A RANGELAND EDUCATION PROGRAM FOR IDAHO'S CLASSROOMS

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AUTHORIZATION TO SUBMIT THESIS

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ABSTRACT

Idaho's predominant land type is rangeland (43% of land cover). However, nearly half of respondents in a 1997 Idaho survey indicated they know little about rangeland issues. One way to increase Idaho's citizens' knowledge of rangelands was to develop and implement a range education program in Idaho's classrooms. The objectives of this rangeland education project were to: (1) assess what Idaho teachers need regarding rangeland education; (2) develop a rangeland education program that meets these needs; and, (3) train teachers to use a rangeland education program. During 2000, Idaho teachers were surveyed, interviewed, and observed to determine their needs and preferences in an educational program. Other natural resources education programs (i.e., Projects WILD, WET, and Learning Tree) were studied to determine elements that made them successful. The most successful projects focused on student-centered learning, skills integration and transfer, and connections to local environments. A science education program based on rangeland plant identification and inventory was developed. The program includes a plant identification manual, a field lab manual, and equipment to complete the field procedures. Procedures include an ecological site inventory, ground cover survey, biomass estimation, and plant species survey. Summer workshops were held in 2001 to train teachers to use the program. Teachers were given classroom sets of equipment and manuals, and practice collecting and analyzing rangeland data. About 30 teachers attended the workshops and pledged to use program components during the 2001-2002 school year.

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CHAPTER I

What Science Teachers Need in a Rangeland Education Program

Idaho's predominant land type is rangeland; the open unforested land that characterizes the image of the American West. Idaho's rangelands and the uses and values derived from them are extremely important to Idaho's economy, ecological health, natural beauty, and cultural heritage (Harp and Hyde 1999). The majority of Idaho's rangeland (69%) is public land managed by government land agencies (Sharp and Sanders 1978), which are influenced by public opinion. All of Idaho's citizens can influence rangeland management policy; however, nearly half of respondents in a 1997 Idaho survey indicated they know little or nothing about rangeland issues (Harp and Hyde 1999). The perceptions of this uninformed population could have an unknown impact on current and future rangeland management policies in Idaho.

One way to increase the knowledge of Idaho's citizens regarding rangelands is to develop and implement a rangeland education program in Idaho's classrooms. This would give Idaho's future citizens and policymakers an objective knowledge base on which to form opinions. Training teachers in a rangeland science education program and providing materials and incentives for classroom implementation is an effective way to achieve the greatest return on investment in terms of numbers of students reached.

Background

In Idaho today, the decisions about whether to teach natural resource topics or what program to use in teaching is largely up to individual teachers. Certified teachers are required to take 6 continuing education credits every 5 years. Many of these teachers interested in biology and natural resources often take training workshops for programs like Projects WILD, WET, Learning Tree, GLOBE (Global Learning and Observations to Benefit the Environment), and others. University students majoring in education are also offered training at the University of Idaho and Boise State University in these programs. Though teachers are trained in these programs, they may not be implemented in classrooms. Teachers may not be able to implement the programs because of time constraints, lack of supplies, inadequate training, or lack of incentives or administrative support.

Teachers were not required to address natural resource topics until July 1, 2000 when new Idaho State Exiting Standards for science took effect (Idaho State Board of Education 2000). The exiting standards include sections on social and personal perspectives in science. The content knowledge in these sections includes: identifying environmental issues in Idaho, population growth and natural resources, understanding the roles of natural resource managers of public and private lands, exploring the role of land ownership in land use decisions, differentiating between preservation and conservation, and other natural resource issues in science. Teachers are now seeking ways to meet these standards in their science classes.

Justification for Including Rangeland Studies in Idaho's Classrooms

There are several natural resource education programs currently in place in Idaho's schools; however, coverage of rangeland topics in these programs is sporadic at best, and is often absent. Following are some key reasons that rangeland ecology can and should be included in Idaho's classrooms:

- Rangelands are a major land component in Idaho. Approximately 22 million acres, or 40% of Idaho's land area, are classified as rangeland (Sharp and Sanders 1978). This includes open forests, mountain meadows, mesic grasslands, sagebrush grasslands, juniper woodlands, and salt-desert shrublands (Tisdale 1986). Additionally, most of Idaho's urban centers (i.e., Lewiston, Boise, Twin Falls, Pocatello, and Idaho Falls) are surrounded by rangeland. Residents of these towns often recreate on local rangelands and are affected the activities that occur there.
- A large proportion of the rangeland in Idaho is publicly owned land. The federal government owns about 64% of Idaho's land area, which is primarily managed by the US Forest Service and the Bureau of Land Management, and the state manages 5% of Idaho's land area (ID Dept. of Commerce, 2000). This means every citizen owns, has access to, and affects policy decisions concerning rangelands. Rangeland issues are often complex political issues that involve a wide array of people and interests.
- Rangelands are a major natural resource in Idaho that has been mostly overlooked in other natural resource education programs. Several excellent long-standing programs are in place to educate students about forests, wildlife, and water resources. Only recently have new programs begun to address

rangelands. These include SITE (Students Investigating Today's Environment) Noxious Weeds, Burning Issues, and the Idaho Natural Heritage Project. These programs will be discussed in further detail below. They were presented for the first time in the summer of 2000, and limit their discussion of rangelands to specific ecological topics, like fire and weeds.

- Rangeland education is an opportunity to integrate science, math, social studies, and language arts in Idaho's schools. Understanding rangeland topics requires the use of all these skills. Rangeland issues can be designed and presented as problem-based lessons or projects that require several skills and disciplines to complete.
- Rangeland education can be used to meet objectives of the Idaho State Exiting Standards for social and personal perspectives in science. Rangeland projects or lessons could effectively provide instruction about natural resources, public land issues, local environmental issues, and conservation issues.

Natural Resources Education Curricula Used in Idaho

The major curricula used in Idaho can be separated into two categories; activity-based or inquiry-based curricula. Most programs are activity-based, such as Projects WET, WILD, Learning Tree, and the Idaho Natural Heritage Project. The programs are compilations of relatively short activities organized into themes. The activities have the same general format, including Objectives, Background, Materials, Procedures, Assessments, and Extensions. These activities are engaging, "hands-on" projects that are mostly examples, stories, or hypothetical demonstrations designed to illustrate ideas or principles of specific topics. The "Extensions" section of the activities involve deeper scientific investigations and

critical thinking about the subject. The activities can be used individually or as a unit with others.

The scientific inquiry-based programs are distinct in that they allow students to conduct experiments and collect and analyze data. The students must also report their findings to scientists, administrators, or other students. These programs allow in-depth investigations of topics of interest to the students. The GLOBE Project and SITE are examples of inquiry-based programs. GLOBE is an international database of environmental information collected by students around the world. Each school's data and analyses are available to other GLOBE schools. SITE is an Idaho-based project developed by Robert Beckwith, a biology teacher in Eagle, Idaho. The original project was a water quality monitoring program based on the Idaho Department of Environmental Quality protocols. The SITE Noxious Weeds project was recently developed to locate and quantify noxious weed infestations, based on Idaho Department of Agriculture standards.

Project Learning Tree

Project Learning Tree was one of the first national natural resources education programs. It is a preschool to 12th grade program, first released in 1975, and last updated in 1992. It is sponsored by the Council for Environmental Education and the American Forest Foundation. There are 88 activities in Project Learning Tree, divided into seven main themes: Environmental Awareness, Diversity of Forest Roles, Cultural Contexts, Societal Perspectives on Issues, Management and Interdependence of Natural Resources, Life Support Systems, and Lifestyles. The goals of Project Learning Tree are to develop awareness and knowledge of the

renewable and nonrenewable resources of our planet. There is no reference to rangelands in the activities, except for isolated sections about wildlife habitat.

Project WILD

Project WILD is a Kindergarten to 12th grade (K-12) curriculum sponsored by the Council for Environmental Education and the Western Association of Fish and Wildlife Agencies. This program was introduced in 1983, and a second edition was released in 1992 (WAFWA and CEE 1992). The major themes and organization of the activities are: a. wildlife awareness and appreciation; b. values of wildlife; c. ecological concepts; d. conservation and management of wildlife and habitat; e. people and wildlife; f. issues and consequences, and; g. human actions. The stated goal of Project WILD is "to assist learners of any age in developing awareness, knowledge, skills, and commitment to result in informed decisions, responsible behavior, and constructive actions concerning wildlife and the environment upon which all life depends" (Project Wild 1996). According to the Idaho Department of Fish and Game, about 80% of Idaho's teachers have Project WILD in their classrooms (Idaho Fish and Game 2000). The activities in Project WILD do not directly address rangelands, but some of the activities related to habitat or habitat loss, carrying capacity, riparian areas, and public land issues deal indirectly with rangelands.

Project Wet

Project Wet is a K-12 curriculum sponsored by The Watercourse and the Council for Environmental Education, and was introduced in 1995 (Watercourse and CEE 1995). The main topics covered are watersheds, wetlands, groundwater, water and environmental history, and water conservation. The goal of Project WET

is “to facilitate and promote awareness, appreciation, knowledge, and stewardship of water resources through the development and dissemination of classroom-ready teaching aids and through the establishment of state and internationally sponsored Project WET Programs” (Project WET 1995). This program is dedicated to water resources and water quality, and the main inferences to rangelands are limited to discussions of upland components of watersheds, riparian areas, and water pollution issues.

Global Learning and Observations to Benefit the Environment (GLOBE)

GLOBE is an international project sponsored by the National Aeronautical and Space Administration and the National Oceanic and Atmospheric Administration, designed for students age 5 to 18. There are about 94 countries currently participating. The major educational elements of the GLOBE program are: a. selecting local study sites; b. taking careful measurements on a regular schedule; c. data submission on the GLOBE website (www.globe.gov); d. completing learning activities; e. using the GLOBE website and database to communicate and explore, and; f. promoting investigations by students. The major investigative sections of GLOBE include Atmosphere, Hydrology, Soil, Land Cover/Biology, GPS, and Seasons. There are several protocols or experiments in each section. For example, in the Land Cover and Biology investigation, the protocols are designed to help ‘ground truth’ a satellite pixel near where the students live. The protocols include qualitative and quantitative cover measurements for trees and herbaceous vegetation, identification of tree species, and classification of land type by the Modified UNESCO Classification (MUC) scheme, an international ecological land cover classification system (GLOBE 1997). Students can also delineate land cover

types on a satellite image. Students use a computer program called Multispec to cluster pixels on their image then assign MUC classes to the clusters to create their own land cover map. Students then assess and validate the accuracy of their sample sites with a difference/error matrix. Each of the major investigations includes these types of in-depth studies of local sites. While the MUC classification system used in GLOBE delineates major rangeland vegetation regions, it does so in an 'ecological biome' fashion, and does not address details of North American rangelands. Additionally, the GLOBE program has no plant identification keys for vegetation other than trees. Students living in southern Idaho and participating in GLOBE Land Cover investigations could not learn to identify the vegetation in their study areas beyond classification as 'Grass' or 'Forb', and the data sheets exclude shrubs altogether. For students in southern Idaho and in much of the western United States, this would limit descriptions and understanding of their study site characteristics.

Burning Issues

Burning Issues is a new program developed by the Bureau of Land Management about fire ecology. It includes a notebook of activities, and an interactive CD-ROM that explores the effects of fire in different ecosystems. The Burning Issues teacher training workshop uses a combination of activities and discussions about fire ecology and management in the major vegetation zones in Idaho. The only rangeland ecology issue directly addressed in the program is a section on sagebrush steppe fire ecology. To earn continuing education credit, the teachers work in groups to perform a fire related drama at the end of the week. It is unclear if

the teachers were expected to implement the workshop activities in their classes, or if the workshop was simply intended to inform and educate the teachers.

Students Investigating Today's Environment (SITE)

SITE is a state-centered water quality testing program developed by Robert Beckwith, a biology teacher at Eagle High School. It is aimed at science students in grades 6-12. One lab notebook includes all the protocols, data sheets, and reference tables that the students need to complete the project. The water monitoring protocols are based on Idaho Environmental Protection Agency (EPA) standards, so the data collected by students is scientifically valid and useful to water quality experts. The SITE program requires teachers to take their students to the field three times to collect data. First, students learn the protocols in the classroom. When students visit a study site, they work in groups to conduct experiments and collect data. Then, students return to the classroom to compile and report the data to the SITE web database (www.wqi.org), which can be accessed by other SITE schools. At the end of the school year they participate in a statewide showcase to display research posters and give presentations based on their data, much the way professional scientists present their research at professional meetings.

The SITE project also held workshops in 2000 and 2001 that focused on noxious weeds. With the help of the Idaho Rangeland Resource Commission (IRRC) and the Idaho Department of Agriculture, teachers were taught about noxious weeds in Idaho and given a project for them to take their students out to monitor weed populations in their area. The steps of the program are essentially the same as the aquatic SITE program. Teachers instruct students in the protocols and take them out three times to collect data on noxious weeds in their area. Students compile and

analyze the data and report it to a SITE/Noxious Weeds database for use by other schools and county and state noxious weed professionals. The students that participate in the weeds program also complete projects and participate in the SITE showcase at the end of the school year.

The Idaho Natural Heritage Project

The Idaho Natural Heritage Project is an educational outreach program sponsored by the Sawtooth Science Institute, for K-12 classrooms and informal educators. There are three themes or chapters to this program. The first theme is "Understanding the Work of Nature." It includes lessons about biodiversity, habitats, species adaptations, the flow of energy through natural systems, and the interrelationships of species in an ecosystem. The second theme, "Appreciating Nature's Services," deals with the products we receive from nature, the services that healthy watersheds and soils provide us, and the spiritual benefits we receive from nature. The third theme, "Conserving the Diversity of Life," includes lessons about species extinctions, causes of extinctions and reduced biodiversity, the effects of human lifestyles on nature, and heroes of the conservation movement. Each theme includes a "treasure chest" with items like animal skins, pictures, plastic tracks, bones, and other props for students to feel and examine. Each trunk also has a notebook of activities about the themes. The Sawtooth Science Institute also offers a traveling display for schools, fairs, and other public events. This display is a three-sided floor-to-ceiling display with a computer kiosk for interactive learning activities. The trunks and traveling exhibit are available to teachers and informal educators on one-month loans.

Elements of a Good Rangelands/Natural Resource Education Program

All of the programs discussed above are good programs, and several have won national awards for their environmental education efforts. While their approaches to natural resources education may differ, their basic elements are quite similar. The following is a summary of key elements that a rangeland education program needs, based on the programs that were reviewed and environmental education literature:

- *Interested, knowledgeable, and skilled teachers.* Teachers should have enough training about rangeland ecology and issues, adequate support personnel and/or background materials, and should be informed and excited about rangelands in some way. Teachers tend not to teach topics they do not know thoroughly or in which they are not interested. The amount of time teachers spend teaching environmental subjects is directly related to the amount of in-service or pre-service training the teachers have received (Knapp 2000).
- *Student-centered, project-based learning.* Student-centered or constructivist learning changes the role of the teacher from lecturer to facilitator. Facilitators do not give students answers, they provide sources for students to find the answers. Inquiry-based learning allows students and teachers to focus on problems or topics that interest them most (Lord 1999). Students conduct their own experiments and collect real data, that they then analyze or use to complete the project. These methods of learning can lead to deeper understanding of information by students (Lord 1999).
- *Integration and transfer of skills.* Students should be able to use skills they have learned in science, math, social studies, and/or geography to conduct ecological

experiments and examine rangeland problems and issues (North American Association for Environmental Education 1998). Students should learn to use existing knowledge and skills to gather information needed to complete a project or solve a problem.

- *A sense of place, or connections to the local environment.* Students should gain understanding of the ecology and issues of their area. This will help them develop into active, responsible citizens of their community (Sanger 1997).

Objectives

The objectives of this rangeland education research project were to:

1. Assess the needs of Idaho teachers concerning rangeland education.
2. Develop a rangeland education program that meets the needs of Idaho teachers.
3. Train teachers to use the rangeland education program that is developed.

Methods

To develop a rangeland education program and meet my project objectives I first surveyed teachers to determine the formats, topics, and resources they needed. Based on this information I selected an appropriate format and layout for the rangeland education program. Once the general structure of the program and its components were chosen, the topics and protocols were developed. Drafts of the program components were field-tested by students and rangeland specialists and modified as needed. After the appropriate revisions were finished, the program was presented to teachers at training workshops.

Assessment of What Teachers Need Regarding Rangeland Education

To create a rangeland education program that teachers can use in the classroom, I needed to determine their requirements of educational materials. Teachers' logistical limitations and curriculum restraints were also important considerations. The program needed to be easy for teachers to use and understand, and meet curriculum content requirements. Teachers' current knowledge of rangeland ecology topics also needs to be addressed. Additionally, because teachers are a rather closed group and do not readily accept educational programs from non-education sources, I needed to meet influential teachers and gain their assistance and support. I began with initial phone contacts, and progressed to a mail survey (Appendix A), personal interviews and observations. I assisted or attended five natural resources and environmental education teacher workshops. The objectives of attending these workshops was to network with and interview more teachers, to learn about the programs, and to determine through observation the effectiveness and implementation of the programs. The ideas important to a successful education program I gathered from the workshops and teacher interactions included:

- Integrate the latest technologies into the program whenever possible.
- Give students "real-world" problems and the chance to present their work to scientists or administrators who can use the data.
- Integrate the social, political, and cultural aspects of science topics into the science classroom. Knowing the land use history of an area is necessary to understand the current ecology of that area.

Development of the Rangeland Education Program

The development of this rangeland education program was based on the experience and knowledge gathered during 2000, the knowledge gained from field-

testing with students, and the input of an advisory panel of rangeland specialists experienced in rangeland measurements. Ease of use in the classroom and the field was the main priority in the choice of formats. It was important for the layout to be clear and classroom ready; specifically, 3-ring or spiral notebooks that lie flat on a desk, with numbered handouts ready to copy and hand out to students. The materials needed for the lessons should be inexpensive, safe, and readily available (NAAEE 1998).

The summer workshops in 2000 were also an opportunity to observe existing knowledge of science teachers in regard to plant science, identification, and ecology. This helped to determine the amounts and types of background information needed to make an effective rangeland education program. At the workshops teachers had very little knowledge of rangeland plants, however, they had great interest in learning about plants and about the relationships of range plants with their environments. Based on these observations, I decided to focus the rangeland education program on rangeland plants and vegetation inventory data collection.

Program Components

The rangeland education program was developed into two main components: a set of rangeland vegetation inventory field labs and a rangeland plant identification guide. The rangeland vegetation inventory field labs would include measurements of some basic vegetation and site attributes, including ground cover, biomass, plant species inventory, and ecological site inventory. The field lab manual would also include introductory and background information to accompany the field labs. An equipment kit was assembled that could be distributed with the

field lab manual. By including the equipment needed to complete the field labs, the field labs were essentially self-contained and more logistically attractive to teachers.

The plant identification guide was titled, “Backpack Guide to Idaho Range Plants.” The guide included about 75 of the most common and abundant rangeland plants of Idaho. Each plant had a clear, easy to understand description and a detailed line drawing to aid in identification. The guide also includes plant identification diagrams, instructions and activities. The plant book was designed to assist students completing the rangeland vegetation inventory field labs, and could serve as a stand-alone manual for learning rangeland plant identification.

Field-Testing the Rangeland Inventory Field Labs

To fine-tune the rangeland education program components, a junior high science class and rangeland science graduate students tested the field lab procedures and equipment. The lessons were adjusted based on information and logistical details that were overlooked, and the ability of the junior high students to understand and complete the lessons in the time allowed. The rangeland science graduate students then performed the vegetation inventory field labs and evaluated the procedures and equipment to ensure that the best techniques for obtaining objective, reliable data were included in the field lab procedures.

Teacher Training Workshops

Three summer workshops were held in 2001 to train teachers to use the rangeland vegetation inventory field labs. Teachers were given a classroom set of equipment and manuals, and practice collecting and analyzing rangeland vegetation data on a variety of rangeland sites. Teachers also received classroom copies of the Backpack Guide to Idaho Range Plants. About 30 teachers attended the

workshops and pledged to use components of the program in their classes in the 2001-2002 school year.

Summary

In Idaho today, teachers have many options when designing natural resources education lesson plans. Unfortunately, few of the existing programs address Idaho's rangelands. Creating this rangeland education program and training teachers to use it can give teachers the tools they need to implement an effective rangeland ecology program in their classrooms. The students living near rangeland will benefit from an increased "sense of place," and Idaho's land policy decisions will be better when its citizens and policymakers have a scientific basis on which to form their opinions. As a result, the entire state will benefit from the increased public knowledge about the values and uses of Idaho's rangelands.

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CHAPTER II

Rangeland Vegetation Inventory as a Tool for Science Education[1]

As rangeland managers and scientists, an important yet often overlooked endeavor is public relations. To gain public support for management decisions it is important that people understand basic principles and issues in rangeland science and management. Through our grazing heritage, rangeland managers have gained a wealth of knowledge of rangeland ecosystem components and functions such as plant communities, fire, wild and domestic animals, water, and climate (Hart 1996). Kreuter and Schellenberg (2001) report that the public generally perceives rangeland management as a profession solely focused on livestock production. If this narrow view of rangeland professionals continues, society may deem rangeland specialists unable to effectively manage rangelands in the face of the evolving public values and uses (Kreuter and Schellenberg 2001). As the population becomes more and more urban, familiarity with natural resources and how they are managed is lost (Pitt and Bailey 2002). This new audience of urban and suburban rangeland dwellers needs knowledge to understand the natural processes and management of rangelands that surround them (Hart 1996). A study of rangeland vegetation attributes in science classes is one way to showcase the diverse rangeland resources that exist and the work that rangeland specialists perform. Such a program could spark an interest in rangeland plants and range ecology among a new audience of students. The goal of this project was to develop a rangeland vegetation inventory and monitoring program for use in science classes.

[1] This chapter is being prepared as a manuscript for publication in Rangelands or a Science Education journal.

Challenge of This Rangeland Education Project

The primary challenge to developing a rangeland science education program is how to present rangeland vegetation ecology, a body of knowledge that takes years of experience and/or one or more college degrees to understand, to science teachers and students. The solution in this project was to develop a basic rangeland vegetation inventory model that fits the needs of science educators. This includes simple, consistent, and scientifically valid data collection equipment and techniques. Instead of trying to teach a lifetime of range vegetation knowledge in a two-week science unit, the emphasis of this program is on the scientific inquiry process. Students observe basic vegetation attributes on several sites, then form research questions, design experiments, collect data, and report results.

Rangeland Vegetation Inventory Program Goals

The first goal of this rangeland education program was to spark an interest in rangeland science and management in an audience of middle school and high school students. Agricultural technology, biology, and general science classes are good avenues for studying rangeland management and ecology. Another goal for this program was to increase a "sense of place," or understanding and awareness of local environments among students. Sense of place is defined by Sanger (1997) as "an experientially based intimacy with the natural processes, community, and history of one's place." There is a concern that students currently learn more about the rainforests in South America than the rangelands in their own back yards. A rangeland vegetation inventory program would give teachers tools to explore their local rangeland environments with their students.

This program was developed in Idaho and was designed to meet state and national science education standards. A new set of Idaho State Exiting Standards for science took effect in 2000. The Idaho State Exiting Standards for Science follow closely and include virtually the same content standards as the National Science Education Standards. The National Science Education Standards have several content standards including Science as Inquiry, Physical Science, Life Science, Earth and Space Science, Science and Technology, and Science in Personal and Social Perspectives (National Academy of Sciences 1995).

This rangeland vegetation inventory program can satisfy requirements in two sections of the Idaho State Exiting Standards for science, Concepts of Scientific Inquiry and Social and Personal Perspectives in Science. The content knowledge and skills within Concepts of Scientific Inquiry include: a. identify questions and concepts that guide scientific investigations; b. design and conduct scientific investigations; c. use technology and mathematics to improve investigations and communication; d. formulate and revise scientific explanations and models using logic and evidence; e. recognize and analyze alternative explanations and models; f. communicate and defend a scientific argument, and; g. know the differences among observations, hypotheses, and theories (Idaho State Board of Education, 2001). The content knowledge and skills in the Social and Personal Perspectives in Science section includes: a. identifying environmental issues in Idaho; b. population growth and natural resources; b. understanding the roles of natural resource managers of public and private lands; c. exploring the role of land ownership in land use decisions; d. differentiating between preservation and conservation, and other natural resource issues in science (Idaho State Board of Education, 2001). The

content standards remain the same for grades 6-8 and grades 9-12, although the skills levels and applications become more complex as students progress. Idaho teachers are seeking ways to meet these exit standards in their science classes. Because the program also aligns with the National Science Education Standards, teachers in other states should also be able to use this program to meet their skills and content knowledge requirements in scientific inquiry and social and personal perspectives in science. This rangeland inventory program could be a productive tool for teachers in Idaho and around the intermountain west to meet requirements in both of these content areas.

Our rangeland education program was designed to teach science inquiry, methods, and processes. When students engage in "real" scientific data collection, experimental design, and analysis, they come away with a deeper understanding, appreciation, and retention of the material (Lord 1999). By creating a logistically appropriate and flexible set of field labs, teachers will be able to incorporate them completely or in parts to fit into their current lesson plans.

Rangeland Vegetation Inventory as Scientific Inquiry

The basic tenet of inquiry-based science teaching (also known as problem- or project-based) science teaching is that students learn science processes by actively performing them. Students collect data, develop questions, and present their results. Teachers become "coaches" that guide students as they discover what they need to know and do to answer their own questions (Greenwald 2000).

A classic inquiry-based science experiment involves measuring and monitoring heart rates of class members. The first set of pulse measurements demonstrate to the class that each student's resting pulse is unique to that student.

Several variables affecting heart rate include the individual's metabolism, body size, age, physical fitness, recent intake of caffeine or other chemicals, recent physical activity, etc. The first resting pulse is only a starting point; a baseline measurement. When all students' resting heart rates are compared, students begin to make connections between their heart rates and the variables at work on each of them. Students can begin developing ideas for experimenting with the different heart rate variables. One group might measure the heart rate of the same person over time while changing their activity level. Another group may compare several students of varying body sizes after controlling as many other variables as possible.

The pulse rate experiment is a good analogy for designing an inquiry-based study of rangeland vegetation. The differences in individual heart rates are similar to the natural variations in vegetation and ecological inventory measurements taken on different range sites. Each range site has characteristics that make it unique, like each student's pulse. These characteristics include location, climate, soil type, topography, present vegetation, and current or past land uses. The "pulse," or responding variable, of rangeland vegetation includes basic vegetation attributes, such as cover, biomass, density, frequency, and species composition. Once students compile and study their inventory data, they can look for connections or correlations between physical characteristics or land uses and differences in the vegetation attributes they measured. They can also form range research questions that require further data collection and analysis.

Elements of This Rangeland Assessment Program

The complete rangeland vegetation inventory program we designed includes a field lab manual, equipment kits, and a training workshop with follow-up

assistance. The field lab manual presents introductory information about rangeland inventory and monitoring, instructions on selecting study sites and detailed descriptions of field lab methods. Four protocols were designed, including a site inventory, biomass estimation, ground cover estimation, and plant species inventory (Appendix B). The protocols were designed for people without range expertise who want to perform scientific investigations on rangelands. Data collected using these protocols can be analyzed in several ways, including comparisons of different study sites, estimating carrying capacity and forage suitability for various herbivores, or tracking noxious weeds. Also, after collecting "baseline" rangeland vegetation data, students can pose range research questions and design experiments to find answers to these questions.

When developing the field labs, a balance was struck between scientific accuracy and ease of use for inexperienced observers. The inventory of rangeland

Figure 1. Teachers performing vegetation inventory protocols in southern Idaho.

vegetation attributes had to be pared down to a model that could provide simple, objective, and reasonably accurate data for analysis. The protocol techniques were designed with inexperienced observers and the limitations of a junior or senior-high school class in mind (Fig. 1). The techniques and equipment were designed to be scientifically valid for most of Idaho's rangeland types, which are common rangeland types in several other states. This program would work on rangelands across western North America with little or no adaptation.

The site inventory protocol provides both ecological and management information about the selected study site. Information collected in the site inventory includes physical location and topographic and abiotic features of the site (BLM 1996). Photographs of the study area and survey transects are also included. Site inventory data describe the location and basic physical attributes of the study sites, and allow for comparison with other study sites. The biomass protocol involves clipping four 0.25 m^2 square plots (Passey 1963, BLM 1996, NRCS 1997) along each transect line on the study site and separating the clipped vegetation into grasses, grass-like plants, forbs, and shrubs. The samples are weighed and biomass is estimated for the site. A chart is used to convert field weight to dry weight for various vegetation types and stage of growth (NRCS 1997). Ground cover is estimated using a line-point method, where "hits" are recorded at each meter mark along a 30-meter transect line (Evans 1957, Heady 1959, Fisser 1966). Each point is counted in one of several cover classes, including grasses, grass-likes, forbs, woody plants (shrubs and trees), rock, bare ground, and litter. The plant species inventory requires ranking the 5 to 7 most abundant species on the site. Any noxious weeds present on the site are also recorded. The plant species

inventory is the only attribute of the inventory program that requires identification of plant species. When a plant cannot be identified in the field, it can be collected and pressed for later study and identification.

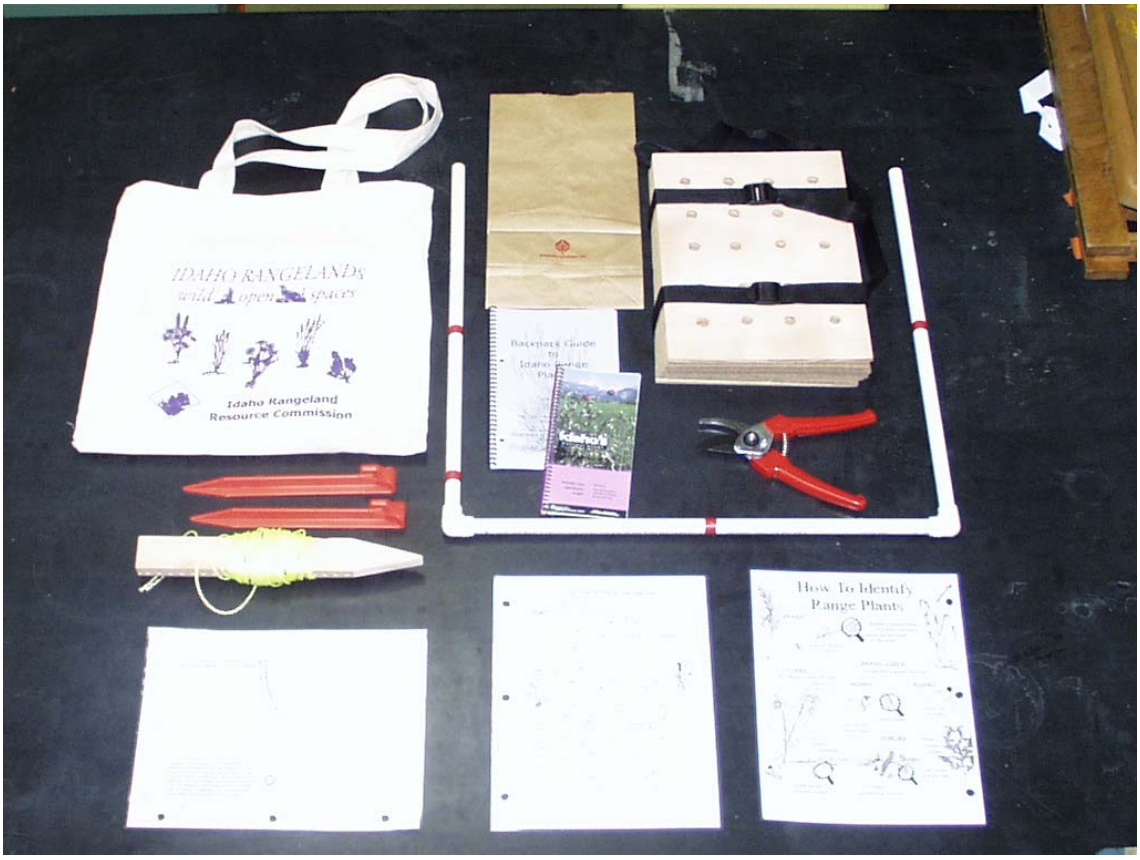

Figure 2. Contents of the equipment kits.

Equipment kits were developed to accompany the field labs. The kits include materials that are simple and inexpensive to assemble and replace, durable, and reasonably safe for student use. The kits include: a 30-meter transect line, a 50 x 50cm square collapsible three-sided plot frame made from PVC pipe, bypass pruning shears, paper bags for biomass samples, Idaho's Noxious Weeds book, Backpack Guide to Idaho Range Plants, a 9 by 12 inch plant press, Soil Texture by

Feel Analysis worksheet, clinometer (adapted from the GLOBE program), photo label sheet, map of Kuchler Potential Natural Vegetation for Idaho, map of average annual precipitation for Idaho, and a tote bag to carry everything (Fig. 2).

How the Rangeland Inventory Program is Being Used

Teachers are using the rangeland vegetation inventory program in several different ways. Several teachers have adapted the protocols for mapping infestations of noxious weeds around their schools. Some are working with county weed agents to study the effects of various treatments on target weeds and associated vegetation. Others are estimating stocking rates and forage suitability on grazing lands. One teacher adapted the biomass and cover protocols for her students to conduct an economic feasibility analysis of producing hay on her own land. Many teachers are taking advantage of the flexibility of the vegetation inventory protocols, and using them as templates to design vegetation studies specific to their area, needs, and interests.

Implications for Rangeland Monitoring

Rangeland managers and landowners monitor rangelands for many different reasons. One primary reason is to quantify ecological changes over time. This requires establishing study sites that can be revisited periodically to reassess the "state of the range." Changes can then be documented and assessed to determine if management objectives or rangeland health goals are being met.

The initial visit to a study site is an opportunity to take an inventory of the rangeland. It is a "snapshot" of current conditions. Future visits and data collection can allow rangeland monitoring to assess the trend, or changes over time. Monitoring is like time-lapse photography that shows changes from one snapshot to

the next. Without an initial inventory, there is no yardstick by which to measure changes that may be revealed in later visits. Without continued monitoring, there is no way to assess whether management objectives are being met. It is also impossible to determine if the health and productivity of the rangeland is improving, staying the same, or declining.

Rangeland monitoring is an evaluation process usually conducted to determine the response to management practices (Artz 1993, Holechek et al. 1995). The kinds of information that is collected and recorded depend on the answers to several questions: Who owns or manages the rangeland? Who performs the monitoring? What are the social values and management objectives for the land? The standards or objectives that vegetation data are used to evaluate are also based on human value judgements (West and Smith 1997). Vegetation data must be tailored to fit the characteristics of the rangeland and the needs of landowners and land managers. The techniques and data gathered by the rangeland inventory protocols presented here are valid, but may be oversimplified and inadequate for designing and evaluating rangeland management objectives and actions.

The rangeland vegetation inventory field labs we designed are intended to teach science methods and processes. Although the data are valid and useful for the purposes of science classes, the rangeland vegetation inventory field labs are not a one-size-fits-all monitoring program to be implemented by landowners and rangeland managers. The vegetation and ecological data collected in our rangeland vegetation inventory protocols are intended to describe rangeland sites, highlight correlations between physical rangeland variables and vegetation attributes, generate research questions and provide tools for answering those

questions. Students could also repeat the vegetation protocols on a range site to observe change in vegetation attributes over time and to observe environmental and physical differences that may affect vegetation attributes.

Summary

Today's teachers have many choices in environmental education programs. There are several natural resource education programs currently in place in Idaho schools. However, coverage of rangeland topics in these programs is sporadic at best, and is often absent. With the development of this rangeland vegetation inventory program, teachers living around rangelands now have a set of tools to explore their local environments.

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CHAPTER III

Overview of the Backpack Guide to Idaho Rangeland Plants

Plant identification is an important component of rangeland inventory. Knowing the plant species present in a pasture or study area is necessary to make assessments and management decisions. Every species needs a slightly different combination of environmental factors to grow and thrive, and presence or absence of particular species on a given site can indicate natural environmental gradients, past disturbances, or current management issues. Plant identification skills are crucial to understanding and recognizing plant communities and the effects of invader species like noxious weeds.

Need for the Book

During the first year of this range education project, science teachers were surveyed and interviewed about their knowledge and interest in rangelands. Teachers were most interested in plant identification and ecology, but unfortunately, most had little or no training or skills in plant identification. Many teachers expressed willingness to teach their students about range plants, but were not comfortable doing so at their current skill level. Science teachers need training and practice identifying range plants before they will teach range plant identification to their students.

Range plant identification can be difficult to learn and teach. The standard references used are very technical and based on botanical keys. The terms and language used in most plant references require a lot of time and practice to master. Students of plant identification often need hand lenses and Latin lessons to

correctly identify plants. The range plant novice can be easily overwhelmed. There are several good picture books about trees and wildflowers available in bookstores, but most do not include less showy range plants like grasses, and many forbs or shrubs. There are very few nontechnical range plant references, especially with color photos, and none that address the range plants found in Idaho. Additionally, the Idaho Rangeland Resource Commission and the University of Idaho Department of Rangeland Ecology and Management wanted to have an interesting and informational plant guide that could be distributed to educators and others interested in Idaho range plants. A complete manuscript of the Backpack Guide to Idaho Range Plants can be found in Appendix C.

Scope and Organization of the Book

The Backpack Guide to Idaho Range Plants was developed with teachers, students, and other novice plant lovers in mind. The book is intended as an informal guide, with limited use of technical botanical terms. When the use of technical terms couldn't be avoided for accurate description, they are explained or defined. Descriptions give the common name(s) of each plant, and the genus, species, and family names. Although the scientific names of many range plants are being changed to reflect current taxonomic knowledge, the plants in the Backpack Guide are listed under the older, better known genus and species names used by Hitchcock and Cronquist (1973). The new accepted scientific names are cross-listed in the index.

The choice of which of Idaho's range plants to include in the book was the result of surveying several plant specialists. It began with the Idaho FFA range plants list, which had 78 plants. Then, several professors from the Rangeland

Ecology and Management Department at the University of Idaho (Drs. S.C. Bunting, J.L. Kingery, K.L. Launchbaugh, and K.D. Sanders) and two plant ecologists (Drs. C.G. Johnson and N.L. Shaw of the US Forest Service) were asked to review this list and identify what they believed to be the 50 most common, abundant, and important range plants in Idaho. These scientists were also asked to list any plants that were not on the list that should be included. Their lists were compiled and the 48 most "popular" plants were chosen for the first version of the book. Later versions of the book added more plants that were chosen through the same process as the original 48. The current Backpack Guide now contains 76 of Idaho's most common and abundant range plants. This includes 26 grasses, 5 grass-like plants, 26 forbs and 19 shrubs and trees.

Plant descriptions were then developed for an audience of "interested novices." I chose to describe basic identifying characteristics along with some interesting information about the history and uses of the plants. Each plant has its own page in the book. The plants are listed by their common names, followed by genus and species. There is a detailed black and white drawing of each plant. There are six main parts in each plant description. First is the introduction, which lists the plant's family, origin, general growth form (i.e., bunchgrass or sodgrass), and where it grows on the North American continent. Next, the life cycle describes when the plant germinates or begins growth, when it flowers or produces seeds, and how the plant propagates itself (i.e., sprouting or seeds). The identifying characteristics section gives a basic description of both the flowering parts and vegetative parts. Next, the distribution and habitat section presents the general habitat types and associated species, along with soil types on which the plant tends

to grow. The “interesting facts” section gives information like forage value, historical and current uses (e.g., medicinal, food, etc.) by humans, and any other information about the plant. The last section lists “look-alikes” for the plant, similar looking species that could confuse a novice. This section also gives the differences between the individual plant and the look-alike species.

While the plant descriptions are the main body of the book, there is a lot of additional information included to give the reader background information about plant identification and Idaho’s rangeland types. The Table of Contents, Preface, and Introduction give the layout and scope of the book, and a brief description of Idaho’s rangelands. A section called Idaho Vegetation Regions begins with a map outlining the locations of the five major vegetation types in Idaho, and follows with a description and black and white photo of each of the five vegetation types. The vegetation regions include the Pacific Bunchgrass, Coniferous Forest and Mountain Meadow, Juniper Woodland, Sagebrush Grassland, and Salt-Desert Shrubland. Identifying Range Plants and Their Parts is a section that includes a picture key to identify the major range plant types (grass, grass-like, forb, and shrub), and diagrams of grass structure, forb and shrub inflorescences, leaf arrangement, leaf types, leaf shapes, and leaf margins.

The plant descriptions are arranged by plant type (grasses, grass-likes, forbs, and shrubs & trees) and listed in alphabetical order by genus. After the plant descriptions is a section of activities for learning range plants. The first activity is Building a Backpack Plant Press. It lists reasons for collecting and pressing plants, and has a materials list and instructions for building a 9 by 12 inch plant press. The Collecting, Pressing, and Mounting Plants section lists the materials and

instructions needed for a novice to properly collect, press, mount, and identify their collection of rangeland plants. There are also suggested references to help with plant identification. Also included are four activities that provide the user practice with learning Range Plant Classification, Leaf Morphology, Grass/Grass-like Morphology, and Range Plant Identification. These activities are intended as a hands-on activity guide that can be used or adapted by teachers, 4-H leaders, or other educators.

The final pages of the Backpack Guide include a Glossary, which lists and defines the technical botanical terms that were used in the book, References used to develop the Backpack Guide, and the Credits for all of the illustrations found in the book. Acknowledgements are also given to all who helped with the book's development. Finally, an Index of Plant Names lists the common names, genus and species names, and any alternate names in use for each plant in the book.

Uses and Future of the Book

The Backpack Guide to Idaho Range Plants was developed with some specific uses in mind. The first intended use of the book was as a stand alone plant identification guide and activity workbook that could be used and adapted by youth educators. The information in the book is also intended as a supplement to the Rangeland Vegetation Inventory Field Lab Manual. Information in the Backpack Guide about the vegetation regions and plant identification could help students correlate their vegetation data and site inventory data. The Backpack Guide could also help students complete the plant species composition protocol. Excerpts from the Backpack Guide are being used by Idaho FFA students studying for the Rangeland Assessment Career Development Event. Forty of the plant descriptions

in the Backpack Guide are available on the internet for use by FFA students at (<http://www.uidaho.edu/range>).

Eventually, the entire book could be on the University of Idaho Rangeland Ecology and Management or the Idaho Rangeland Resources Commission Web Pages. Color photos of each plant in the Backpack Guide are also being assembled for use on the Web or to be included in a later published edition of the book. The Backpack Guide may also be adapted as an Extension publication and/or a 4-H Range Plants project.

The Backpack Guide to Idaho Range Plants provides interesting and useful information about some of Idaho's most common and abundant rangeland plant species. The book provides plant identification and plant species information for the Idaho FFA program, the Rangeland Vegetation Inventory program, and others that require identification of range plants. The University of Idaho Rangeland Ecology and Management Department and the Idaho Rangeland Resources Commission have distributed the book to many Idaho teachers, ranchers, students, and others interested in Idaho range plants. Hopefully, the Backpack Guide to Idaho Range Plants will become a valuable reference for individuals interested in the range plants of Idaho.

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APPENDIX A

Survey Questions for Biology/Ecology/Environmental Science Teachers

1. What classes do you teach in biology, ecology, or environmental science?

2. Do you focus your classes on the basic principles of ecology, or on current environmental topics in your area?

3. Do you cover any of the following topics in your classes? Please circle topics covered.
   - Range plant identification
   - Plant physiology
   - Soil morphology
   - Nutrient cycling
   - Rangeland wildlife ecology
   - Water quality
   - Riparian areas
   - Weeds/plant invasions
   - Grazing ecology and management
   - Terrestrial ecosystems of Idaho

   Others:_____
   _____

4. What, if any, specific environmental science/natural resource curricula do you use? Examples:
   - Project Wet
   - Project Learning Tree
   - Students Investigating Today's Environment
   - Adopt a Watershed
   - Project Wild
   - Leopold Education Project
   - None

   Other:_____

5. If you use one of the above curricula, why did you choose it? (circle reason)
   - It was cheap/free
   - It dealt with issues in my region
   - It included outdoor activities
   - It covered interesting topics
   - It used computer technology
   - It fit into the time I had available

   Other:_____

6. Is your background sufficient to teach any of the following topics? Please put a check mark in front of topics for which you feel academically prepared. Circle topics in which you would like more background.
   - ___Range plant identification
   - ___Plant physiology
   - ___Soil morphology
   - ___Nutrient cycling
   - ___Rangeland wildlife ecology
   - ___Water quality
   - ___Riparian areas
   - ___Weeds/plant invasions
   - ___Grazing ecology and management
   - ___Terrestrial ecosystems of Idaho

   ___Others:
   _____
   _____

7. Which types of materials and support would help you in teaching these topics?
   - Teacher workshops
   - Textbooks
   - Information on CD-ROMs
   - Predesigned lectures
   - Web based information
   - Videos

   Other:_____

8. What formats would work best for incorporating these topics into your curriculum? i.e. small pieces to fit into other areas, or one complete unit?

9. Which types of information would you be most able to use in your classes?

Lecture/written materials	Laboratory exercises
Outdoor exercises	Computer based work
Others_____	
_____	

10. How much class time could you devote to these topics? How long should a "rangeland unit" last?

11. How much outdoor work could realistically be incorporated into your classes?

12. What obstacles do you face in doing more outdoor teaching activities?

13. Do you have nearby access (walking distance) to native grassland, shrubland, or forested land?

14. Which of the following topics would you be most interested in including in your classes?

Range plant identification	Water quality
Plant physiology	Riparian areas
Soil morphology	Weeds/plant invasions
Nutrient cycling	Grazing ecology and management
Rangeland wildlife ecology	Terrestrial ecosystems of Idaho
Others:_____	

15. Do you know any rangeland professionals in your area? Would you like to know who your local rangeland professionals are for technical support?

16. Are you familiar with the Idaho Rangeland Resource Commission or the Rangeland Ecology and Management Department at the University of Idaho?

Thank You!

Please fax to (208) 885-5190, attn: Juley Hankins

Or mail to Department of Rangeland Ecology and Management, University of Idaho College of Natural Resources, P.O. Box 441135, Moscow, ID 83844-1135, attn: Juley Hankins.