sunshine.
   Which area appears to have the most wildlife present?
   What causes more wildlife to be present in specific areas?
   Which area has the tallest grasses? Trees? Forbs? Can you explain why these areas have taller vegetation?
   Which area has the most vegetation? the least?
   Which area has the greatest variety of vegetation?
   What causes there to be a difference in vegetation present?
   What is the relationship between slope, temperature and abundance of vegetation?

Evaluation:

Ask the students to write a summary of what they discovered during this comparison. They should:

(1) compare and contrast the habitat variances in the four sites;
(2) explain how differences in soil, water, wind and slope might affect the amount and types of vegetation present; and,
(3) explain how differences in soil, water, wind and slope might affect the amount and types of wildlife present.

Enrichment:

a. Have the student perform a similar habitat variance study in another type of ecosystem, i.e. forest, wetland.
b. Ask the student to perform a habitat variance study around his/her home. He/she should look at sites on the north, south, east and west side of his/her home or apartment building, taking temperatures and making observations both in the morning and evening.

Suggested Variation/Expansion Activities

Project Learning Tree:	Field, Forest, Stream; Living with Fire
Project WILD:	Smokey Bear Said What?; Fire Ecologies

Habitat Variance Survey

	Site 1	Site 2	Site 3	Site 4
Air Temperature				
Soil Temperature				
Amount of Light				
Soil pH				
Soil Color/ Appearance				
Percent of Sand in Soil				
Water Source Present? Y/N				
Evidence of Water Present? Y/N				
Clouds Present? Y/N				
Wind Speed (compared to other areas)				
Slope of Land (estimate)				
Wildlife Present a. Animals b. Birds c. Reptiles and Amphibians d. Insects e. Other				
Vegetation Present a. Trees - b. Shrubs - c. Grass/Forbs-	Height	Height	Height	Height

Topic Nine

Other Last Great Places: Migratory Birds of Oklahoma

Topic Overview: Students study migration patterns of North American birds, including waterfowl and neotropical migrants, and migratory birds of Oklahoma. In Activity 9A, students study waterfowl migration patterns using a board game and learn about problems that migratory species may encounter. In Activity 9B, students study aerial photography and topography, and consider how birds find their way to traditional nesting and wintering grounds.

Activity 9A: Migration Station

Objectives:
Students will be able to:

(1) name the migration route for migratory waterfowl which passes through Oklahoma;
(2) name a possible nesting area for North American waterfowl;
(3) name a possible wintering area for North American waterfowl;
(4) list four environmental or human-created hazards which migratory birds may encounter as they travel; and,
(5) list three factors that might aid a migrating bird as it travels.

Main Ideas: Migration, neotropical songbirds, waterfowl, Central Flyway, deforestation.

Teacher Note: This activity allows the learners to interact in a Monopoly-type game as they study bird migration and its problems.

Background Information:

NEOTROPICAL MIGRANTS

It is almost inconceivable to the imagination that about five BILLION birds in North America alone migrate each year. These birds fly north from wintering areas in the tropic regions of Central and South America into North American temperate and Arctic zones. There they breed and take advantage of abundant food and space during summer months.

Oklahoma is in the migration path for many neotropical song birds. These birds include species such as orioles, cuckoos, warblers, thrushes, tanagers, flycatchers and vireos. The Scissortail Flycatcher, Oklahoma's state bird, and the Black-capped Vireo, an Oklahoma endangered species, are also included. These birds are neotropical migrants which spend the winter south of the United States and the spring and summer months in the United States, where they enrich our lives with their lovely songs and bright plumage.

The Least Tern, a neotropi-

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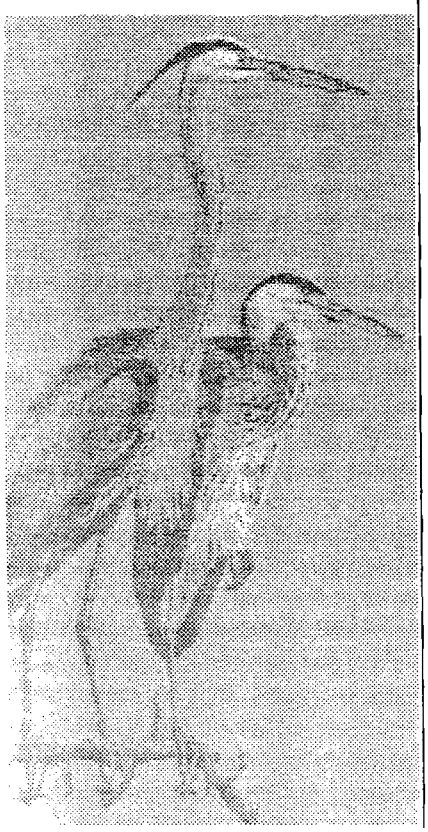

cal shore bird, winters in South America then migrates north to breed on the sand bars of rivers of the Great Plains area. This bird is a Federal and State Endangered species.

WATERFOWL

In North America, migrating waterfowl such as ducks and geese typically fly in four designated Flyways or Migration Routes: the Atlantic (East Coast to the Appalachian Mountains); the Mississippi (Appalachians to the eastern edge of the Great Plains); the Central (from the Great Plains to the Rocky Mountains) and the Pacific (from the Rockies to the Pacific Coast). The boundaries of these flyways are not always well defined. Also, birds do not always fly in a north-south direction. Some follow a zig-zag pattern as they make their way south, sometimes even crossing from one Flyway to another as they migrate.

Oklahoma rivers and lakes make up an important segment of the Central Flyway, which is the main migratory route for waterfowl (ducks and geese). The Cimarron River, Arkansas River, Canadian River and Red River of Oklahoma provide rest stops for these waterfowl.

Unfortunately, many populations of migratory birds are decreasing. This is partially due to the hazards the birds encounter as they migrate. These hazards include pollution, predation, disease, bad weather, habitat alteration and habitat destruction. Sometimes when the birds arrive at a resting stop on their route, or at their final destination, the habitat has been destroyed or altered so that they are unable to live there. Destruction of habitat is the biggest contributor to the decline of populations of water and shore birds.

DECLINING POPULATIONS

Several studies have documented the decline of neotropical species. From 1978 to 1987, one study showed that the decline in some areas was as high as 70 percent. Again, destruction of habitat is one of the major reasons. Forests across North America have become extensively fragmented, both from development and logging. The birds find their traditional nesting grounds gone. Food sources and other birds of their species to mate with are often in short supply.

Another problem these birds have is nest predation. Most of these birds build a cup-like nest near the ground or in shrubs, in which they produce only one brood of eggs per breeding season. These nests are plundered by raccoons and opossums which eat the eggs.

An even larger problem is the Brown-headed Cowbird. The female of this species lays her eggs in other songbird's nests. These songbirds tend, hatch and even feed the cowbird hatchlings as their own. The young cowbird is bigger than their own young, so the smaller young often

starve. Nest parasitism by the cowbird has become so extensive that three species of birds, including Oklahoma's Black-Capped Vireo, are listed as endangered species, with the cowbird specifically to blame.

In addition to problems in the United States, these songbirds are facing destruction of habitat in their tropical wintering grounds. In Mexico and other Central/South American countries, deforestation is a major problem. Mature forests are being cleared.

Finally, birds in general face other destructive forces, including: air pollution; pesticide use; elimination of hedgerow and other edge habitats which border fields and small developed areas; and windowpanes, which result in 100 million bird deaths each year (a conservative estimate).

Notes:

Materials, Preparation and Setting:

a. Materials:

Migration Station Game Board, Hazard Cards and Rest Station Cards (Topic Nine materials)
Migration Station Equipment/Rules for Migration Station (Topic Nine materials)
One dice for each student group
Game token or piece for each member of the class
Migration Station Research Sheet for each student (Topic Nine materials)

b. Preparation: This activity focuses specifically on the migration of waterfowl across the United States. It should be clarified that the Game Board is designed to reflect the Central Flyway states which might be utilized as rest stops for migrating waterfowl flying in a zig-zag pattern. Hazard and Rest Station Cards reflect situations the waterfowl may encounter while migrating. Although the game board is not applicable to neotropical migrants, as they do not use named flyways, the problems they might encounter while migrating are the same.

c. Setting: Classroom

Procedures:

a. Briefly discuss with the class the information on migratory birds included in the Overview section.
b. Divide the class into groups of four and provide each group with a "Migration Station" game board and one dice.
c. Provide each student with a game token or piece.
d. Review the Rules for Migration Station with the students.
e. Distribute a Migration Station Research Sheet to each student. Explain that the students should fill out this sheet as they play the game. This material will be asked in their evaluation at the conclusion of the topic section.
f. Allow the class to play the game. Approximately thirty minutes is required to have a winner!
g. Allow the group to work together to finish filling in Research Sheets.
h. Have the students turn in Research Sheets and answer any questions they may have.

Evaluation:
Ask the student to turn in the Migration Station worksheet. Allow class members to assist in grading the sheets under teacher supervision, seeing that all questions are completed and correct with answers from the Migration Station game.

Enrichment:
a. Birds are not the only type of wildlife that migrates annually. Ask the student to research another migrating species and share what they discovered with the class either in a visual form as a poster, mobile or diorama, in written form as a newspaper article, or in oral form as a radio or television broadcast report.
b. Have the student research the Oklahoma and United States laws, and the international treaties which affect migrating species. Prepare a report and share it with the class.

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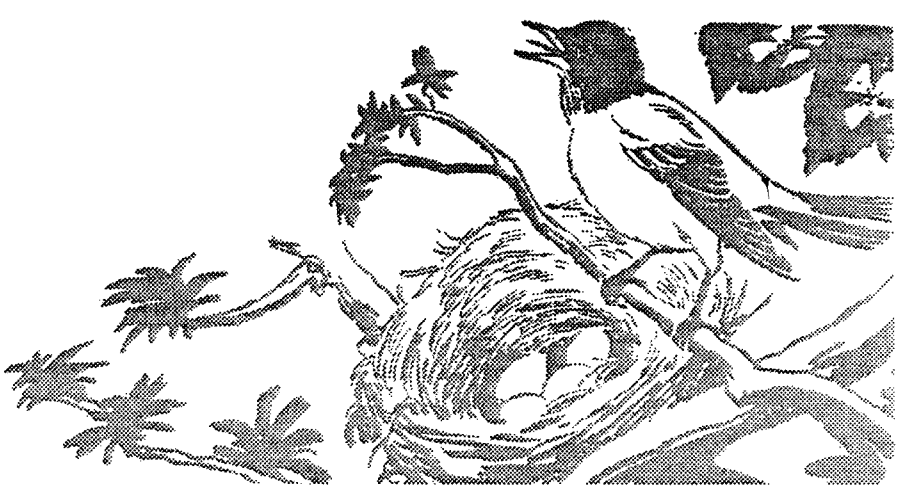


Migration Station Equipment

Tokens for two-four players per game board group (teacher provides)

One die per game board group

One set of Rest Station Cards per group

One set of Hazard Cards per group

Nine Hatchling tokens per group (teacher provides)

NOTE: Tokens may be pieces of cardboard with stickers or sketches on them. Hatchling tokens should be something entirely different from the playing tokens, but all Hatchling tokens should be identical.

Rules for "Migration Station"

1. Two to four players may play this game.
2. Each player receives a unique token, which is moved in a clockwise direction around the Migration Station game board.
3. A player's move begins when the player throws one die, then moves one-six spaces according to the top face of the die.
4. If the player's move positions his/her token on a state space, such as North Dakota, his/her play ends until that player's next turn.
5. If the player's move lands on a Rest Station space, he/she should draw a Rest Station card. There are fifteen of these cards. Read the card aloud to the other players, then move the game piece as directed on the card. The player should then return the Rest Station card face down to the bottom of the Rest Station card pile, and the player's turn ends.
6. If the player lands on a Hazard space, he/she should draw a Hazard card. There are fifteen Hazard cards. Read the card aloud to the other players, then move the game piece as directed on the card. The player should then return the Hazard card face down to the bottom of the Hazard pile. That player's turn ends.
7. Once a player has successfully moved around the gameboard and returned to the Nesting Grounds (Start) he receives one HATCHLING card, and play proceeds as previously in turn around the board. After receiving a hatchling card, when the player draws a Hazard card which results in the loss of a HATCHLING card, that HATCHLING card must be returned to the HATCHLING pile on the game board.
8. Play continues in this manner until one player returns to the Nesting Ground and collects his third hatchling. That player is declared the winner of the game.

HAZARD CARDS

Heavy cloud cover. No travel possible. LOSE ONE TURN	Encountered early blizzard. GO BACK TO NESTING ZONE	Heavy cloud cover. No travel possible. LOSE ONE TURN
Water polluted. GO BACK TO LAST REST STOP	Blown off course by winds. LOSE ONE TURN	Water polluted. GO BACK TO LAST REST STOP
Bird disease in your flock. LOSE ONE HATCHLING	No food available. GO BACK TO LAST REST STATION	Bird disease in your flock. LOSE ONE HATCHLING
Wetlands drained. LOSE ONE HATCHLING	Nest disturbed by predator. LOSE ONE HATCHLING	No food available. GO BACK TO LAST REST STATION
Urban development encountered. LOSE ONE TURN	Drought dries up habitat. GO BACK TO LAST REST STATION	Wetlands drained. LOSE ONE HATCHLING

MIGRATION STATION
REST STATION CARDS

Rest area closed, habitat paved. MOVE BACK 2 SQUARES	Dry year. Only half the usual habitat available. GO BACK 4 SQUARES	Local group restores resting habitat. MOVE AHEAD 2 SQUARES
Extra grain from local bird feeding program. MOVE AHEAD 2 SQUARES	Pollution in river damages habitat. GO BACK 6 SQUARES	Environmental education efforts result in habitat protecton. ADVANCE 2 SQUARES
Clear skies. Good wind. MOVE AHEAD 2 SQUARES	Wetlands healthy. MOVE AHEAD 2 SQUARES	Poor grain crop year in local fields. Little food. LOSE 1 TURN
Trespassing, poaching, and damage to nests regulated by U.S. government and laws. MOVE AHEAD 2 SQUARES	Clear skies. Good wind. MOVE AHEAD 2 SQUARES	Clear skies. Good wind. MOVE AHEAD 2 SQUARES
Environmental education efforts result in habitat protecton. ADVANCE 2 SQUARES	Rest Area Closed, habitat cleared. MOVE BACK 2 SQUARES	Wetlands healthy. MOVE AHEAD 2 SQUARES

MIGRATION STATION
RESEARCH SHEET

Look at the Migration Stations Game Board:

1. What is the name of the migration route that migratory birds follow through Oklahoma?

_____

2. What is the name of the nesting area for migratory birds used in "Migration Station"?

_____

3. What is the name of the wintering area for migratory birds used in "Migration Station"?

_____

As you play the game, keep track of the following:

4. List the hazards (both environmental and human) that birds may encounter as they migrate.

_____ _____

_____ _____

_____ _____

_____ _____

5. List the factors (both environmental and human) that might aid a migrating bird as it travels.

_____ _____

_____ _____

_____ _____

_____ _____

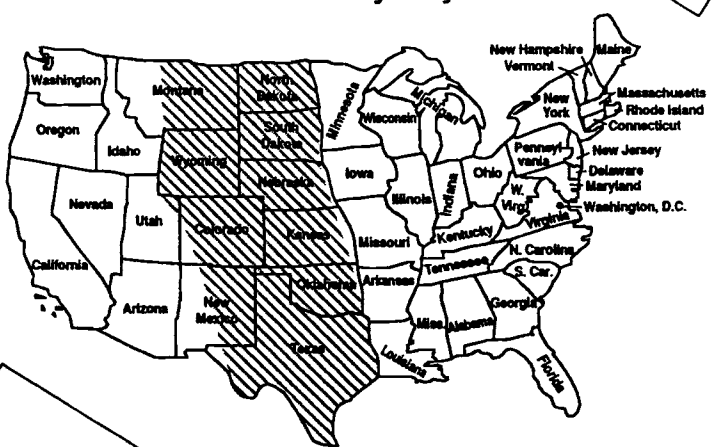
START HERE!

Nesting Zone (Canada) 1 hatchling as you pass	North Dakota	Montana	Rest Station Draw 1 Card	South Dakota	Wyoming	Hazard Draw 1 Card	Nebraska	Colorado	Rest Station Draw 1 Card
North Dakota									Oklahoma
South Dakota									New Mexico
Hazard Draw 1 Card									Hazard Draw 1 Card
Nebraska									Texas Panhandle
Kansas									East Texas
Rest Station Draw 1 Card									Rest Station Draw 1 Card
Colorado									West Texas
Oklahoma									Padre Island
Hazard Draw 1 Card	Texas Panhandle	New Mexico	Rest Station Draw 1 Card	West Texas	South Oklahoma	Hazard Draw 1 Card	East Texas	South Texas	Wintering Zone (You made it!)

Migration Station

Hazard

Central Flyway



Rest Station

Activity 9B: A View from the Air

Objectives:
Students will be able to:

(1) name the two Oklahoma rivers where The Nature Conservancy has located Least Tern Preserves;
(2) define "topography";
(3) list Oklahoma landmarks or topographic features which birds might use;
(4) list three events that might change a land feature; and,
(5) locate several named features on an aerial photograph.

Main Ideas: Topography, aerial photography.

Teacher Note: Prior to working with the students on this topic, the teacher should become familiar with aerial photography and interpretation. Assistance in this can be povided by your local USDA/Soil Conservation Service office, which is a good place to get local aerial photographs.

Background Information:

Migration itself is a mystery. Research into migration patterns over the last fifty years has shown that birds winter in approximately the same areas each winter and return to the same nesting regions as in previous years (sometimes even the same nests)!

It appears that various bird species use different methods to follow traditional migration routes. Almost all are believed to use landmarks such as mountain ranges and rivers to some extent. These surface features are the topography of the land. Many birds migrate at night, and it is believed that they use the stars, while day-flying birds use the sun, or polarized light on cloudy days. It is likely that some birds are genetically programmed to return to a wintering ground, while others follow the lead of mature members of their species.

The Least Tern winters primarily in Central America, flying to North America to breed on the sandbars of rivers of the Plains and the Mississippi River Valley. Most of these rivers are now regulated by humans. They have been altered in some ways, and may be used for flood control, irrigation, navigation, hydropower and even as water supplies. No longer are these rivers balanced by nature, subject to shifting sands from fluctuating water levels. No longer do flooding waters wash vegetation from the beaches, creating the clean, sandy sites which the Least Tern prefers for nesting.

Water is added or withdrawn according to the manipulations of human desires, and vegetation begins the natural process of plant succession, covering sand bars and shorelines of rivers.

Wherever the Least Tern still finds the preferred ground, nests are created in shallow depressions filled with loose

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material. In these depressions, the Tern lays two or three speckled eggs. In time, the eggs hatch, and the chicks are born with eyes open. The hatchlings can soon run, but depend on their parents for food and for temperature regulation. Parent birds, frightened away from the nest, cannot shade eggs and chicks. Many chicks die each year from overheating during the summer months.

Materials and Setting:

a. Materials: Aerial photographs of your area (contact your county USDA/Soil Conservation Service office)
Aerial photographs of the Canadian and Arkansas Rivers (Topic Nine materials)
Topographic or relief map of Oklahoma (classroom resources, USDA/SCS office, U.S. Geological Survey, hunting supplies, Walmart)
Oklahoma State highway maps

b. Setting: Classroom.

Procedure:

a. Distribute Oklahoma State highway maps and contour maps and/or topographic maps of Oklahoma. Explain to the students how different landscape features look on each of these types of maps.
b. Distribute aerial photographs of your area (obtained from the SCS) and help the students identify various features. Can they find where they live? Can they find their school? town? Can they find a nearby river or stream? The students might want to work in groups, sharing with one another.
c. Ask the students to make a list of what they would watch for from the air that would tell them that they are close to home.
d. Distribute the aerial photographs of the Canadian and Arkansas Rivers where the Least Terns nest.
e. Ask the students to list features they see in that area that might help the Least Tern find its nesting grounds each year.
f. Review the overview materials on the Least Tern with the students.

Evaluation:

Ask the student to:

(1) name the two Oklahoma rivers where the Nature Conservancy has located Least Tern Preserves;
(2) define "topography";
(3) list Oklahoma landmarks or topographic features which birds might use to return to a traditional nesting site;
(4) list three events that might change a land feature and prevent a bird from finding its way to a traditional nesting site;
(5) provide each student with an aerial photograph, then, ask him/her to locate several land features, including roads, homesites, waterways, and cultivated fields.

Enrichment:

a. Have the student write a personal essay about how he/she can individually assist migratory birds passing through Oklahoma.
b. Have the student study the other North American Flyways, and list specific waterfowl which use each one.
c. Have the student participate in a Nature Conservancy volunteer workday on one of the Least Tern Preserves, and report his/her experience to the class.
d. Have the student visit one of the Least Tern Preserves during nesting season, and make a report to the class.

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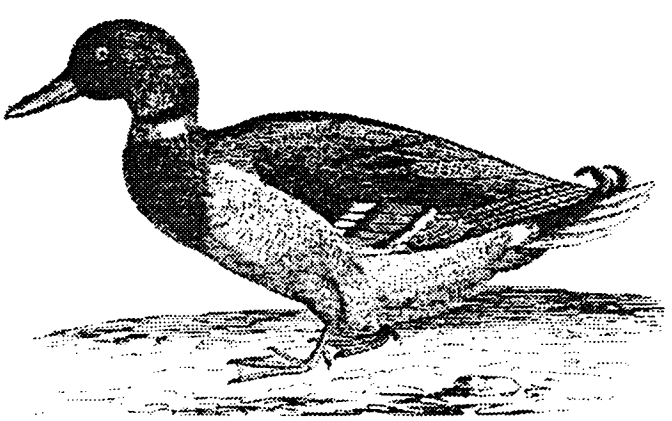



DO NOT SCALE

Nature Conservancy Highlight:

The Oklahoma Chapter of the Nature Conservancy has placed primary importance on the task of preserving habitat for migratory bird species, in particular the Least Tern. Two Oklahoma Preserves, one on the Canadian River south of Oklahoma City near the city of Purcell, and the second on the Arkansas River flowing through Tulsa, are designed to offer this federally endangered shorebird important habitat sites for nesting. Another Preserve in LeFlore County was created to benefit interior nesting neotropical migrant birds. (Those that inhabit inland or interior shores, rather than coastal shores.)

The Least Tern which inhabits the interior of North America was placed on the federal Endangered Species list in 1985. Damming, dredging and other changes made to river systems result in destruction of nesting habitat throughout the central United States. This species of bird migrates over the area which contains major tributaries of the Mississippi River drainage basin and the Rio Grande River. In Oklahoma, the Least Tern nests along the Arkansas, Canadian, Cimarron and Red Rivers as well as at the Great Salt Plains National Wildlife Refuge on the Salt Fork River.

The tern's preferred habitat is freshwater sandbars, saltflats, islands and barren beaches of gravel, shells, sand or mud. This type of habitat is maintained by natural flooding, which deposits sediment and prevents the growth of vegetation. The tern's preferred diet is small fish, plus an occasional insect and crustacean.

The Least Terns migrate to Oklahoma in mid-May after wintering in Central America. They leave the state in September, after nesting and raising their young. Very sensitive to disturbance, the terns often abandon their well-concealed nests after recreational vehicles have invaded their habitat. Many of their young starve or succumb to summer heat, if they are not eaten by predators first.

At the Canadian River Least Tern Preserve, most of the land is owned by private individuals, and posted to prevent trespassing and wildlife disturbance. These landowners voluntarily list their property as part of the Preserve to see that these migratory birds are undisturbed during nesting season.

The Arkansas River Least Tern Preserve in Tulsa extends from 11th street to 91street. This 1,000 acre site is considered prime breeding habitat. This preserve is an excellent example of how endangered species and people, representing private concerns, business and industry, can coexist and work voluntarily side-by-side. The nesting terns can be observed from jogging trails and pedestrian bridges in the area. Actual nesting sites are marked, and observers are asked to keep themselves and pets away from these areas.

The Nature Conservancy Preserve in LeFlore County, near the Arkansas-Oklahoma border was created to benefit interior nesting neotropical migrant birds. These birds prefer undisturbed riparian areas as resting and nesting sites. This preserve also provides habitat for many plants and animal species native to the area.

Suggested Variation/Expansion Activities

Project WILD:	Adaptation Artistry, Shrinking Habitat, Migration Barriers
Aquatic Project WILD:	Hooks and Ladders, Migration Headache, Dragonfly Pond

Topic Ten

"The Spirit of the Last Great Places": Making Environmental Decisions

Topic Overview: Students consider how land-use management decisions are made and the viewpoints that are a basis for such decisions. In Activity 10A, the perspective is global, as students participate in a land-use decision-making simulation. In Activity 10B, students consider their personal priorities and ways in which they can play an active role in environmental efforts.

Activity 10A: A Land-Use Case Study

Objectives:
Student will be able to:
(1) name six possible categories of land usage;
(2) discuss several (at least three) concerns that must be considered when land-use planning is responsibly undertaken; and,
(3) discuss the best methods for making land-use management decisions.

Main Ideas: Multiple land use, development, stewardship.

Teacher Note: This activity is lengthy, and will require two classroom periods or a total of 100 minutes.

Background Information:

Making management decisions about land-use is extremely difficult. Everyone has personal opinions about the use of individual units of land, usually based on their own personal priorities.

To some people, economic considerations are the highest priority - land should be used so that individuals or communities benefit economically. This might mean using the land to build new factories or shopping malls where people can find employment and business dollars can be earned and spent.

To other people, recreational opportunities are a high priority - can people "play" there? (hunt, camp, fish, swim, use ATVs, etc.) This might mean allowing all kinds of "fun" activities on the land, regardless of the effect of those activities on the plants and animals which live there.

To still others, care of the environment is a top priority. Can the land be used without driving out the animals or harming the environment those animals live in? Ultimately, can the land be used in harmony with all residents (including people!)?

Some categories of land use include: commercial, industrial, recreational, agricultural, educational and housing.

Sometimes it is possible to

Notes:

Notes:

have multiple land-use, when land is used for more than one purpose at a time, such as use for limited recreational purposes while still serving as a wildlife refuge. Sometimes land development, alterations made to a natural site to allow another use, may be done in such a way that damage to the environment is minimized. Such low impact development may be considered one form of stewardship (responsible care of the land so that the rights of all creatures living there are maintained).

Stewardship also extends to the way we live our lives, whether or not we are placed in active charge of a piece of land. Being a good steward means being aware of the results of our actions, knowing how they affect other people, animals and all other creatures as well as the Earth's systems. It requires living in such a way that we do not harm those things which share the Earth ecosystem with us.

In a democratic society, we can take an active role in decision-making through the voting process. It is our responsibility as good stewards to be knowledgeable about the issues and vote with environmental awareness.

Materials and Setting:

a. Materials:

Land Use Simulation sheets, Tasks A, B and C (Forest Service, U.S. Dept. of Agriculture FS-349-7) (Topic Ten materials). Copies of A, one per student. Copies of B, one per group. Copies of C, one per group plus one for Board members

Blackboard or overhead projector, screen and transparencies

Large sheets of paper, enough for five groups

Marking pens or crayons

b. Setting: Classroom.

Procedure:

DAY ONE

a. Explain to the students that the class is going to simulate a decision-making process on land use. They are members of a hypothetical community, and must decide how one square mile, 640 acres, of land near the city will be best utilized. Review the background information on the community with the class, encouraging students to imagine that the information you are reading is actually about their community.

b. Distribute Task A to the students and ask them to begin writing down possible uses of the land. Provide only thirty seconds for this to begin, and then ask the students to share their answers with the class in a brainstorming session. Record their answers on the blackboard or on a transparency used with the overhead projector. Ask the students to help in paraphrasing lengthy answers.

c. When you have a good variety of uses, ask, "Which of these possible uses are similar?" and note similar uses by letter, symbol or color.

d. Then ask, "What label could we give to all the items in the same category?" Categorize the responses (industrial, commercial, agricultural, recreational, educational, housing). Some uses may be placed in more than one category.

e. Count the number of land-use categories, and divide the class into that number of groups. Assign each group a particular category of land-use.
f. Distribute Task B, one per group, and give each group ten minutes to list and analyze the advantages and disadvantages of possible uses for the vacant land in their assigned category. Consider those already listed, as well as any others that the group can come up with. Stress that this task is simply to analyze the uses of the land.
g. Then tell the groups their next task is to develop a land-use plan for the area; that is, select the best use or uses in their category and construct a map of how the area will be developed. As the students are settling down to this task, tell them, "We have just received word that the members of the Board of County Commissioners have all resigned. Each group has one minute to elect one member to represent them on the board." Have them use the "Point At" method. (All members raise their arms into the air with one finger pointed. On the count of three, have them lower their finger and point at the person they want to elect as chairperson. The one student with the most fingers pointed at them is elected.)
h. After election, take the newly elected board to the side, or out of the room, and distribute one copy of Task C to them. Review this information, then ask the board to select a chairperson using the "point at" method.
i. Ask the Commissioners to select a timekeeper, and to decide what criteria they will use in evaluating the land-use proposals. Group presentations will be made during the next class period.
j. Return to the other groups and tell them they have until the end of the class period to finish their plans and develop a three-minute presentation for the "County Board of Commissioners." This presentation should include a visual display, such as a land-use map, and more than one person in each group must participate in making the presentation. Distribute markers and a large sheet of paper to each group. Encourage library time if students want to pursue resources outside of the classroom.

DAY TWO

a. When all groups are ready, have the board enter the room and sit at the front. The chairperson should make the announcements from Task C and stick to them, in order to keep the process moving. The timekeeper is to stop all presentations at three-minutes and give one-minute warnings.
b. When the presentations are finished, the board retires for 5 minutes to select the best proposal.
c. While the board is "retired", ask each group to gather briefly and consider what criteria the board should be using in evaluating the plans submitted. Pass out Task C for them to use in developing the criteria.
d. Have the County Board re-enter the room, read their criteria aloud, announce their decision and read the criteria used in making the decision.
e. Adjourn the board and ask former board members to rejoin their original groups. The groups will now evaluate the process which was used to determine the land use.
f. Lead the discussion of the following questions:
    1. What additional data would you have liked to have for planning your group's proposal? List these example answers on the blackboard or an overhead transparency prior to beginning discussion: topography, vegetation, economy of area, railroad, shopping center, adjacent land, climate, soil survey, historical information, flood plain, wildlife, interest of board of control, money available, educational needs, regulations by State, existing zoning, political climate, population information (age, needs, race, jobs).

2. Where would you go to collect information on these topics?

g. Point out that a variety of information and data is necessary to make intelligent land management and environmental decisions which best meet the needs of both people and their environment. This list has many of the elements that need to be considered in studying a local environmental issue or concern. It also includes elements of all the curriculum subject areas (social studies, science, language, arts, etc.). Point out that it is necessary to use information from the entire community, and that the community would serve as a classroom when making a land-use planning decision.

Evaluation:

Ask each group to prepare a summary of the process their group went through. The summary should include their category of land use, concerns they considered as they developed their plan and any final thought which group members have about making land-use management decisions.

Enrichment:

a. Ask the students to attend a meeting of the city commissioners in your town. Have them listen for discussion of land usage, including building permits. What considerations do your commissioners use to help decide how to utilize land in and around your city? Have them share their experience with the class, either as a radio news report or a newspaper article.

b. Ask the student to pretend that he/she is a city planner, assigned to plan an entire city for 100,000 people. How would he/she lay this out? He/she may want to visit with your city's City Planner. The computer game, Sim-City, could offer a place to start and some considerations. Have him/her report on the city they would create to the class.

Notes:

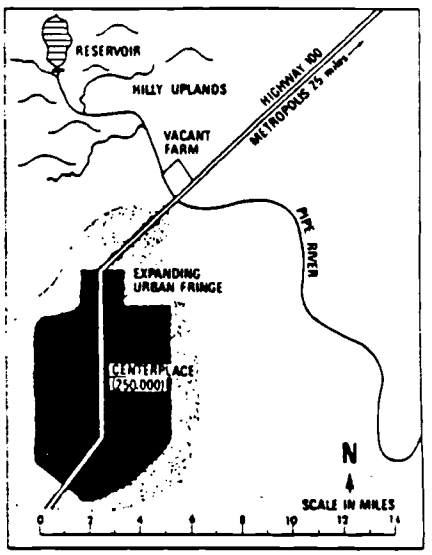
TASK A (individuals)

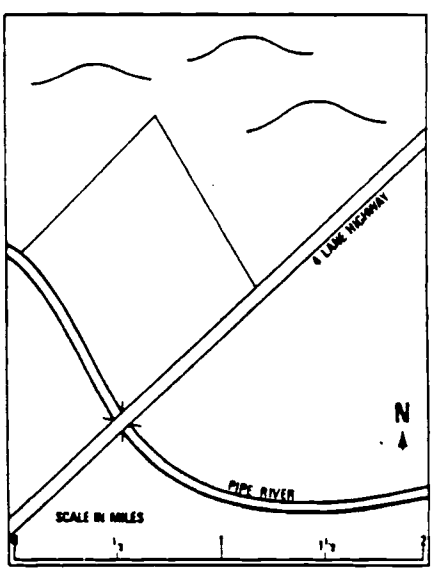
"One square mile (640 acres or 259 hectares) of unused county farmland, 4 miles (6.4 k) northeast of the city, is now available for the city's use."

Read the background information for Centerplace City, and then list some possible uses of the vacant farmland.

Background Information Sheet For Centerplace City

- The population is 250,000 and rapidly increasing.
- The city's boundaries are being extended, but the suburban fringe is expanding even more rapidly.
- The rapid population growth is accompanied by demands for more housing, more jobs, additional city services, and recreational areas.
- The power for industrial uses, adequate public transportation, and a skilled labor force are available.
- The city is located near forests, to the north.
- The land to the east is devoted mainly to farming.
- The Pipe River is unpolluted and is the source of irrigation water as well as the municipal water supply.
- The river is too small for freight transportation, but logs could be floated on it.
- The gravel bed of the river is appropriate raw material for concrete manufacture.
- The present sewage treatment plant and garbage disposal area are at maximum capacity.
- The citizens of Centerplace are concerned about the maintenance of a scenic regional environment.
- The County Board of Commissioners is the authority for land zoning, and many citizens' groups are being formed to influence zoning decisions.





List possible uses of the land.

_____	_____
_____	_____
_____	_____
_____	_____

LAND USE SIMULATION Task Card
Forest Service-USDA

TASK B (in groups)

Group _____ Assigned Category of Land Use _____

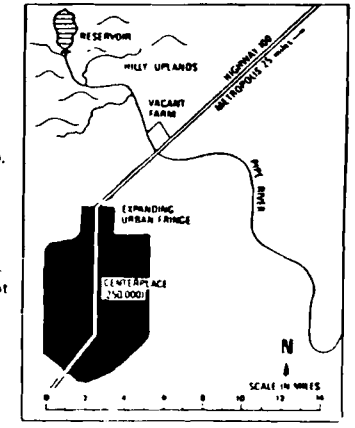
Your only task is to analyze and list possible consequences of different land uses within your assigned land use category. Do not decide which is the best use.

Use	Advantages to land/people	Disadvantages to land/people

TASK C (County Board members only)

"One square mile of unused country farmland, four miles northeast of the city, is now available for the city's use."

1. Using this information, your task is to:
   a. Develop criteria to evaluate the proposals.
   b. Develop a system to record your evaluation of each proposal.



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The gravel bed of the river is appropriate raw material for concrete manufacture.

The present sewage treatment plant and garbage disposal area are at maximum capacity.

The citizens of Centerplace are concerned about the maintenance of a scenic regional environment.

The County Board of Commissioners is the authority for land zoning, and many citizens' groups are being formed to influence zoning decisions.

Group Making Presentation (use category)	Criteria to Evaluate Proposal (Rating)					
	1	2	3	4	5	6

Elect a chairperson to preside during the presentations to the group and to run the meeting in an orderly manner. (5 minutes) Announcements to be made by chairperson:

- Because of time constraints, there will be no rebuttal after presentations.
- The Board may ask two or three clarifying questions of each group after all the presentations.
- You have 3 minutes to give your presentation. You will be given a warning when you have 1 minute left.

Activity 10B: Personal Views and Action

Objectives:
The student will:
(1) consider his/her personal viewpoints;
(2) consider ways which he/should could become environmentally active; and,
(3) complete a personal action plan on the subject of "My Commitment" toward the environment.

Main Idea: Commitment.

Teacher Note: The final activity is designed to provide an opportunity for reflection. The stage was set in the first activity for the student to begin to consider views which are behind environmental decisions. In this activity the student will consider his/her personal viewpoints. Students may need help with some definitions of terms on the Priority list. The teacher should try to assist students as they search for environmentally-correct activities which are consistent with their personal priorities.

Background Information:

Making a personal decision to be environmentally aware and active sometimes seems overwhelming, especially for young people. They wonder, "what difference can I possibly make...me...one person?" Even adults often feel that way.

However, there are many seemingly small ways to be environmentally active. These small steps achieve major results when a large number of people commit to them. These are the commitments which make a difference in the world.

A commitment is a choice made after much consideration.

The first step to making a commitment is to decide what your views are. Then, prioritize them from least to most important. If you had to choose just one all-encompassing priority, what would it be? Are you living in line with your beliefs?

How do your views relate to your personal treatment of the environment? Do you live in such a way that your priorities are obvious to others? If not, are your priorities strong enough that you can willingly change your behavior so that it lines up with your beliefs?

Tough questions, but worth spending time reflecting on.

Notes:

Materials and Setting:

a. Materials:
Priorities list (Topic Ten materials)
Options for Personal Involvement (Topic Ten materials)
Pencil and paper
Trade books selected by the teacher (fiction or nonfiction books which consider environmental issues. Example: Sand County Almanac)

b. Setting: Classroom.

Procedure:

Part 1 - Priorities

a. Review the Priorities list with the class. Be sure that the students understand the definitions of all the terms.

b. Ask the students to consider what is most important to them. Have them circle the eight things from this list which they consider to be priorities. After they have done this, ask them to narrow it down to only four, and to place an X before those four. Next, have them choose their top two, and finally, the most important priority.

c. Ask the students to consider whether their actions (the way they live their lives) show others what they view as important.

d. Finally, have them consider how those priorities relate to the environment.

e. Allow time for students to look through the books you selected which consider environmental issues.

Part 2 - Personal Involvement

a. Review the Options for Personal Involvement pages with the class.

b. Allow time for questions from the students, and for the students to share information about things they might already have done.

c. Ask the students to write a personal action plan, titled "My Commitment" about what they plan to do in the future to help the environment. The essay should include a specific concern they have about the environment either in their community, their state or in the world, and their thoughts on what they specifically can do to help the situation. Ask them to set an initial goal to accomplish (such as writing a letter to a Congressman, joining an organization, subscribing to a magazine or breaking a habit) and give a deadline date of within one month to accomplish that goal. Ask them to set as many other "step goals" as possible with deadline dates. They'll be surprised what they can actually accomplish!

Evaluation:

Ask the student to complete a personal action plan on the subject of "My Commitment" toward the environment. This plan should include a specific concern, some specific things he/she can do to help, an initial goal and its deadline, and a list of other "step goals" in his/her environmental effort.

Enrichment:

a. Ask the student to investigate an environmental problem in the community or region. Have him/her make a list of steps to help with the problem. Then ask him/her to make goals of these steps, and set deadlines. Finally, get started!

b. If your community does not participate in recycling, have a student investigate how to get a program going in his/her own neighborhood or school. Perhaps a nearby town has a recycling program. Have the student offer to collect his/her neighbors' recyclables and transport them to that town!

c. Ask the student to attend a volunteer work project for a local environmental organization or recycling group.

Notes:

The Nature Conservancy:

Incorporated in 1951 for scientific and educational purposes, The Nature Conservancy (TNC) is a nonprofit organization supported by individual and corporate contributions, foundation grants, and membership dues. The Nature Conservancy is a steadfastly single-purpose organization. TNC resists temptations to stray from our mission of biodiversity preservation through habitat protection and management. TNC endeavors to be collaborative, nonadversarial, and solution-oriented and to use direct action. TNC searches for multiplying factors, such as partnerships, to advance the mission. The Conservancy strives to balance conservation and economic development. The Conservancy is not a radical, litigious organization.

The Conservancy has fifty U.S. state offices and operates in fourteen Latin American countries, the Caribbean, Canada, and the Pacific Region. Outside of the U.S., the organization develops partnerships with like-minded, nongovernmental organizations to protect threatened habitat.

The Conservancy's headquarters is located in Arlington, Virginia. Nationwide, the Conservancy employs more than 1,100 professional staff and has a volunteer force of more than 13,000. Staff and volunteers have backgrounds as diverse as the ecosystems they protect.

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

The Nature Conservancy works in three ways to accomplish conservation goals: (1) identifying, through systematic evaluation, the best examples of ecosystems and habitat where rare plants, animals and natural communities can be protected. This is accomplished by the Oklahoma Natural Heritage Inventory (a TNC project); (2) protecting habitat and ecosystems, usually through acquiring land by gift or purchase, but also by lease, easement or non-binding agreement; and (3) managing preserves using staff and volunteers. TNC preserves range from less than one acre to more than 50,000 acres. Most are open for recreational and educational uses.

The Oklahoma Chapter of The Nature Conservancy was established in July, 1986. By 1994, the Chapter had acquired more than 75,000 acres and had protected hundreds of species. The Chapter has established preserves across Oklahoma's landscape, from Black Mesa in the Panhandle to Cucumber Creek in Southeast Oklahoma's LeFlore County. More than 5,400 Oklahoma citizens, corporations, and private foundations support Chapter activities.

National membership is over 750,000. 1.3 million acres are managed by the Conservancy nationally, and 7.9 million acres have been protected in the U.S. since 1953. Nationally, 1,300 preserves are managed by TNC. For more information about The Nature Conservancy, write: **The Nature Conservancy, 320 South Boston, Suite 1700, Tulsa, OK 74103.**

Suggested Variations/Expansion Activities:

Project WILD:	Checks and Balances, Deer Crossing, Riparian Zone, Changing Attitudes, Philosophical Differences, Enviro-Ethics, Ethi-Reasoning, Cabin Conflict, To Zone or Not to Zone, Planning for People and Wildlife
Aquatic Project WILD:	To Dam or Not to Dam, Facts and Falsehoods, Dragonfly Pond
Project Learning Tree:	Values on the Line

Priorities List

Money	Travel
Family	Compassion
Possessions	Cooperation
Friends/Friendship	Law and Order
Animals/Pets	Loyalty
Life	Kindness/Generosity
Love	Physical Fitness/Sports
Religion/Church	Patriotism/Love of Country
School/Education	Honesty
Wilderness	Peace
Freedom	Nature/The Outdoors

Opportunities for Personal Involvement

Several handbooks have been published by **The Earthworks Group**, 1400 Shattuck Avenue, #25, Berkeley, CA 94709. A selected sampling of those appears on the next two pages, under the title of the handbook in which it appeared. Further details on "how to" appear in the handbooks.

50 Simple Things You Can Do To Save the Earth

1. Stop Unwanted Junk Mail. Write to Mail Preference Service, Direct Marketing Association, 6 East 43rd St., New York, NY 10017 and tell them to remove your name from the mailing lists.
2. Snip six-pack rings.
3. Use phosphate-free laundry detergents.
4. Use low-flow faucet aerators on your kitchen and bathroom sink faucets.
5. Use re-usable food storage containers instead of plastic bags.
6. Turn your water heater down to 130 degrees and use an insulating "blanket".
7. Find out about recycling in your community, and participate. Aluminum is the most profitable recycled material - take advantage of this! (More on recycling down the list.)
8. Use latex paint instead of oil-based paints and wash brushes clean in the sink instead of outside, so that excess paint passes through your town's water treatment facility instead of into the soil.
9. Don't leave the water running while you brush your teeth, shave, wash the car (or the dog), or wash the dishes.
10. Don't buy aerosol cans, but if you do, don't buy those which use CFC's or halons (check the ingredients list).
11. Use rechargeable batteries, or recycle your alkaline batteries.
12. Use NEITHER plastic or paper bags when shopping. Carry your own cloth, draw string bags to put your purchases in.
13. Water your lawn in early morning; leave the grass at least 2 to 3 inches high and during dry periods, leave lawn clippings on the lawn to serve as mulch and fertilizer; use organic pesticides and fertilizers (not chemical!) on your lawn and in your garden.
14. Don't use foam packaging or buy styrofoam cups. Use paper plates and cups instead.
15. If you live near a beach or shore, take a trash bag with you the next time you go and spend a few minutes collecting litter.
16. Don't buy ivory, tortoiseshell, coral, reptile skins, cat pelts or other products from endangered animals or plants.
17. Be sure the tuna you buy is labeled "dolphin-safe" or don't buy it!
18. Flea collars are dangerous to your pet as well as to fleas, and to the environment after you throw them away. Don't buy them!
19. Buy a "low-flow" showerhead for your shower and save up to 50 percent of water consumption.
20. Use compact fluorescent light bulbs whenever possible instead of traditional light bulbs.
21. Don't buy or use latex balloons! They may wind up in the ocean where they may be eaten by turtles or whales, and usually result in death.
22. Recycle newspapers and magazines in your community's recycling program. Then buy recycled paper goods whenever possible.
23. Recycle glass bottles and jars.
24. Avoid plastic containers - especially "squeezable" ones.
25. Consider the packaging when you buy anything. Buy vegetables without the package! Buy cereal in recycled paper boxes; buy beverages in glass or aluminum containers.
26. Use rags to wipe up spills rather than paper towels. Use cloth diapers rather than disposable ones!
27. Build a wildlife refuge in your backyard.
28. Do an energy audit in your home - then insulate attic, walls, windows, doors!
29. Help save the rain forests by writing letters and refusing to buy goods made from tropical hardwoods!
30. Plant a tree which will grow well in your area, and care for it for at least the first two years!

The Student Environmental Action Guide - 25 Things You Can Do

1. Carry a mug and a spoon wherever you go, to prevent using a Styrofoam cup and a plastic stirrer.
2. Cut back on food waste at your school- take only what you can eat.
3. Carpool to campus whenever possible. We have so much extra room in our 140 million cars that everyone in Western Europe could ride with us.
4. Always use both sides of the paper, whether making copies, taking notes or doodling. Then recycle!
5. When you leave a room, turn off the lights. Also, dust your light bulbs - dust can cut back the light put out by a bulb by 35 percent!
6. Plant a tree every time you subscribe to a new magazine or newspaper.
7. For short trips, walk instead of drive - or invest in a bike! Better yet, use public transit.
8. Create a compost pile in your backyard and save space in your local landfill.
9. Buy only environmentally sound products - those which are biodegradable and made from recycled materials.
10. Join a local, regional or national environmental organization.

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30 Simple Things You Can Do To Save Energy

1. Microwaves use around 50 percent less energy than conventional ovens and are most efficient for small portions or defrosting. For larger items, stove-top cooking is more efficient, particularly with gas. For large items, like turkeys, microwaving is least efficient.
2. Don't open your oven door while cooking - every time you do you lose 25-50 degrees or more!
3. If you use glass or ceramic baking dishes, you can lower the baking temperature 25 degrees, since these materials retain heat better than others.
4. Use the right soap and wash in cold water! As much as 90 percent of the energy consumed by washing machines goes to heating the water. With the right soap, many lightly soiled clothes can come clean even in cold water.
5. Clean the lint filter in your dryer after each use so that air circulates efficiently and clothes dry faster.
6. Dry heavy and light fabrics separately so that all the clothes in the load are done at once.
7. Whenever possible, use a clothesline to dry clothes!
8. Keep the thermostat under control: winter setting - 68 degrees in the daytime, 55 degrees at night.; summer setting - 78 degrees.
9. If your dishwater has an air-dry setting, use it. You can knock 15 percent off the energy used!
10. Keep track of your gas mileage and keep your car well tuned. Don't let your car idle! Idling for sixty seconds takes more energy than shutting off your car and restarting it!

Another source: **Save Our Planet: 750 Everyday Ways You can Help Clean Up The Earth.** Diane MacEachern. 1990. Dell/Bantam: New York.

An interesting source on biodiversity of food plants and how you can help maintain it is **Rain Forest in Your Kitchen,** Martin Teitel. 1992. Island Press: Washington, DC.

One final source (although there are many more out there - look for yourself!) is **Save the Earth, An Action Handbook for Kids,** Betty Mills. 1991. Alfred A. Knofp, Inc: New York, N.Y.

Environmental Organizations (partial listing)

Center for Marine Conservation, 1725 DeSales St. NW, Washington, DC. 20036.

Citizen's Clearinghouse on Hazardous Waste, P.O. Box 926, Arlington, VA 22216. (703) 276-7070.

Citizens for a Better Environment, 33 East Congress, Suite 523, Chicago, IL 60605.

Clean Water Action, 317 Pennsylvania Ave. SE, Washington, DC 20003. (202) 547-1196.

Environmental Action, 1525 New Hampshire NW, Washington DC 20036. ((202) 745-4870.

Environmental Defense Fund, 257 Park Ave. S., NY, NY 10010. (212) 505-2100.

Greenpeace USA, 1436 U. St. NW, Washington, DC 20009. (202) 462-1177.

Izaak Walton League of America, 1401 Wilson Blvd., Level B, Arlington, VA. 22209.

League of Conservation Voters, 1150 Connecticut Ave., NW, Suite 201, Washington, DC 20036. (202) 785-8683.

National Audubon Society, 950 3rd Ave., NY, NY 10022. (212) 832-3200.

National Toxics Campaign, 1168 Commonwealth Ave., Boston, MA 02134. (617) 232-0327.

National Wildlife Federation, 1412 16th St. NW, Washington, DC 20036.

Native Americans for a Clean Environment, P.O. Box 1571, Tahlequah, OK 74465. (918) 458-4322.

Natural Resources Defense Council (NRDC), 40 W. 20th St., NY, NY 10112 (212) 727-2700.

Nature Conservancy, 1815 N. Lynn St., Arlington, VA 22209. (703) 841-5300.

Oceanic Society, 218 D. St., SE, Washington, DC. 20003.

Rainforest Action Network, 301 Broadway, Suite A, San Francisco, CA 94133. (415) 398-4404.

Rocky Mountain Institute, 1739 Snowmass Creek Rd., Old Snowmass, CO 81654. (302) 927-3128.

Save America's Forests, 1742 18th St. NW, Washington, DC. 20009. (202) 667-5150.

Sierra Club, 730 Polk St., San Francisco, CA 94109. (415) 776-2211.

Wilderness Society, 1400 I St. NW, Washington, DC 20005.

World Resources Institute, 1709 NY Ave. NW, 7th Floor, Washington, DC 20006. (202) 638-6300.

World Wildlife Fund, 1250 24th St. NW, Washington, DC, 20037.

Worldwatch Institute, 1776 Massachusetts Ave. NW, Washington, DC 20036.

Oklahoma Organizations

Oklahoma Conservation Commission, 2800 N. Lincoln Blvd., Oklahoma City, OK 73105. (405) 521-2384.

Oklahoma Corporation Commission, 2800 N. Lincoln Blvd., Oklahoma City, OK 73105. (405) 521-2261.

Oklahoma Department of Agriculture, 2800 N. Lincoln Blvd., Oklahoma City, OK 73105. (405) 521-3864.

Oklahoma Department of Health, Environmental Health Administration, 1000 N.E. 10th Street, Oklahoma City. OK 73105. (405) 271-4200.

Oklahoma Department of Mines, 4040 N. Lincoln Blvd. Suite 107, Oklahoma City, OK 73105. (405) 521-3859.

Oklahoma Department of Pollution Control and the Pollution Control Coordinating Board, P.O. Box 53504. N.E. 10th and Stonewall, Oklahoma City, OK 73152. (405) 271-4468.

Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln Blvd. , Oklahoma City, OK 73105.

Oklahoma Water Resources Board, P.O. Box 150, 600 N. Harvey, Oklahoma City, OK 73101. (405) 231-2500.

The Nature Conservancy - Oklahoma Chapter, 23 West 4th St., Suite 200, Tulsa, OK 74103 (918) 585-1117.

TOPIC INDEX

Activity	Indoor	Outdoor	Field Trip	Group	Game	Movement	Sensory Awareness	History	Ethics	Language Arts	Math	Geography	Station Investigations	Art
1 - A	X	X		X		X	X			X				
1 - B	X			X								X		
2 - A	X	X		X		X					X			
2 - B	X									X				
3 - A	X	X					X							
3 - B	X			X		X				X			X	
4 - A	X			X		X				X	X		X	
4 - B	X	X								X			X	X
5 - A	X			X								X		
5 - B	X	X		X		X								X
6 - A	X						X							X
6 - B	X	X		X		X								
7 - A	X			X	X	X		X		X	X	X		X
7 - B	X							X		X	X			
8 - A		X	X							X			X	
8 - B		X	X			X				X			X	
9 - A	X			X	X							X		
9 - B	X			X								X		
10 - A	X			X		X			X	X				
10 - B	X								X	X				

GLOSSARY

A Horizon - the second layer of most soils, also called the topsoil. This layer contains organic matter from plants and animals living in the same area and billions of small organisms which live in the soil. (Topic 4)

Abiotic - nonliving elements of the environment, such as those which make up climate, geology and soil. (Topic 1)

Adaptation - an adjustment to the environment made by a plant or animal so that it can survive in certain environmental conditions. (Topic 2)

Aerial photography - photography showing how land looks when viewed from above the earth, as in an airplane. (Topic 9)

Annual - having a life cycle which is completed in one year or season. (Topic 5)

Aquatic - growing in, living in, or frequenting water. A community in which the majority of members either grow in, live in or frequent the water. (Topic 3)

Aquifer - Underground rocks and compacted soils which are porous enough to hold a lot of water. (Topic 3)

B Horizon - a major layer of the subsoil which is made up primarily of minerals and materials which have disintegrated through the top soil. (Topic 4)

Bedrock - the unweathered parent rock which underlies the soil of an area. (Topic 4)

Biennial - a plant which lives for two years or two growing seasons, usually flowering and producing seeds in the second year. (Topic 5)

Big Four - the four most common grasses which characterize the prairie; Big Bluestem, Little Bluestem, Switchgrass and Indiangrass. (Topic 5)

Biodiversity - the variety of life forms in a given area. (Topic 1)

Biomagnification - a process in which chemicals are accumulated in ever-increasing amounts when progressing up the food chain. (Topic 6)

Biome - a large geographic area with somewhat uniform climactic conditions; a group of communities characterized by a distinctive type of vegetation and maintained by the climate of that region. (Topic 5)

Bison - a large herbivore characterized by a hump behind its head and shaggy, long hair covering the front part of its body. (Topic 7)

Biotic - living elements of the environment, that is, plants and animals. (Topic 1)

C Horizon - a major layer of subsoil below the B Horizon. This layer contains more minerals than the B Horizon as well as larger pieces of disintegrated rock from the bedrock. (Topic 4)

Carnivore - any meat-eating animal. (Topic 6)

Carrying capacity - the number of members of an animal population which a given area can support. This number may vary from year to year, and season to season, depending on the requirements of the animal and the changing climactic conditions. (Topics 2, 7)

Central Flyway - The main migratory route for waterfowl migrating between Canada and Central/South America. (Topic 9)

Chemical energy - see Food energy. (Topic 1)

Chemical weathering - weathering caused by acids which attack rock. These acids are created through oxidation or the combination of atmospheric gases with water vapor. (Topic 4)

Clay - the smallest particle of soil, less than 0.002 millimeters in diameter. (Topic 4)

Climate - the average weather conditions of a given area over time, with weather defined as temperature, precipitation and wind velocities. (Topic 5)

Cloud - a visible mass of water droplets in the earth's atmosphere above the surface of the ground. (Topic 3)

Commitment - a choice made after much consideration. (Topic 10)

Competition - the struggle among organisms for food, space and other requirements for existence. (Topic 7)

Condensation - the process by which a gas (such as steam or water vapor) changes into a liquid. (Topic 3)

Conservation - the use of natural resources in a way that assures their continuing availability to future generations.

Consumer - that member of a food web which utilizes the producers as food (the primary consumer); can in turn be used by other consumers (secondary) as food. (Topic 5)

Deciduous forest - a forest made up of broad-leafed, flowering trees that lose their leaves in winter, or at a particular season. (Topic 1)

Decomposers - bacteria, molds, fungi, etc., that feed on plant and animal material, bringing about the process of decay. (Topic 6)

Deforestation - the clearing of forested land. (Topic 9)

Development - alterations made to a natural site to allow another use. (Topic 10)

Diurnal - daily, active during the daytime. (Topic 2)

Diversity - variety.

Dominant species - a species of animal or plant which plays a major role in a community, influencing and controlling the interactions of other plants and/or animals. (Topic 7)

Echolocation - the method a bat uses to locate food. The bat produces sounds of varied length, frequency and intensity in its larynx, then interprets the location of prey from the reflected signal. (Topic 2)

Ecological niche - the role played by an organism in its biological community; includes its feeding habits, socialization habits, movement habits; and reproductive habits. (Topic 2)

Ecology - the study of the relationships of organisms to each other and to their environment.

Ecosystem - a system of ecologically linked animals and plants that have evolved together in a certain environment. The elements of an ecosystem are mutually dependent. (Topic 1)

Endangered - a species which is in danger of extinction throughout all or a significant portion of its range. (Topic 7)

Energy - the capacity of a body or system to do work, or the measure of this capacity. (Topic 1)

Environment - the total of all the surroundings that has an influence on how living plants and animals are able to exist in that area. This includes the air, water, vegetation, wildlife and human elements of an area.

Erosion - the wearing away of rocks and soil by water, wind and ice. (Topic 4)

Evaporation - the process by which water (or another liquid) turns into vapor. (Topic 3)

Extinction - no longer existing on the earth. A plant or animal is extinct when it has vanished from the earth. (Topic 7)

Fibrous roots - small fiber-like, many-branching clumps of roots characteristic of grasses. Fibrous roots bring water and nutrients into the plant. (Topic 5)

Food chain - the way energy is transferred through food, beginning with a plant, and continuing through the series of animals which eat the plant and then eat each other. Any one species is found in several food chains. (Topic 6)

Food energy - the chemical energy which living organisms take in and utilize in life processes. (Topic 1)

Food web - the interlocking pattern of food chains of a given habitat or environment. (Topic 6)

Forage - vegetation which is a natural food of herbivores. (Topic 5)

Forbs - low growing, annual or perennial herbaceous (not woody) plants. (Topic 5)

Forest - a vegetative community in which trees are the most visible member. (Topic 1)

Grasses - any plant of the family Gramineae, characterized by jointed stems, sheathing leaves, flower spikelets and fruit consisting of a seedlike grain or caryopsis. (Topic 5)

Grassland - a vegetative community in which grasses are the most visible member. (Topics 1, 5)

Grazing - the action of eating grass and other live plant matter. (Topics 6, 8)

Guano - a natural manure, food waste (feces) from bats or birds. (Topic 2)

Habitat - the place or community where a plant or animal naturally grows and lives. Habitat includes the arrangement of food, water, shelter or cover and space which suits an animal's needs. (Topic 2)

Herb - a plant with a soft, not woody, stem that dies to the ground in winter. (Topic 5)

Herbivore - an animal that eats only plant food. (Topics 6,8)

Humidity - the amount of water vapor in the atmosphere. (Topic 8)

Hydrologic cycle - the constant circulation of water through the atmosphere, to land, through land and subterranean routes back to the sea and eventually back to the atmosphere. (Topic 3)

Kinetic energy - Energy created by motion. (Topic 1)

Limiting factor - an influence in the life of a plant or animal which affects its ability to successfully live and reproduce. May be environmentally caused or related to human activities. Limiting factors generally involve the availability of a habitat component. (Topics 2, 7)

Litter - dead leaves and other plant and animal material which has not yet decayed but is present on top of the soil. (Topics 4,8)

Loam - soils with a proportion of sand, silt and clay which allows water to be absorbed or retained and yet easily released to the root systems of plants. (Topic 4)

Management - the intentional manipulation or non-manipulation by humans of a habitat or the organisms within it.

Mechanical weathering - see Physical weathering.

Meristems - tissues which produce new cells responsible for the growth of the plant. (Topic 5)

Migration - Some birds and other animals make annual migrations or travel distances in seasonal movements. Migrations can be lengthy or short distances, and vary from species to species. (Topics 2,7,9)

Mixed grass prairie - prairie dominated by both short and mid-height grasses, usually between two and four feet tall. (Topic 5)

Multiple land-use - a system of management in which lands and waters are used for more than one purpose. (Topic 10)

Neotropical songbirds - various songbirds which nest and breed in North America then fly south of the United States to spend the winter months. (Topic 9)

Nocturnal - active at night. (Topic 2)

Node - the place on the stem where leaves or branches are attached. (Topic 5)

Nonrenewable resources - resources which do not regenerate themselves. Once they have been used, they cannot be replaced. (Examples: rocks, minerals, petroleum, coal)

Nutrients - elements or compounds which are essential to life (required by living organisms). This includes carbon, oxygen, nitrogen, phosphorus, etc.

O Horizon - the topmost layer of soil which is made up of dead leaves and other plant material which has not yet decayed, and animal material, such as feces. (Topic 4)

Omnivore - an animal that eats both plant and animal materials. (Topic 6)

Organic matter - chemical compounds of carbon combined with other chemical elements and generally manufactured in the life processes of plants and animals. (Topic 4)

pH - see Soil pH.

Perennial - living more than two years; or any plant that uses the same root system to produce new growth. (Topic 5)

Pesticide - any chemical preparation used to control populations of organisms, including plants and animals, perceived to be injurious.

Physical weathering - weathering caused by temperature changes or mechanical action from water, wind and/or ice. (Topic 4)

Pollution - harmful substances deposited in the air or water or land which cause a state of dirtiness, impurity, or unhealthiness.

Population - the number of a particular species in a defined area.

Prairie - common name for grasslands, especially those of central North America. (Topic 5)

Prairie mosaic - differences in vegetation types and height found in a prairie ecosystem, primarily due to uneven burning and grazing. (Topic 8)

Precipitation - water which falls to the earth's surface in either liquid (rain) or solid form (snow, hail or sleet). (Topic 3)

Predator - an animal that kills and feeds upon another animal. (Topic 7)

Prescribed burning - the planned application of fire to natural fuels with the intent to confine the burning to a predetermined area. (Topic 8)

Preservation - protection which emphasizes nonconsumptive values and uses, including no direct use by humans, contrasted with conservation which emphasizes both consumptive and nonconsumptive values and uses. (Topic 2)

Prey - animals that are killed and eaten by other animals. (Topic 7)

Primary consumer - a member of the food chain which eats plants or primary producers. Also known as a herbivore. (Topic 6)

Primary producers - green plants which are able to manufacture food from simple organic substances. (Topic 6)

Radiant energy - energy which travels in a wave motion. (Topic 1)

Range - that area which the animal frequents to find food, water and shelter. (Topic 7)

Rare - referring to species of plants, animals,etc. that are few in number. (Topic 7)

Renewable resource - living resources, such as plants and animals, which have the capacity to renew themselves when conditions for survival are favorable.

Resource - a portion of an environment upon which people have placed or assigned value or see as being available for use.

Rhizome - an underground stem, usually growing horizontal to the primary stem, which produces both shoots and roots, thus allowing the plant to spread. Plants with rhizomes are usually perennial. (Topic 5)

Sand - the largest particle of soil. Ranges in size from 0.05 to 2.0 millimeters in diameter. (Topic 4)

Secondary consumer - The members of the level in the food chain which eat other consumers (animals). Also known as a carnivore. (Topic 6)

Shortgrass prairie - prairie dominated by grasses which are less than two feet tall, located in the region just east of the Rocky Mountains in North America. (Topic 5)

Silt - soil particle which ranges in size from 0.002 to 0.05 millimeters in diameter. (Topic 4)

Silt-loam - see Loam.

Soil - mixture of disintegrated rock and organic materials; characteristically broken down as clay, silt and sand. The organic component is humus. (Topic 4)

Soil horizons - layers of soil which indicate the extent of matter decomposition and mineral disintegration. (Topic 4)

Soil pH - the degree of acidity or alkalinity of the soil. (Topics 4,8)

Species - a population of individuals that are more or less alike and that are able to breed and produce fertile offspring under natural conditions.

Stem - the ascending portion of a plant which grows in an opposite direction from the root. The main body of the portion of a tree, shrub or other plant, that is above ground. (Topic 5)

Stewardship - responsible caretaking and management of natural resources for the sake of future generations. (Topic 10)

Stolon - a horizontal stem which grows above, or rests upon the ground. It spreads the plant, like a rhizome. (Topic 5)

Subterranean - meaning "below ground". The environment of a cave. (Topics 1, 2)

Tallgrass prairie - prairie dominated by grass species more than three feet tall. This prairie is found on the eastern edge of the prairie region of North America. (Topics 1, 5, 6, 7, 8)

Threatened species - a species which is present in its range but in such small numbers that it is likely to become endangered. (Topic 7)

Topography - the surface features of the land, caused by geology. Includes mountains, valleys, canyons, riverbeds, etc. (Topics 4,9)

Vegetation - the mass of plants that covers a given area.

Wallow - usually low, wet places on the prairie where bison would roll in the dust to discourage mites and insects from bothering them. Constant use over the years left depressions in the earth which still remain. (Topic 7)

Water - an odorless, tasteless and colorless liquid formed when two parts hydrogen and one part oxygen combine. (Topic 3)

Waterfowl - waterbirds, usually ducks, but including shore and wading birds, geese, etc.

Watershed - an area of land over which water runs to reach a certain place in a drainage system or body of water. (Topic 9)

Weathering - the disintegration and decomposition of rock and already weathered rock debris. (Topic 4)

Wetlands - lands where water is saturated into the soils so that plant and animal communities living there have been determined by, and are dependent on, that state of saturation. This includes marshes and ponds. (Topic 1)

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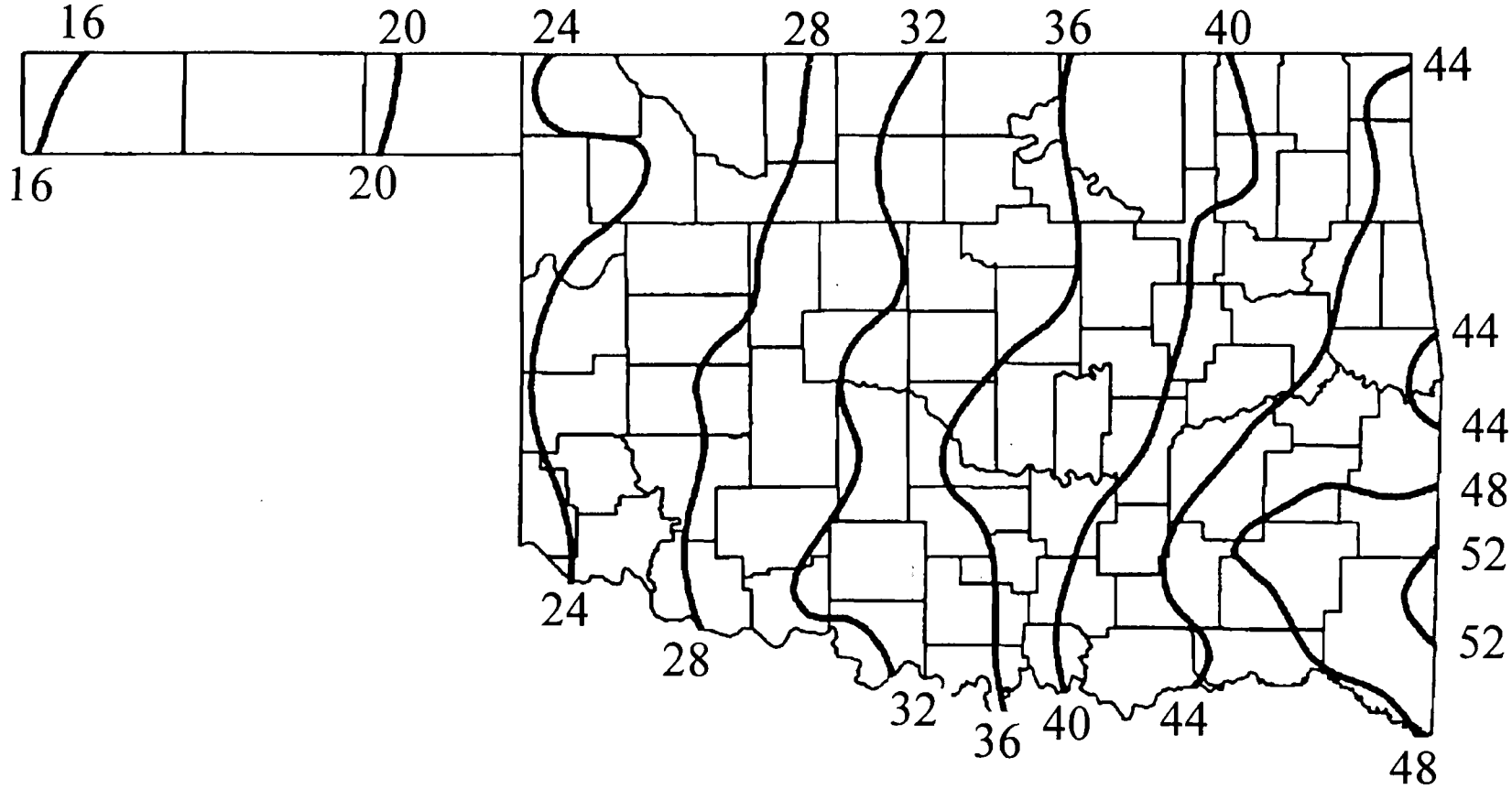
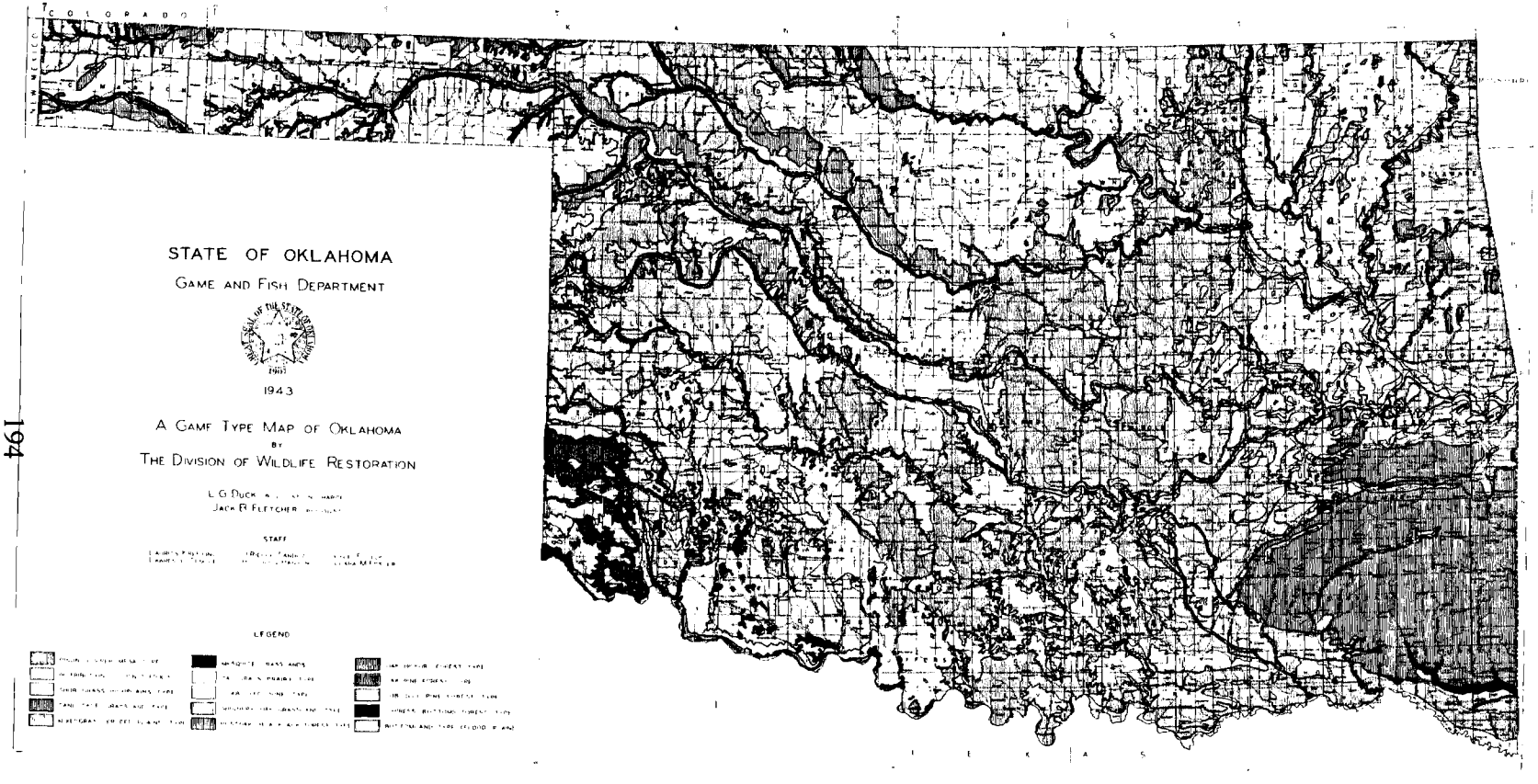


Figure 3.1 Oklahoma mean annual precipitation (inches)


COLORADO
NEW MEXICO
TEXAS
STATE OF OKLAHOMA
GAME AND FISH DEPARTMENT
1943
A GAME TYPE MAP OF OKLAHOMA
BY
THE DIVISION OF WILDLIFE RESTORATION
L.G. DUCK
JACK B. FLETCHER
STAFF
LEGEND

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OKLAHOMA VEGETATION

The original map of Duck and Fletcher (1943) has been reprinted by the Oklahoma Biological Survey with the permission of the Department of Wildlife Conservation.

The state slopes southeastward from an elevation of 1,518 m (4,980 ft) on the Black Mesa in the Panhandle to 99 m (325 ft) along the Red River in the southeastern corner. Topography is generally flat to rolling, exceptions being the Wichita Mountains in the southwest, the Arbuckle Mountains in the south-central section, and the Ouachita, Boston, and Ozark Mountains along the eastern border. Mean annual temperatures vary from 15°C (59°F) at Woodward in the northwest to 18°C (64°F) at Idabel in the southeast. The average frost-free period is about 100 days at Woodward and about 240 days in southeastern Oklahoma. Average annual precipitation varies from 38 cm (15 inches) in the Panhandle and 65 cm (26 inches) in the northwest to 115 cm (45 inches) in the southeast, with well over 130 cm (51 inches) locally in the mountains along the eastern border. The western section has greater extremes of temperature and more variable precipitation than the central and eastern sections. Wind velocities and evaporation rates are much higher in western than in eastern Oklahoma.

The pinon-juniper type represents an eastern extension of the Rocky Mountain flora and is found only in the Black Mesa region of the Panhandle. The shortgrass plains occur in areas of relatively low rainfall and are composed of blue grama, buffalo grass and other xeric species. Along the major rivers of the northern half of the state, there are numerous sandy areas and stabilized dunes, which support sand sage, oaks and various shrubs. The western edge of the state is characterized by a sandy region that is covered with sand sage and islands of a taxonomically complex group of oaks, called oak shinnery. Most of the central part of the state is either covered with blackjack-post-oak forest or was once tallgrass prairie. Since the prairie soils are very rich and suitable for farming, virtually all of the prairie has been modified as a result of grazing or raising crops. The oak forests cover areas of abandoned farmland or represent areas topographically unsuited for farming. The Ozark region is mostly deciduous forest dominated by a variety of oaks and hickories. The southeastern corner of the state is dominated by shortleaf pine or a number of deciduous tree species. Bottomland forests are characterized by willows, cottonwoods, elms, ashes, hackberries, and sycamores.

In general, the grasses and trees become taller and larger from west to east and there is a greater number of species in the eastern part of the state. Although the state is dominated by tall grass and blackjack-post-oak forest, there are representative vegetation types of the Rocky Mountains, High-Plains prairies, tallgrass prairies, Ozark hardwoods and Coastal-Plains forests.

Oklahoma Biological Survey

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