Ecologists, Educators, and Schools: No Child Left Indoors

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ECOS Objectives: To meet the need for enhanced understanding of environmental sciences in the northern Rockies, the ECOS Program will:

- Develop scientific ways of thinking and understanding in K-12 students through authentic research experiences in their schoolyards and adjacent habitats
- Promote teaching practices focused on "learning by doing" and inquiry instruction for both teachers and future science faculty (ECOS Fellows)
- Develop and model linkages between educators in the K-16 continuum
- Identify project indicators to make the program sustainable at UM, and facilitate transfer to other sites in Montana and around the country
- Ultimately, ECOS will contribute to a national model of how authentic ecological research can be introduced into the K-16 curriculum to enhance the teaching and learning of science.

Elements of the ECOS Program

What is the ECOS Program? ECOS is a partnership program for enhancing science education in K-12 schools in western Montana by using the schoolyard and adjacent open areas as outdoor laboratories for learning about the environment.

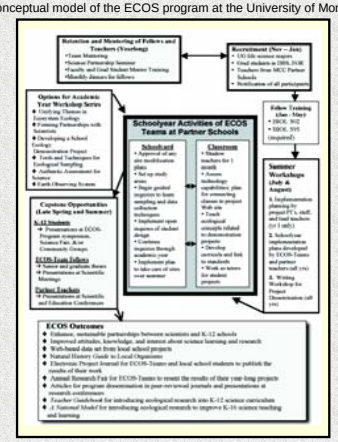
What is the ECOS mission? No Child Left Indoors! Ecology graduate and undergraduate students from the University of Montana are showing K-12 students and their teachers how to use an ecological lens for viewing their schoolyard. Instead of a playground, they learn to see an ecological laboratory filled with organisms with interesting adaptations and interactions. The ECOS teams model what ecologists do by immersing themselves in ecological investigations with their partner school collaborators in their schoolyard and classroom laboratories.

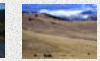
Who is on an ECOS Team? ECOS Teams are comprised of two Ph.D. candidates and one undergraduate from the environmental sciences at the University of Montana, and two lead teachers from the partner school. Each year ECOS supports five partner schools with "ecologists in residence".

What does an ECOS team do? The team works together for an entire academic year to mentor students in ecological investigations, both inside and outside of the walls of the classroom. Teams work together to develop ecological curriculum materials that are well-matched to the habitats in and around the schoolyard, and that meet the recommendations of the National Science Standards for science education. And, the teams provide support for enhancing general science instruction in a school by consulting with all interested teachers.

What is the plan for making a sustainable impact at the participating schools? One activity of the ECOS fellows is the development of *demonstration research sites/laboratories* on the grounds of their "residency" school to provide school-based authentic research experiences for local K-12 students. These projects are designed to 1) take advantage of unique ecological features in a given schoolyard or adjacent "natural area" to develop sustainable outdoor ecological research laboratories, 2) integrate technology, and 3) sustain long-term use of these resources for teaching and learning about science and allied fields in general, and ecology in particular. The projects also serve as models for schoolyard-based ecological research and science education that can be readily transported to other sites and schools, both within and beyond the region.

Conceptual model of the ECOS program at the University of Montana.




ECOS INQUIRIES FOR SCHOOLYARDS

The habitats in and around schoolyards in western Montana lend themselves to rich ecological investigations. Nearly every school is within a short walk of some type of open area. Indeed many schoolyard may adjoin national forests, hillsides, ponds and streams, grasslands and mountains. ECOS teams have developed and/or adapted a wide assortment of inquires that take advantage of these outdoor laboratories to teach about the environment. All of our tested curricula are posted on the ECOS web site at **www.bioed.org/ecos.**

Guide to Ecology of the Northern Rockies

Contents of the Guide

- **Introduction**—ecology, interactive maps, history, geology, and habitat descriptions common to the region
- **Plants**—Description of all the common plant species along with photos of seedlings, flowers, fruits, leaves, bark, and general habit for the most common species
- **Animals**—Representative amphibians, reptiles, fishes, invertebrates (families), birds and mammals.

Bringing Natural History to the Schoolyard

The Ecology Guide, a collaborative project of the ECOS fellows and project staff, is an innovative and interactive tool for students and teachers to identify and learn more about the ecology and natural history of plants and animals in western Montana. Oftentimes it is difficult to use guidebooks and keys for groups of organisms such as plants or insects because the terminology is difficult, or the local organisms are not covered in its pages, a frustrating barrier for people to easily discover what they are looking at, and to fully appreciate the beauty and diversity of their local environment. The Ecology Guide minimizes these problems by providing a dynamic on-line database that includes local photographs (frequently covering many life stages), drawings and descriptions of the most common species, as well as information on how to use these species for schoolyard ecology investigations and references for further information.

Ecology Guide Objectives

- Describe common species of plants, animals, and their habitats in the Northern Rocky Mountain region
- Provide interactive illustrated keys and more intuitive means to identify species in the region accurately by using any combination of characters to search the guide
- Improve scientific accuracy of field observations and overall educational value of field-oriented studies by making natural history information on ecosystems around our region and their species more accessible to both teachers and students.
- Provide ecological information about each species or species group to help identify topics for student field investigations and to stimulate greater interest in the natural history and ecology of this region.
- Link entries in the Guide to suitable curricular materials developed by ECOS fellows.

Example Species Description From the Ecology Guide

Scientific Name: *Lomatium dissectum*
Family: Apiaceae (Carrot family)
Common Name: large biscuit root
Origin: Native

General Description: fragrant herb with woody taproots and a hollow stem rising 0.5 to 1.5 m from the ground. Has clusters of yellow or purple flowers at the top.
Bark: N/A
Leaves: Most leaves are basal and pinnately divided 3 to 5 times. Each division is typically less than 1 cm long.
Flowers: tiny, yellow or purple flowers in twice divided flat topped clusters. Each cluster is at the tip of a stalk and has 10-30 branches.
Phenology: flowers from May to July
Life History: perennial
Cones/Fruits: the seeds are flat and elliptical with narrow wings. Typically about 8-17 mm long.
Habitat: rocky, dry or moist, open areas. Grassland
Distribution: Interior Western North America from Alberta and eastern BC in Canada south to New Mexico and California
Cautions: This plant is on the concerned/endangered plant list in Idaho. Should not be eaten unless it is certain which species you have, as there may be species which appear similar but are inedible.
Did you know? A member of the carrot family, this plant is also known as Indian Consumption plant, *Lomatium* is used in herbal medicines as an antiviral for maladies such as the common cold and the flu. It was used in the Southwestern US during a flu pandemic in 1917 and was very effective. Burning the root and inhaling the smoke was used to treat asthma. It has also been used to combat other infectious diseases including tuberculosis. A poultice made from the roots can be applied to cuts, sores and bruises. The roots are edible and it can be cooked or dried and crushed to use as a seasoning for soups or to make bread or biscuits. Some native tribes used dried roots as trade items or for food stores. Crushed root can also be burned as incense. The name biscuit root may come from the large size of the root. –it is more likely that this name comes from the fact that roots of biscuit root (mostly *L. cous*) was ground up to make a flour for the Salish and Kootenai tribes). It is kind of interesting that plant is endangered in Idaho, yet around Missoula it is fairly common.
Keywords: parsley, edible plant, herbal medicine
Glossary: Pinnate: of a leaf shape; featherlike; having leaflets on each side of a common axis
References:

Kershaw, Linda, Andy MacKinnon, and Jim Pojar. 1998, Plants of the Rocky Mountains. Lone Pine Publishing, Vancouver. http://altnature.com/gallery/lomatium.htm http://www.diet-and-health.net/Naturopathy/Lomatium.html

Contributor: Frank Janes

CREATING AN OUTDOOR CLASSROOM AT FLORENCE-CARLTON SCHOOL


Investigating surface:volume ratios in outdoor classroom with water bottles


Measuring soil temperature

SCHOOLYARD ECOLOGY AT FLORENCE-CARLTON SCHOOL

Florence Carlton is a rural K-12 school in western Montana. Our focus is to develop cross-curriculum use of **Our Outdoor Classroom (OCC)**. Our goal is to develop and make available outdoor space for every class, from art to English, biology to history, geometry to media arts. By making this classroom available to all students and the community, ecological appreciation and learning will be promoted.

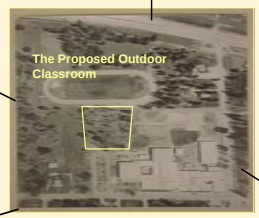
FLORENCE-CARLTON SCHOOL ECOS TEAM

Nancy Adams, Kindergarten Teacher
Lisa Verlanic, T-1 Teacher,
Sarah Keller, Undergraduate Fellow,
David Nicholas, PhD Fellow
Megan Parker, PhD Fellow

DEMONSTRATION PROJECT THEME

Restoration and development of Our Outdoor Classroom(OCC), an acre-large space with varying habitat types.

- **Goal:** To increase student and community use and appreciation of this outdoor area, inspiring each visitor to learn more about their environment. To restore this area with native plants and secure it for the long term, developing an environment that promotes ecological investigations.
- **Expected Impact:** To increase the interest and awareness of ecology in the student body, in G K-12 with hands-on learning of local species with global ramifications. To promote a student culture of environmental awareness and ecological exploration.




Learning to collect data and field notes in the OCC

APPROACH

The Florence ECOS team is developing the OOC with the help of a landscape architect, county extension agent, and specialists on native plant, arthropod, avian and mammal. Our vision is to keep the wild elements in this beautiful space and enhance it with accessible paths, amphitheatre and signage.

WHAT DO STUDENTS AT FLORENCE-CARLTON SCHOOL HAVE TO SAY?

"You must keep the outdoor classroom because kids need a place to express themselves." – First grader

One Kindergartner says he prefers the Outdoor Classroom to recess and snacks!

"I want to be a scientist because then I can ask all the questions I want!" – Fourth grader


Looking through a microscope to see a smaller world


Measuring trees in Africa and Montana to compare patterns

ADAPTING TO A LUNAR HOME

Joyce Shraeder's 5th grade class exemplifies the spirit of ecological enquiry at Florence-Carlton school. While studying a unit on space, we asked the students to do research about the moon in order so they could design an animal adapted to the lunar environment. Each was asked to consider and demonstrate how an animal takes in food. This multi-week project included web and library research, a written report and presentation. It culminated in building the animal from found objects.

LEWIS AND CLARK THE DISCOVERY CONTINUES


Hailey records observations from a river field trip


A diverse schoolyard habitat including streams, xeric gardens, and large trees
Plants attract numerous native insects, birds, and small mammals
Gardens maintained by students


Jeff helps Sophie see fungi


Hollie teaches the kids to "look deeper"

LEWIS AND CLARK ELEMENTRY ECOS TEAM

Kathy Dungan- 1st& 2nd grade grade teacher
Mary Jane Mcallister- 4th grade teacher
Tammy Mildenstein- PhD fellow
Jeff Piotrowski- PhD fellow
Hollie Sexton- Undergraduate fellow


Team Lewis and Clark

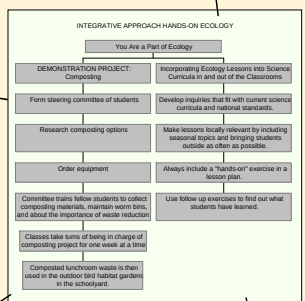
ECOS THEME

Our vision for sustaining the influence of ECOS on Lewis and Clarke elementary is the creation of ecological minded demonstration projects that can remain at the school after the ECOS project has expired.

THEME: Seasonality and nutrient cycling

GOAL:
Creation of a school-wide worm composting system to reduce lunch room wastes and provide compost for our outdoor discovery area and to teach students soil and microbial ecological concepts

EXPECTED EFFECTS:
Students get hands-on experience with waste reduction techniques
Students develop an understanding the principles of nutrient cycling
School benefits from reduced lunch room waste and rich, organic fertilizer for their outdoor classroom



APPROACH

We created a school-wide steering committee of elementary students, teachers, and ECOS fellows. Together we decided to create a worm composting system. The students agreed this would be an exciting way to involve the entire school in a conservation minded, ecological project. The students themselves designed the composting set-up and implementation.


Lucy and Kailee describe the fungi they saw

THE POWER OF FUNGI
Reflections by an ECOS Fellow

As I taught the children to flip over logs and look for insects and fungi, I was amazed by their interest in the fungi. I figured this was just an excitement associated with being outside. At the end of the exercise all the children from every grade left knowing more about fungi and soil, but I doubted if they would take this awareness home. A few days later there was an article in *The Missoulian* about the recent rains and mushroom blooms in the surrounding forests. A parent later disclosed that she had showed the article to her second grader (Sammy Clark) out of curiosity. The child jumped up saying, "Fungi! Fungi are really important!" The child then sat down to try and read the entire article. I had imagined that mushrooms and fungi would not pique a young child's curiosity as much as they did.

"I saw a fungi!!!" Sophie (first grader)

The Radish Party

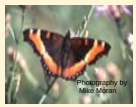
A major component of our demonstration project is a composting system to generate nutrient rich soils for our outdoor classroom. We have designed a series of lessons on soil ecology and soil health to give students a greater connection to the project.
Students participated in an inquiry on the role of organic matter in soils to answer the following questions they had generated :
What are the benefits of soil organic matter?
Will plants grow better with compost than just fertilizer?
This inquiry tested the growth of radishes in sand, sand plus fertilizer, and sand with compost. After we set up the experiment the seedlings were allowed to grow a week and the students drew their predictions. When we returned we were mobbed by first and second graders who wanted to show us their radishes. They were so proud of their plants *and* that their predictions were met. We discussed nutrients as well as water retention by compost. Now these students KNOW the importance of soil organic matter

ECOS Schoolyard Demonstration Projects in Western Montana

One of the centerpieces of the ECOS program in western Montana is the development of permanent on-the-ground resources for teaching about the environment now and into the future. Called "**Schoolyard Demonstration Projects**", they are designed to 1) take advantage of unique ecological features in a given schoolyard or adjacent "natural area" to develop sustainable outdoor research laboratories, 2) integrate technology, and 3) sustain long-term use of these resources for teaching and learning about science and allied fields, and the ecological sciences ecology in particular. The projects will serve as models for schoolyard research and science education that can be readily transported to other sites and schools within and beyond the region. In a nutshell, demonstration projects relate to the ecological theme at a partner school; focus on developing the outdoor teaching and learning infrastructure for authentic student research at the site; are set up in a schoolyard or adjacent open area for on-going all-season projects over the entire school year; and link with curricular materials and teaching resources developed by the ECOS fellows. Schools are eligible for a $1500 minigrant to develop their ecology-teaching demonstration project. The fellows from each site developed the following panels to describe the demonstrations projects developed during year in in the ECOS partner schools.

BUTTERFLIES, BIRDS AND BLOOMS AT SUSSEX SCHOOL

7th Graders with their plant competition experiment



Native plant & invasive weed competition experiment

SUSSEX SCHOOL ECOS TEAM

Margie Kinnersley, PhD Fellow
Wendy Ridenour, PhD Fellow
Dianna Fairchild, UG Fellow
Maree Mitchell, 6th – 8th teacher
Lisa Hendricks, 4th/5th grade teacher

ECOS THEME
"Our Native Montana"

The Sussex School ECOS team has implemented a long-term schoolyard-based restoration project with the goal of transforming the Sussex school grounds from an area that consists almost entirely of non-native invasive species to one that represents a healthy Montana habitat. Through inquiry-based approach, students of all ages (including parents) will gain a better understanding of basic ecological principles, their surroundings, and their own responsibilities as part of an ecosystem. They will learn what happens to the habitat quality and health of their schoolyard during its transition through hands-on investigations about weed elimination, non-native species invasion, bioremediation, successional change, and land management.

- ❖native habitat restoration
- ❖increase schoolyard wildlife habitat value
- ❖education and awareness through inquiry

SCHOOLYARD ECOLOGY AT THE SUSSEX SCHOOL, YEAR 1

BASELINE SURVEY OF EXISTING PLANTS AND INSECTS IN THE FUTURE BUTTERFLY GARDEN / SCHOOLYARD (7TH)

⇩

WEED TREATMENT EXPERIMENT (7TH)

⇩

COMPOST EXPERIMENT (4TH/5TH)

⇩

NATIVE PLANTS AND SPOTTED KNAPWEED: COMPETITION EXPERIMENT (7TH)

⇩

"WHAT'S THIS PLANT GOOD FOR?" RESEARCH REGARDING WILD BIRD AND BUTTERFLY FOOD HABITS (7TH)

⇩

SCHOOLYARD BIRD SURVEY (4TH/5TH)

⇩

BUTTERFLY SURVEY and BUTTERFLY SHELTER CONSTRUCTION (2ND/3RD)

⇩

PUTTING IT ALL TOGETHER: BUILDING A BUTTERFLY GARDEN! (K – 8TH)

Compost experiment

A CASE OF COMPETITION?

Seventh grade students are conducting a greenhouse style experiment in which 5 different species of native plants are planted in 1 gallon pots with spotted knapweed (competition treatment) or with conspecifics (control). Students decided what to measure to determine "who" is competitively dominant. They hypothesized that those native species that are the toughest competitors with knapweed will be the best plants to use extensively in their schoolyard habitat restoration project.

APPROACH

The "Our Native Montana" demonstration project was designed to be implemented over the course of four years. Year 1 (highlighted in the adjoining panel) focuses on surveying existing schoolyard conditions and will culminate in the construction of a native bird and butterfly habitat.

- ❖**Year 2-** greenhouse, common garden plots and "orchard" restoration to a native state
- ❖**Year 3-** outdoor classroom and windmill construction
- ❖**Year 4-** organic garden community service project

Butterfly Garden site preparation weed treatment experiment

RESTORATION AND SUSTAINABILITY
TARGET RANGE SCHOOL

Knapweed Biocontrol Inquiry

In a survey about the outdoor classroom, Target Range 5th graders indicated their desire to see the following added to their schoolyard:

- ❖a natural trail
- ❖more sights to see
- ❖more nature and wildlife
- ❖an outdoor learning area
- ❖a couple of flowers so we can learn about them
- ❖a garden and a grassy sheltered place for science

TARGET RANGE SCHOOL ECOS TEAM

Rachel Loehman: PhD fellow
Carl Rosier: PhD fellow
Lauren Priestman: Undergraduate fellow
Melodee Burresson: 5th grade teacher
Jann Clouse: 5th grade teacher

Clearing Weeds!

ECOS THEME
Restoration and Sustainability in the Target Range Schoolyard

Approach: Design and build an accessible outdoor ecological laboratory for hands-on science education and ecological exploration – collaborative project between students, teachers, ECOS, and the community.

Goals

- ❖Create an outdoor ecology laboratory
- ❖Increase floral and faunal diversity
- ❖Restore native vegetation and control noxious weeds
- ❖Engage students in studies of ecological concepts

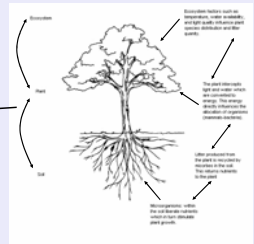
Themes

- ❖Ecological connectivity at multiple scales
- ❖Resource sustainability and management
- ❖Native vs. invasive plant communities

Expected Impacts

- ❖Create a school-wide (K-8) science resource
- ❖Target important regional ecological issues
- ❖Protect and sustain schoolyard open space

SCHOOLYARD ECOLOGY AT TARGET RANGE SCHOOL



The purpose of our project is to demonstrate connections at the ecosystem, plant and soil levels. This is done through development of curriculum pieces that emphasize and reflect this connectivity.

Dismantling a "Landfill-in-a-jar"

INVESTIGATING MICROORGANISMS

The purpose of this curriculum unit was to teach our students about the major contributions of microorganisms to ecosystem health. Several lesson plans were developed that introduced the students to microorganisms, and demonstrated how they are beneficial to both plant and humans.

Investigations:

- ❖ Bacteria are Everywhere: There's no safe place to hide!
- ❖ Bread mold: Why bread goes bad!
- ❖ Brewing Rootbeer: It's all about the yeast.
- ❖ Composting: Even microbes recycle.
- ❖ Nitrogen Fixing Bacteria: Plants need bacteria too!
- ❖ Arbuscular Mycorrhizal Fungi: Even fungi help plants grow.

Our assessment of these units has focused on asking students to develop hypotheses, draw pictures, and collect data for analysis. At the end of this unit students will complete a written assessment as well.

ECOLOGY EDUCATION INVESTIGATIONS

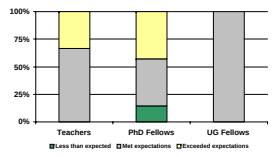
Native plant field trip
Winter insect survey
Adaptation inquiry
Insects as biological controls
Microbiology experiments

Winter Entomology Investigation

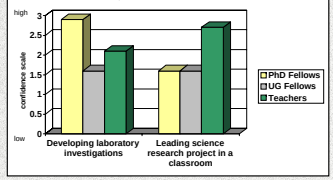
Gauging the Impact of the ECOS Program

The University of Montana GK-12 Program has just completed its first full year. We have collected several types of evidence to document the impact of the program over the course of the year, and to refine our program based on formative feedback. Tools we have developed include pre- and post-participation skills and attitudes surveys, midterm formative assessment survey, an on-line weekly reflective log, and feedback surveys for in-service workshops. We also have developed a photo archive to document program activities. At the end of the academic year, our external evaluator will be interviewing all participants. Here we present our initial findings.

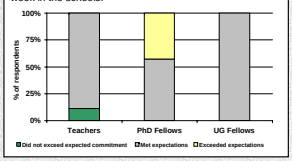
Overall, the ECOS fellowship experiences have met or exceeded participants expectations.



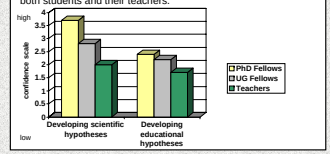
PhD Fellows felt they were fairly skilled at developing laboratory investigations (>2.5 on scale of 0 to 5). In in a complementary result, teachers felt they were fairly skilled at implementing research-oriented inquiries in the classroom.



The workload commitment generally met expectations of teachers and undergraduate fellows, but was greater than expected for some of the PhD fellows. This result led us to mentor students more carefully on their time management to ensure that they did not spend more than 20 hours per week in the schools.



Before beginning the program, PhD Fellows felt their skills for developing hypotheses (both scientific and educational) were well above average (2.5 on scale of 0 to 5), while teachers had less confidence in these skills. Many of the demonstration projects now feature extensive hypothesis-posing activities for both students and their teachers.



UP IN FLAMES AT BIG SKY HIGH SCHOOL

Big Sky High School teacher instructs students before they sample fish in Bitterroot River

Big Sky High School is ideally located for conducting a variety of ecological investigations.Two habitats used extensively for investigations this year are:

- ❖Sleven's Island on the Bitterroot River (see photos)
- ❖Public fields for burn experiment (see photo bottom right)

Field adjacent to high school scheduled for prescribed burn. Two students are marking the corners of a burn plot

Sampling fishes in the Bitterroot River.

BIG SKY HIGH SCHOOL ECOS TEAM

Andrew Whiteley, PhD Fellow
Jennifer Woolf, PhD Fellow
Frank Janes, Undergraduate Fellow
Kathleen Kennedy, 10th Grade Teacher
Dave Oberbillig, 10th Grade Teacher

SCHOOLYARD ECOLOGY AT BIG SKY HIGH SCHOOL

- Sampling Fishes in the Bitterroot River
- Sampling Safari
- What is a Population?
- Asking a Scientific Question
- Preliminary Observations & Questions for Fire Experiment
- Pre-fire Data Collection
- **Experimental Burn**
- Post-fire Data Collection
- Data Analysis
- Poster Presentation

Students at Big Sky High School in Missoula Montana are learning what ecologists do when they head off to the "office". During the sampling safari investigation (described to the right), Big Sky High School student TJ was "calling in" the number of animals in each square of the sampling grid over his "radio'when he exclaimed

You have a cool job!

ECOS THEME

We conducted an experimental prescribed burn in a field dominated by invasive weeds. We designed and implemented other outdoor exercises throughout the school year to ensure the students could fully participate in the experiment, including lessons on sampling, population biology and data collection.

- ❖ **Ecological Themes**: Disturbance ecology, invasive organisms
- ❖ **Goal:** To teach students about the scientific process and about ecology as science by having them develop and participate in a field experiment.

APPROACH

In spring 2005, we conducted prescribed burns of field plots on land adjacent to the school that is owned by Montana Department of Natural Resources (DNRC). DNRC agreed to allow use of their land, oversee the fire, and provide a fire engine. There are nine 20 x 20 m plots, all of which are dominated by invasive weeds. Three of the plots serve as controls, and the remaining six plots are divided into two groups, one of which received a moderate amount of fuel augmentation, and the other which received heavy augmentation. During a previous activity, the students came up with scientific questions to ask and the ECOS team helped them narrow their focus to eight questions. Students addressed their questions as teams.

Fire crew burning plots at Big Sky High School (left); field experiment after burn is completed (right).

SAMPLING SAFARI - HOW MANY ANIMALS ARE THERE??

The goal of this Investigation was to show students how to subsample a small area so they could estimate the number of organisms in a larger area. We designed a grid in the schoolyard and placed plastic safari animals in the grid. The students begin by choosing random sample units from a hat, then used five to ten subsamples to estimate population size. The students finished the stud by graphing their results and comparing sampling effort in the context of organism distributions. This exercise will help students understand how to accurately sample data as part of the fire experiment.

Fellows Future Careers - What the Fellow Have to Say…

One student reflected that, "*As a PhD student involved in the ECOS GK12 program, my experiences and contributions provide direct benefit to my program of study and my career potential. Participation in the ECOS program has given me exposure to and forged connections with students and researchers in related disciplines, which has increased the scope and breadth of my scientific knowledge. I have been called upon to present my research to various audiences from the GK12 to university level, which has strengthened my understanding of my work and its real-world implications.*" **Another fellow wrote,** "*the community-building this program promotes has helped dispel fears of ecologists as threats to local jobs (i.e. logging). Through this increased communication between teachers, students, parents, and ecologists, the community comes to perceive ecologists as everyday people and less threatening. This ultimately will benefit my career as a scientist, because a population that is aware of what ecologists actually do may prevent conflicts and promote cooperation when conducting research on pubic lands.*" **These experiences already are having an impact.** "*A gap in my graduate education prior to ECOS was the knowledge of how to be a good teacher. I have been inspired by the quality of educators we work with and have learned more about effective teaching by working directly with our teachers in the classroom setting than I had hoped.*"

ECOS

For more information, contact Carol Brewer at carol.brewer@umontana.edu and see **www.bioed.org/ecos**

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