Nature UNBOUND

the impact of ecology on Missouri and the World

MDC DISCOVER nature SCHOOLS

TEACHER GUIDE

Forward

Nature Unbound, this instructional unit, has been developed to help high school students understand how all the pieces of their science knowledge are inter-related and to demonstrate how to connect those pieces to solve the puzzle of the natural world around them.

This teacher guide includes activities that have been designed to be incorporated into and to satisfy the ecology components of a high school biology course. Ecology Course Level Expectations (CLEs) are assessed in the end of course examination for biology, and this unit provides students with relevant content to address those CLEs.

Nature Unbound may also stand alone for high school elective courses in ecology, environmental science or agriculture education and resource management.

Science CLEs are aligned with objectives, content, essential activities and assessment items.

Before you begin, please

- Read through the information in the introductory materials.
- Have students read each chapter before beginning each lesson.
- Adapt activities to suit the needs of your students.

However you decide to incorporate the unit into your science curriculum, the overarching intent of *Nature Unbound* (and of all Discover Nature Schools units) is to lead student learning outdoors and into the natural world—the ultimate laboratory.

Acknowledgments

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Teacher Notes

Discover Nature Schools

Discover Nature Schools (DNS) is a science/conservation education program at its best. Instructional units comprise the backbone of the DNS program and include exciting and engaging hands-on activities designed to bring students in grades K-12 outdoors and closer to nature.

Each unit includes colorful and engaging student books as well as teacher guides with activities designed to meet Missouri Department of Elementary and Secondary Education (DESE) state standards. Grade Level Expectations (GLEs) for elementary and middle school and Course Level Expectations (CLEs) for high school are addressed. DESE at this time has not distinguished biology CLEs specific to ecology. Therefore, the Missouri Department of Conservation has reviewed and assigned those biology CLEs that address ecology for use in this curriculum. Use of science notebooks by students is an important and integrated component.

Lessons guide teachers toward utilizing immediate school grounds (schoolyard ecosystems) as important resources for student learning. At the heart of the DNS program is the belief that the more students equate the outdoors with learning, the more comfortable they become outdoors and the more in tune and familiar they become with outdoor environments. As students become more comfortable and familiar with learning and documenting outdoor experiences, the more they begin to think and act like observant scientists sensitive to and inquisitive about changes in outdoor environments. Many activities in each lesson are designed to be performed outdoors.

Student books and teacher guides (as well as training in their use) are available to all Missouri educators. However, teachers who enroll formally in the DNS program are eligible for additional resources including grant opportunities for field experiences, outdoor classrooms and classroom materials to support specific instructional units.

Timeline for DNS Units

Middle School—*Conserving Missouri's Aquatic Ecosystems*
Available since 2007

Elementary School—*Nature Unleashed: The Untamed World of Missouri Ponds, Forests and Prairies*
Available since 2009

High School—*Nature Unbound: The Impact of Ecology on Missouri and the World*
Pilot - fall of 2010
Available fall of 2011

Kindergarten–2nd grade—*See How the Turkey Grows*
Pilot - fall of 2011
Available fall of 2012

Early Childhood
Pilot - fall of 2012
Available fall of 2013

Unit Overview

Nature Unbound: The Impact of Ecology on Missouri and the World (Nature Unbound) is a unit designed to be taught at the high school level. Ecology CLEs are the primary targets.

Nature Unbound does not teach basic biology course concepts but rather builds on the foundation of prior knowledge achieved by students in biology.

Lessons with activities for teaching each chapter in the student book are provided (see “Lesson Components Overview” for more details) as well as alignment to the Missouri State Standards. An alignment piece in the form of a continuum chart is provided to reflect alignment of *Nature Unbound* to Grade Level Expectations (GLEs) in prior learning, Course Level Expectations (CLEs) in targeted learning; and Science College Board Standards for College Success in future learning.

Essential activities should be taught sequentially in order to guide students toward designing a field study or a multi-step plan—gathering, recording and organizing data while outdoors and presenting a report of findings to the class. The Lesson 9 activity incorporates this field study or plan as a culminating activity. This is intended to allow students the chance to demonstrate their ability to think and act like scientists and to provide a key assessment piece for the teacher.

Nature Unbound activities are designed to be adapted easily by teachers to meet student needs. Most activities in this unit are designed to get students outdoors and exploring, investigating and asking questions about immediate areas around their school. Science notebooks are integrated into each activity and can play a key role in student learning. By using science notebooks, students model the behavior and investigation methods of scientists. A variety of activities has been included to provide tools to meet diverse learning styles of students and to allow for teaching styles and preferences.

A detailed outline of answers to objectives is included with each lesson for teacher reference. Formative and summative assessments are also provided for each lesson.

A brief “misconception quiz” has been included and should be administered to students before beginning the unit to help identify and address any science concept misconceptions students may have.

Students should take the pre-test at the beginning and again as a post-test at the end of the unit. Pre- and post-test scores are important tools for assessment of student learning and for evaluation of the *Nature Unbound* unit.

Learning Outdoors

Most activities for *Nature Unbound* lessons are designed to be held outdoors. Tips for providing successful outdoor learning mirror tips for basic, traditional indoor classroom management and learning:

- Establish rules for outdoor experiences.
- Become familiar with the outdoor areas to be used for the unit’s activities.
- Locate and identify for students any poison ivy, thorny brush, etc. to be avoided.
- Ensure that students are aware of their assignment(s) and time limit(s) as well as study/assignment locations, signals for gathering, signals for time, etc.
- Discuss the importance of being prepared for outdoor learning: weather-appropriate attire, insect repellent, sunscreen, etc.
- Provide field guides and/or encourage students to draw detailed pictures and write descriptions “to solve outdoor mysteries” when they return to the classroom.
- Embrace unexpected teachable moments that might “interrupt” an outdoor learning experience.
- Provide time for students to reflect on each outdoor learning experience.
- Share your reflections with your students.

Unit Time Frame

Nature Unbound unit (all lesson activities)—approximately 3 to 4 weeks excluding assessments.

"Estimated Time" section suggests how much time it may take to teach each lesson and activity. Actual time will be affected by the following factors:

- daily schedule of the school
- need for review of previous learning based on the extent of student prior knowledge
- need for reteaching based on the results of formative assessments
- additional resources/knowledge of teacher
- time allotted for group presentations based on class size
- time allotted for cooperative learning ativities
- number of activities given as homework rather than completed as class activities
- availability of resources for student use
- number and type of "Extension Activities" and "Optional Activities" used

Lesson Title	Estimated Time
Lesson 1: **What is Ecology?**	**Activities 1.1, 1.2, 1.3**—50 minutes
Lesson 2: **Reproduction and Adaptation**	**Activities 2.1, 2.2, 2.3**—50 minutes
Lesson 3: **Population Checks and Balances**	**Activities 3.1, 3.2, 3.3**—50 minutes
Lesson 4: **Interactions—Costs and Benefits of Survival**	**Activities 4.1, 4.2**—50 minutes
Lesson 5: **Extinction—Causes and Consequences**	**Activities 5.1, 5.2**—50 minutes
Lesson 6: **Exploring the Nature of Energy Flow**	**Activities 6.1, 6.2**—50 minutes
Lesson 7: **The Cycling of Elements Through Ecosystems**	**Activities 7.1, 7.2**—50 minutes
Lesson 8: **Diversity and Disturbance of Biological Communities**	**Activities 8.1, 8.2, 8.3**—50 minutes
Lesson 9: Culminating Activity— **Researching and Planning Like a Resource Manager**	Minimum of (2) 50-minute class periods and 1 day for a field experience

Lessons

A lesson is defined as a logical grouping of information to be taught. Individual lessons will most likely be taught over several days. A lesson in this teacher guide does not necessarily equate to a daily lesson plan. Lessons correspond to chapters in the student book. Lesson 1 in the teacher guide corresponds to Chapter 1 in the student book.

Lesson Components

Estimated Time—Estimated time for each lesson indicates the approximate time to teach the Essential Activities of the lesson. Estimated time for each activity **does not** include time for student reading of the chapter and may be adjusted for class discussions and outdoor research.

Science CLEs—Only CLEs specifically addressed in each lesson are listed. Any portion of a CLE not addressed will have a line drawn through it.

Vocabulary—Vocabulary listed in each lesson reflect terms bolded in the corresponding chapter in the student book. These are key terms that students must master to fully comprehend the concepts being addressed. These terms are listed in the CLEs and will be assessed. They are defined in the student book text and glossary.

Lesson Objectives—Objectives addressed in the lesson are listed.

Resource Management Objectives—Objectives addressed in the lesson are listed.

Essential Questions for the Lesson—Essential questions are provided to guide students toward field investigations that have the potential to provide rigorous and engaging inquiry experiences. Essential questions may be used to set the stage for the lesson. They may be listed on a bulletin board, blackboard, whiteboard, etc. and are intended to help students think and address questions and ideas as scientists.

Teacher Notes—This section provides information to help teachers prepare for the lesson. It may contain additional content information, notes or comments about the lesson, any necessary advanced preparation as well as suggested references for background information.

Outline of Answers to Objectives—Content addressed by each objective has been outlined and included in each lesson. Page numbers included at the end of each objective refer to the relevant pages in the student book.

Essential Activities—Most lessons have at least two Essential Activities. These activities address and help meet lesson objectives and CLEs listed for each activity.

Essential Activities include:

- Estimated time
- Objectives
- Teacher preparation
- Materials
- Procedure
- Wrap up
- Assessment

Extension Activities—Extension activities are either optional portions of an Essential Activity or follow-up activities to an Essential Activity. Extension Activities enhance the Essential Activities but are not required to meet the lesson objectives.

Optional Activities—Optional activities do not necessarily enhance specific activities nor are they required to meet lesson objectives. They do provide opportunities for further study related to the lesson. They may also provide an alternative way to teach one of the essential activities. If there are no optional activities for the lesson, this section heading will not be listed.

Summary—This is the "Big Ideas" list provided at the beginning of the corresponding chapter in the student book.

End of Chapter Assessment—This section provides an opportunity for teachers to evaluate and adjust/revisit their instruction through assessment of student learning (i.e., what needs to be re-taught before moving on to the next lesson). Some or all of the items may be used in different ways depending on teacher preference and student needs. An answer key with possible points for each item is provided.

Examples of some ways to use an End of Chapter Assessment:

- Advanced Organizer—Students complete required items as they read the corresponding chapter. These are reviewed to determine student learning and understanding or are referenced during discussions and revised by students as needed.
- Cooperative Learning—Incorporate items into group discussions.
- Worksheet—Items used as in-class activity/activities or as homework when appropriate. Answer key may be used to grade responses.
- Quiz—All or part graded after completing all Essential Activities.

Student Science Notebooks

Science notebooks are an extremely useful tool for students and teachers alike. They promote good data collection and record-keeping habits and provide reference tools for students. For teachers, they provide ample opportunity for assessment of student work and data organization.

An excerpt from *Using Science Notebooks in Elementary Classrooms* by Michael P. Klentschy published in *NSTA Reports* (monthly newspaper of the National Science Teachers Association), September 2008, Volume 20, Number 1, has been reprinted and included below with permission of NSTA. This excerpt provides useful information on different approaches to and support for the use of science notebooks.

Klentschy (2008) states in the excerpt cited above that "scientists keep notebooks; students should do likewise. Scientists' notebooks include what worked and what did not work in the investigation. They sometimes learn much more from what did not work."

Activities in this teacher guide encourage students:

1. To develop their own methods of collecting, recording and presenting data from investigations and long-term observations
2. To share, compare and discuss their methods and findings with other students
3. To re-evaluate their methods, discuss whether or not their investigation was a "fair test" and discuss possible alternatives to their methods
4. To maintain permanent records of all their discussions, observations, data recording methods, etc.
5. To create testable questions, hypotheses and experiments or field research studies

In this way, students are provided "with the opportunity to use science notebooks in much the same way scientists do" and students begin to recognize science notebooks as useful resources for future studies whether the methods used were successful or not.

Science notebooks are important to use with most of the activities found in *Nature Unbound*. Students should record the basic information suggested in the science notebook headings on each outdoor (field) excursion. Abiotic factors such as weather and temperature will affect what they see. As students gather data throughout this unit, they should compare these field notes and draw correlations between abiotic and biotic factors. The data collection sheets supplied with some activities may be attached to the appropriate blank page in a science notebook.

Heading information may vary, but the following basic information should be included for each activity heading. Repetition of this process will reinforce good record-keeping and data collection techniques useful to students throughout their school experiences as well as their lives.

Science Notebook Headings

Title
Date
Time
Location
Air temperature (recorded outside)
Weather conditions* (recorded outside)
Rainfall

* Weather conditions include cloud cover, wind speed and direction, humidity, etc. Students may collect information via the Web (http://www.noaa.gov). Collection of this weather-related data over time provides students the opportunity to correlate weather and weather patterns to organisms and organism behavior. Students should write summaries of such correlations and draw conclusions. How does weather affect animal behavior? How does it affect migration? How are plants affected by the weather?

Klentschy, M.P., *Using Science Notebooks in Middle School Classrooms*, NSTA Press (Arlington, Virginia), 2010

Additional Resources

Britsch, Susan and Daniel P. Shepardson. "The Art of Reviewing Science Journals." *Science and Children*, Nov–Dec 2004. pp. 43–45
Campbell, Brian and Lori Fulton. *Science Notebook: Writing About Inquiry*. Portsmouth, NH: Heinemann. 2003
Campbell, Brian and Lori Fulton, "Student-Centered Notebooks." *Science and Children*, Nov-Dec 2004. pp. 26-29
Calhoun, Jeri and Ellen Mintz. "Project Notebook." *Science and Children*, Nov-Dec 2004. pp. 30-34
Leslie, Clare Walker and Charles E. Roth. *Nature Journaling*. Vermont: Storey Books. 1998
Moriarty, Robin, Jeff Winokur and Karen Worth. "Capitalizing on Literacy Connections." *Science and Children*, Feb 2004. pp. 35-39

Body of the Notebook

Many of the activities start with a question and/or ask the students to develop a question. What students record in their science notebooks may vary according to topic but should include:

- **Record of observations** including labeled sketches
- **Data collection**—Provided data sheets should be incorporated into science notebooks. Encourage students to create their own graphic organizers (data tables, classifying charts, claim and evidence charts, etc.) in their notebooks.
- **Conclusion and/or Summary**—Summarized information collected and answers to questions provided or questions created by students.
- **Reflection**—Reflections on the process, recorded and shared.
  Were there other ways to collect the data?
  Were there tools that might have been better to use?
  What other way(s) could the investigation or experiment have been conducted?
  What other questions could/should have been asked?
- **Page numbers**—Table of contents and page numbers (to allow reference to previous experiences)

National Science Teachers Association Article

Editor's Note: *NSTA Press publishes high-quality resources for science educators. ... The following excerpt comes from* Using Science Notebooks in Elementary Classrooms *by Michael P. Klentschy, edited for publication here. NSTA Press titles are available online through the NSTA Science Store at* www.nsta.org/store.

Student science notebooks are advocated by researchers who believe that writing in science enhances student understanding of science content and process skills. Student science notebooks can be embedded into the science curriculum as a natural part of the goal to assist students in making evidence-based explanations of their science investigations.

The student science notebook is more than a record of data that students collect, facts they learn, and procedures they conduct. It is also a record of students' reflections, questions, predictions, claims linked to evidence, and conclusions, all structured by an investigation leading to an understanding of "big ideas," not just factoids in science. As such, a science notebook is a central place where language, data, and experience work together to form meaning for the student. This form of competence or expertise is developed through active construction of knowledge. Students need time and practice using science notebooks to attain expertise.

Student science notebooks, used well, become an embedded element in the curriculum and thus serve as a ready source of recorded data for both the student and the teacher. They become a direct measure of student understanding of the implemented curriculum and an important means for formative assessment. The science notebooks also reflect an accounting of the progression of an investigation as students formulate and record questions; make predictions; develop a plan of action; record observations, measurements, and data; link claims to evidence; and finally reflect on the investigation. They are the students' personal record that can be referred to and revised throughout an investigation or even an entire unit of study. The science notebooks also serve as the evidence used in group and class discussion.

There are many different approaches to having students create and utilize science notebooks: composition books, blank lab books, lined sheets of paper stapled together or loose-leaf binders.

In primary grades, class or group science notebooks may be created for a unit of study instead of individual student notebooks. Classroom teachers often form covers in the shape of the unit of study, such as a round cover if the students are studying the planets or the Moon. Students as early as kindergarten should be encouraged to keep a record of science investigations. Often these entries will come in the form of scribbles or drawings only decipherable to the student. These form the foundation for later work, when more specific criteria and writing prompts or sentence starters are more formally introduced. The main objective is for teachers to initially provide students with the opportunity to record their science investigation. ...

Scientists keep science notebooks; students should do likewise. Scientists' notebooks include what worked and what did not work in the investigation. They sometimes learn much more from what did not work. These notebooks include data, drawings, charts, and reflections, as well as new questions. Scientist entries are a record of what was learned at the time of the investigation and are not crossed out or erased when new discoveries take place. Newer ideas, thoughts, and reflections are added as new entries. Classroom teachers should adjust their teaching to provide students with the opportunity to use science notebooks in much the same way scientists do.

Citations [from full article]

Amaral, O., L. Garrison, and M. Klentschy. 2002. Helping English learners increase achievement through inquiry-based science instruction. *Bilingual Research Journal* 26 (2): 213–239.

Campbell, B. and L. Fulton. 2003. *Science notebooks*. Portsmouth, NH: Heinemann.

Klentschy, M., and E. Molina-de la Torre. 2004. *Students' science notebooks and the inquiry process. In Crossing borders in literacy and science instruction: Perspectives on theory and practice*, ed. W. Saul, 340–354. Newark, DE: International Reading Association.

Klentschy, M. P., *Using Science Notebooks in Elementary Classrooms*, NSTA Press (Arlington, Virginia), 2008

Rivard, L., and S. Straw. 2000. *The effect of talk and writing on learning science: An exploratory study*. Science Education 84 (5): 566–593.
Shepardson, D., and S. Britsch. 2001. *The role of children's journals in elementary school science activities*. Journal of Research in Science Teaching 38 (1): 43–69.

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Field Investigations

Use of science notebooks and field investigation techniques by students are integrated components of the *Nature Unbound* unit. The following excerpt from *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes* developed for the Association of Fish and Wildlife Agencies' North American Conservation Education Strategy and developed by the Pacific Education Institute is included here to provide teachers with background information on the importance of field investigations and how it relates to student learning.

Field investigations help students become **systems thinkers**, learn the skills of scientific inquiry, and understand that science **doesn't only happen in a laboratory or classroom**. Outdoor experiences in natural settings increase students' problem solving abilities and motivation to learn in social studies, science, language arts and math.

When planning and conducting field investigations, students and scientists grapple with the difficulties of working in a natural system and at the same time develop an understanding of its complexities and subsystems. Systems-thinking involves thinking about relationships, rather than about individual objects. A system can be defined in a number of ways:

- An assemblage of inter-related parts or conditions through which matter, energy, and information flow.
- An organized group of related objects or components that form a whole.
- A collection of things and processes (and often people) that interact to perform some function. The scientific idea of a system implies detailed attention to inputs and outputs and interactions among the system components.

State and national science education standards encourage instruction that focuses on problem-solving and inquiry—activities which characterize the pursuits of scientists. In field investigations, students pose a research question then plan and conduct an investigation to answer that question. Students use evidence to support explanations and build models, as well as to pose new questions about the environment. Students learn that the scientific method is not a simple linear process and, most importantly, experience the difficulty of answering essential questions such as:

- What defines my environment?
- What are all the parts and interrelationships in this ecosystem?
- What is a healthy environment?
- What is humans' relationship to the environment?
- How has human behavior influenced our environment?
- How can our community sustain our environment?
- What is my role in the preservation and use of environmental resources?

Field investigations help students become informed citizen scientists who add knowledge to the community's understanding of an area in order to make issues of concern visible and share differing points of view about the preservation and use of community natural resources.

Classroom science often overemphasizes experimental investigation in which students actively manipulate variables and control conditions. In studying the natural world, it is difficult to actively manipulate variables and maintain "control" and "experimental" groups, so field investigation scientists look for descriptive, comparative, or correlative trends in naturally occurring events. Many field investigations begin with counts (gathering baseline data). Later, measurements are intentionally taken in different locations (Ex. urban and rural, or where some natural phenomenon has created different plot conditions), because scientists suspect they will find a difference. In contrast, in controlled experiments, scientists begin with a hypothesis about links between variables in a system. Variables of interest are identified, and a "fair test" is designed in which variables are actively manipulated, controlled, and measured in an effort to gather evidence to support or refute a causal relationship.

For conceptual clarity, we have identified three types of field investigations—descriptive, comparative, and correlative.

Descriptive field investigations involve describing and/or quantifying parts of a natural system.	Comparative field investigations involve collecting data on different populations/organisms or under different conditions (Ex: times of year, locations) to make a comparison.	Correlative field investigations involve measuring or observing two variables and searching for a relationship.

Each type of field investigation is guided by different types of investigative questions. Descriptive studies can lead to comparative studies, which can lead to correlative studies. These three types of studies are often used in combination to study the natural world.

Ryken, A. E., Otto, P., Pritchard, K., & Owens, K. (2007). *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes*. Pacific Educational Institute.

Reprinted with permission from Dr. Margaret Tudor, Co-Executive Director of the Pacific Educational Institute, Market Place Office Building, 724 Columbia St. NW, Suite 250, Olympia, WA 98501 (mtudor@wfpa.org).

Collection of Organisms

Not all organisms need to be captured. Many organisms, including insects, may be identified by recording observations in the field and using field guides, Internet, etc. in the classroom. If it is necessary to capture an organism for identification and/or observation, release it where it was captured. Obtain permission to collect specimens whether collecting them from the schoolyard ecosystem or other sites. Collection permits may be required. Some areas, including state conservation areas, require a wildlife collector's permit even if captured specimens are to be released unharmed.

Assessment Strategies

Several different assessment strategies are available at the end of each lesson to help determine whether students have grasped and fully understand the concepts addressed in the objectives. Both formative and summative assessment items are provided.