UNIVERSITY OF MONTANA GK-12 PROGRAM
Annual Report for 2005

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And with contributions from the 2004 and 2005 cohort
of GK-12 fellows at The University of Montana

1. Highlights and Accomplishments of the University of Montana ECOS (Ecologists, Educators, and Schools) Program From Sept 2004 – Sept 2005.

The **Ecologists, Educators and Schools (ECOS) – Partners in GK-12 Education** Program brings together teachers and administrators in the Missoula Curriculum Consortium (MCC) and University of Montana (UM) faculty to create authentic research experiences for K-12 students using schoolyards and nearby open areas as outdoor research laboratories. Furthermore, ECOS places scientists in residence (two doctoral level graduate students and one undergraduate) to work with partner teachers to develop science demonstration projects related to local ecology and conservation biology. Throughout the academic year and summer, K-12 students and their teachers will interact with UM faculty, postdoctoral scholars, and graduate and undergraduate students conducting research in ecology.

To meet the need for enhanced understanding of environmental sciences in the Northern Rockies, the ECOS Program will 1) develop scientific ways of thinking and understanding in K-12 students through authentic research experiences in their schoolyards and adjacent habitats; 2) promote teaching practices focused on "learning by doing" and inquiry instruction for both teachers and future science faculty (ECOS Fellows); 3) develop and model linkages between educators in the K-16 continuum; and 4) identify project indicators to make the program sustainable at UM, and facilitate transfer to other sites in Montana and around the country.

In our first year, we were truly impressed by how powerful partnerships like ECOS can be. Teachers, K-12 students, graduate and undergraduate students, University faculty, and community volunteers came together to work on a common mission - to bring new opportunities for learning about the environment to local K-12 students. The ECOS program brings people together to learn with each other. In ECOS teams, teachers learn about science from fellows, and fellows learn from teachers about communicating with students and teaching for learning. What is the result? Great experiences learning about ecology – in schoolyards and classrooms - for students of all ages.

We also learned the value of community support in our efforts. We were amazed at the generosity of area businesses, non-profit organizations, and government agencies (see section 9 of this report for list). They provided equipment, materials, and volunteers to transform schoolyards into ecological laboratories, and helped to extend the impact of ECOS across the Missoula Valley and beyond.

What is possible with the support and work of so many students, teachers and community members? Big Sky High School students learned about fire ecology, not from a textbook, but by conducting a controlled burn experiment near their campus. A native plant garden covers 465 m^2 (5000 ft^2) where there once was rubble at Target Range School. Children at Lewis and Clark School can explore Bancroft Pond with tools in their nature backpacks. ECOS teams also helped improve habitat around schoolyards by building a greenhouse and garden at Sussex School, constructing insectaries that teach about noxious weeds and biological controls, and developing a composting system to help students learn about recycling. Florence Carlton schoolyard was designated as an official National Wildlife Federation schoolyard habitat! And all the while, the ECOS staff has been learning how best to support the effort.

In this report, we detail the activities and accomplishments since September 2004 of the first cohort of ECOS Fellows and teams who participated from July 1, 2004 – June 30, 2005. We also report on the activities to date of the second cohort of fellows who began their fellowship year on July 1, 2005.

2. ECOS Fellows and Teachers for 2004 – 2005

To recruit fellows and schools for both cohorts of fellows, we have used the same strategy. An ECOS color brochure, informational materials, and application packets were developed for regular and email distribution. An online application process was developed for the teachers in year one, but was not used in the second year due to reticence of the teachers to interact with the web form; therefore in year two, all applicants presented paper applications. To recruit student fellows, our efforts entailed sending announcements over e-mail to all PhD students in the Division of Biological Sciences and College of Forestry and Conservation, and additionally to the Departments of Chemistry and Geology in year 2. We also talked with faculty during faculty meetings, and made announcements in targeted undergraduate courses.

To recruit schools and teachers, we worked with the Missoula County Curriculum Consortium science curriculum coordinator. Through this key contact, we made presentations to the board of superintendents and school principals. A broadcast email with information and application packet went out to all school principals in Missoula County and in surrounding rural school districts, and follow-up calls were made to ensure that principals were distributing information to school site teachers and encouraging them to apply for the program. In year 1, we sent out a press release which resulted in a feature in the Missoulian, the major newspaper in this region, recruiting schools to apply to participate in ECOS. A local TV news broadcast featured the ECOS program and highlighted the application process and timelines. We also contacted teachers who had participated in previous programs we have run directly, including Montana Partners in Ecology, Montana Teachers Investigate Ecology, and Schoolyard Ecology for Elementary School Teachers (all programs funded by the NSF). Finally for year 2, we also asked year 1 teachers to invite interested colleagues to in-service meetings. This strategy proved to be the most successful tool for recruiting enthusiastic new teachers.

Applicants for the fellowships were asked to complete the application materials detailed on our website at www.BioEd.org/Ecos/. Potential fellows were asked to write an essay detailing their interest in participating in ECOS and provide evidence of their academic standing and approval to participate from their academic advisor. All fellows were interviewed by a selection committee; in year 2, current undergraduate and graduate fellows served as members of the interview team. Teachers were asked to describe how Scientists in residence at their schools would advance science education. Once selected, teachers and fellows signed a contract detailing expectations over the academic year for their participation.

In both years of the GK-12 program at the University of Montana, we successfully recruited a very strong pool of PhD and undergraduate fellows representing a wide diversity of environmental science departments and programs across two colleges. Students were recruited from the Organismal Biology and Ecology Program and Integrated Microbiology and Biochemistry Programs in the Division of Biological Sciences graduate programs, the

departments of Chemistry and Geology (year 2) from the College of Arts and Sciences, and from the Departments of Ecosystem and Conservation Sciences and Wildlife Program (College of Forestry and Conservation). The undergraduate fellows have majoring in Botany, Human Biology, Science Education, and Microbiology. The teachers have between 4 to more than 30 years of teaching experience.

Year 1 Fellows and Partner Teachers: July 2004 – June 2005

NAME	ROLE	YEAR IN SCHOOL/ WORK	ECOS TEAM/ ROLE	TIME IN ECOS	BRIEF DESCRIPTION OF ROLES AND INTERESTS
ECOS PhD Fellows					
Megan Parker	PhD Fellow	5 years	Florence Carlton School	3	Organismal Biology and Ecology PhD student, with a range of experience in wildlife biology. She is currently studying conservation and behavior of African wild dogs.
David Nicholas	PhD Fellow	3 years	Florence Carlton School	3	Biological Science PhD student studying microbial ecology. His thesis work investigates the cycling of arsenic by bacteria in contaminated lakes and reservoirs.
Jennifer Woolf	PhD Fellow	1 year	Big Sky High School	3	Wildlife Biology/ Organismal Biology and Ecology PhD student working in conservation research applied to management. Her thesis focuses on management techniques of fire-associated species.
Andrew Whiteley	PhD Fellow	5 years	Big Sky High School	3	Organismal Biology and Ecology PhD student working in the ecology and genetics of fish, patterns of genetic relatedness among populations of both mountain whitefish and bull trout.
Tammy Mildenstein	PhD Fellow	2 years	Lewis and Clark School	3	Wildlife Biology PhD student working on conservation management of flying foxes in the Philippines
Jeff Piotrowski	PhD Fellow	2 years	Lewis and Clark School	3	Integrated Microbiology and Biochemistry PhD student working on the ecology of arbuscular mycorrhizal communities.
Margie Kinnersley	PhD Fellow	3 years	Sussex School	3	Integrated Microbiology and Biochemistry PhD student studying microbial biology and ecology. Her research focuses on evolutionary changes in E. coli populations
Wendy Ridenour	PhD Fellow	2 years	Sussex School	3	Organismal Biology and Ecology PhD student working on the ecology of invasive species, in particular knapweed species.

Carl Rosier	PhD Fellow	2 years	Target Range School	3	Integrated Microbiology and Biochemistry PhD student studying how Arbuscular Mycorrhizal fungi influence the phytoremediation of radionuclides
Rachel Loehman	PhD Fellow	4 years	Target Range School	3	Department of Ecosystem and Conservation Sciences PhD student studying within the Numerical Terradynamic Simulation Group. Her research focuses on using remote sensing to predict vector-borne diseases.
ECOS Undergraduate Fellows					
Lauren Priestman	Undergraduate Fellow	4 years	Target Range School	3	Ecology major with extensive naturalist work experiences
Frank James	Undergraduate Fellow	4 years	Big Sky High School	3	Microbiology major planning to attend medical school
Dianna Fairchild	Undergraduate Fellow	4 years	Sussex School	3	Biological Sciences and a secondary teaching in biology and general science majors. Her senior thesis is on the effects of spotted knapweed on grassland bird foraging
Sarah Keller	Undergraduate Fellow	4 years	Florence Carlton School	3	Biology major and avid birdwatcher
Hollie Sexton	Undergraduate Fellow	4 years	Lewis and Clark School	3	Biology pre-medical major
ECOS Partner Teachers					
Dave Oberbillig	Teacher/ Co-PI	9 years	Big Sky High School	3	10th thru 12h grade teacher at Big Sky High School. Holds a BS in Biology and M Ed; currently he teaches Integrated Biological and Ecological Sciences and Ecology
Kathleen Kennedy	Teacher	4 years	Big Sky High School	3	10th thru 12th grade science grade teacher at Big Sky High School. BA in Biology; currently teaches Integrated Biological and Ecological Sciences II, Anatomy
Nancy Adams	Teacher	10 years	Florence Carlton School	3	Kindergarten teacher at Florence Carlton School. She holds a BS in Nutrition and a BA in Education.
Lisa Verlanic	Teacher	10 years	Florence Carlton School	3	T1 teacher at Florence Carlton School.
Kathy Dungan	Teacher	20 years	Lewis and Clark School	3	1st and 2nd grade teacher at Lewis and Clark School. She holds a BA in Social work and MS in Fine Arts in Integrated Curriculum.

Mary Jane McAllister	Teacher	19 years	Lewis and Clark School	3	4th grade teacher at Lewis and Clark School. She holds a BS in Education, MA in Fine Arts and MA in Integrated Arts and Education
Maree Mitchell	Teacher	9 years	Sussex School	3	6th-8th grade teacher at Sussex School. Holds MS, Ed. M. degrees, which focused on environmental education and science education
Lisa Hendricks	Teacher	10 years	Sussex School	2	7th grade science teacher.
Jann Clouse	Teacher	23 years	Target Range	3	5th grade teacher at Target Range School. She holds a BS in Elementary Education
Melodee Burreson	Teacher	28 years	Target Range	3	5th grade teacher at Target Range School

3. ECOS Fellows Demonstration Projects at ECOS Schools in AY 2004 – 2005

ECOS fellows work in a team of 2 PhD candidates, 1 undergraduate student and two teachers at a school. Each year, teams are asked to choose an ecological theme for their fellowship year, and work together to develop and implement ecological investigations with their students that relate to the theme. Over the schoolyear, fellows undertake projects in the schoolyard to support ecological investigations and teaching. ECOS "Demonstration Projects" build sustainable infrastructure at local schools so that teacher and their students will have tangible resources to use year after year to teach about the environment. The Demonstration Projects completed in the first year of ECOS are described below, and on our website at www.BioEd.org/ECOS.

To Burn or Not to Burn: What is the Question?

Big Sky High School

Frank Janes, Kathleen Kennedy, Dave Oberbillig, Andrew Whiteley, and Jennifer Woolf

The goal of the demonstration project at Big Sky High School was to introduce 10th grade students to the scientific process in a hands-on manner, using a subject that is locally relevant. The team chose to focus on two ecological themes: disturbance from fire and invasive organisms, both of which are locally relevant as Missoula residents often burn fields to reduce invasive weeds. The team planned a prescribed burn of field plots with varying levels of fuel augmentation on Department of Natural Resource land adjacent to Big Sky High School. Students were introduced to fire research in

PhD fellow Andrew Whiteley with students during a river inquiry.

Big Sky students observe controlled burn on their experimental plots.

relation to invasive weeds and participated in lessons on sampling methods, population biology and data collection. Students did observations of the area to be burned and decided on what pre and post data would be collected. Data collected by the students included: insect composition and density, biotic and abiotic soil factors, cheatgrass and bunchgrass density, plant biomass, plant vigor and growth, plant species composition and moss density. The Montana Department of Natural Resources fire department volunteered their equipment and professional fire fighters to conduct the burn while students observed.At the end of the investigation, fellows worked with students to present data from the controlled burn in a graphical form, and students interpreted the results of this large-scale field experiment. This project successfully taught students about the scientific process and about ecology as science by having them develop and participate in a field experiment. The demonstration site will continue to be used by the school's ecology classes as well as a nearby elementary school.

Restoration and Development of an Outdoor Classroom
Florence-Carlton School
Nancy Adams, Sarah Keller, David Nichols, Megan Parker, Lisa Verlanic

Florence Carlton debuts their schoolyard habitat

Florence-Carlton School has a large undeveloped area immediately adjacent to the school. This area provides habitat for native Montana flora and fauna and is an excellent site for outdoor learning. The goals of the Florence Carlton team were to improve the area to provide a permanent and formal outdoor learning classroom that could be used by the whole K-12 school as well as the greater community. To do this, the team elevated awareness of the resource in the school and community, began a school-wide project to remove noxious weeds from the area, replanted with native plants, hired a landscape architect to develop a plan for trails, an amphitheatre, and learning points for interpretation, built a shed to house tools and equipment for use in the outdoor classroom, and had the site certified by the National Wildlife Federation (NWF) as an official Schoolyard Habitat. Numerous classes were held on the site, including science, math, geology, art and English classes. Curriculum was developed based on the outdoor classroom and other aspects of ecological inquiry. In spring 2005, the outdoor classroom was designated an official National Wildlife Federation schoolyard habitat and the school board has committed to protecting the area for 10 years.

Sustainability and Restoration – Target Range ECOS Garden
Target Range School
Melodee Burreson, Jann Clouse, Rachel Loehman, Lauren Priestman, Carl Rosier

Target Range School is located in a semi-rural area and is adjacent to extensive open space. However, much of the schoolyard is devoted to turf playing fields or can be characterized as mono-cultures of invasive plant species. The Target Range School team set out to create a

restoration garden to increase local floral and fauna while serving as a visible teaching tool for restoration and sustainability of native ecosystems. As part of the restoration project, the team set three main goals: 1) treat an area of the schoolyard to reduce and contain noxious weed invasion, 2) restore and revegetate the area with native northern Rocky Mountain plants, and 3) develop a noxious weed biocontrol monitoring and sampling program in cooperation with the Missoula County Weed District. Fifth grade students helped remove noxious weeds and planned and prepared a 5000 (ft^2) garden. The garden includes a central teaching area with benches, handicapped-accessible paths, and garden theme areas including a pollinator and butterfly garden, medicinal and useful plant garden, prairie garden, and a water-wise, dry-land garden. The result is an outdoor learning area where teachers and students can explore ecological concepts including plant physiology, plant succession, entomology, nutrient cycling, conservation of resources, and wildlife biology. The garden is a resource that will be utilized by the entire school population (K-8) as part of their teaching curriculum. In addition, fifth grade students have collected baseline data for the biocontrol monitoring program. In August, biocontrol insects were introduced to the area and students will continue to monitor the site and collect data in a citizen science project over the next few years.

Melodee Burreson, 5th grade teacher at Target Range, observing her students during a decomposition activity.

5th grade student at Target Range during their schoolyard weed pull

Vermicomposting and Science Backpacks

Lewis and Clark Elementary

Kathy Dungan, Jane McAllister, Tammy Mildenstein, Jeff Piotrowski, Hollie Sexton

Lewis and Clark Elementary School is committed to bringing outdoor ecology into their regular curricula. They have created a natural area with planted habitat for birds and butterflies, called the Outdoor Discovery Center (ODC) which is recognized by the National Wildlife schoolyard habitat program. The Lewis and Clark team wanted to do a project that would further this schools commitment to ecological learning so an ECOS steering committee was created with ECOS fellows, teachers and students from each grade. The steering committee identified two projects that would be useful: 1) a school-wide composting system to reduce lunchroom wastes and provide nutrient rich compost for the ODC, and 2) creation of "science backpacks" for students to use during field trips and activities in their outdoor classroom.

Students researched worm composting systems and how to implement those systems at the school level. When the composting system was in place, fellows and students gave school-wide presentations on how the compost bins worked. The compost bins served as a teaching tool for lessons in soils, microbes and nutrient cycling. The science backpacks contain an assortment of tools useful for ecological observation and investigation and are designed to make it "easier" for teachers and students to go outside and learn about the environment they live in. These projects

offer opportunities for students to interact with and learn from their outdoor classroom and other natural areas near their school.

PhD fellow Jeff Piotrowski aiding a 1st grader in exploring schoolyard soils

Lewis and Clark students clean up Bancroft pond for Earth Day

Our Native Montana
Sussex School
Dianna Fairchild, Lisa Hendricks, Margie Kinnersley, Maree Mitchell, Wendy Ridenour

The Sussex school ECOS team implemented a long-term schoolyard-based restoration project with the goal of transforming the school grounds from an area that consists almost entirely of non-native invasive species to one that represents a healthy native Montana habitat. The goals for the 2004-2005 school year were to assist students in planning the project, map the schoolyard, conduct initial plant, animal and microbe surveys, plant a butterfly garden, design a greenhouse and develop grade appropriate curricula that could be repeated yearly to monitor the demonstration project habitat transformation. In addition to meeting these goals, the Sussex team installed plants to enhance bird habitat, constructed and installed butterfly boxes, birdhouses and birdfeeders as well as began construction on the greenhouse. Each grade level participated in the planning and construction of a piece of the project. Kindergarteners and 1st graders cleaned a pond area; 2nd and 3rd graders censused mammal populations, researched butterflies, and built butterfly houses; 4th and 5th graders researched local bird species, built bird houses and feeders and planted shrubs to enhance bird habitat; 6th graders improved irrigation ditches; 7th graders evaluated the vegetation and soil composition in the butterfly garden site, performed weed treatment experiments and planted the butterfly garden; and design testing and assembly of the greenhouse was done by the 8th grade science class. Through inquiry-based implementation of this project, students of all ages (including parents) have gained a better understanding of basic ecological principles, their surroundings, and their own responsibilities as part of an ecosystem.

4. Special Projects

One of the goals of the University of Montana ECOS Program is to build a sustainable infrastructure for ecology teaching in local schools. One of the strategies we have developed to meet this goal is to create tangible teaching tools that can be used by teachers in Montana during outdoor investigations with their students. We also are building more awareness of the ECOS program in the community. In this section, we describe several of the special projects currently underdevelopment. Three of these are being led by second year ECOS fellows. This group of

fellows was charged with taking on a project to sustain ECOS, provide mentoring to the new fellows, and work as consultants in past and current ECOS schools.

Guide to Ecology of the Northern Rockies

http://www.bioed.org/nhguideweb
Illustrations provided by ECOS fellow Brooke McBride

Overview

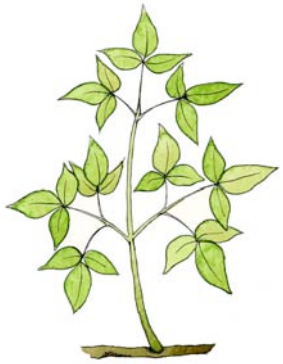
The ecology guide is an innovative and interactive tool for students and teachers to identify and learn more about plants and animals in western Montana. Oftentimes it is difficult to use guidebooks for large groups like plants and insects making a barrier for people to easily learn what they are looking at, and to fully appreciate the beauty and diversity of their local environment. The guide minimizes these problems by providing a dynamic on-line database that includes local photographs, often at 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

Goals:

- Describe common species of plants, animals and their habitats in the Northern Rockies region.
- Provide interactive keys and more intuitive means to identify species accurately in the region, by using any combination of characters
- Improve scientific accuracy of field experiments and overall educational value of field-oriented studies by making natural history information on ecosystems around our region 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.

Structure

Habitats—this section includes information on geography, history, ecology, and habitats that dominate our study area including maps linked to descriptions and environmental data. Information will eventually include soils, geology, topography, hydrology, climate, land-use and land ownership. We are working on developing interactive maps which will allow displaying geographic distribution of environmental features as well as key species groups in the area. We also have a section describing all the habitats referred to in plant descriptions. We will add aquatic and invertebrate habitat sections as these groups are completed.



Plants—all the common plant species in schoolyards and nearby forests and parks our area will be included. We have already described 150 species initially and make reference to another 100 species that might be confused with them. This list will be expanded in the next two years, so that by the end of this grant cycle the guide should include the most common plant species in this region (approximately 300-500 species). We have already photographed 300 species of plants in our area including seedlings, flowers, fruits, leaves, bark, and general habit for the most common species. Quick field indentification sheets (photos and short descriptions) are also being developed for school field projects.

Other groups—Sections are being developed to include representative species, generally 30-60 each of amphibians, reptiles, fishes, invertebrate (families), birds and mammals. All amphibians and reptile species have been described and will be added to guide as soon as photos and other graphics are available.

Why an Interactive Key?

- Easier to use, since you can use visible characteristics of plant or animal at any time of the year, and you can use characters that a teacher or student can readily see or understand

- Avoids frustration of technical dichotomous keys, which often lead to mis-identifications since it is easy to make mistakes in choosing paths in the key, and they often rely on technical characteristics which are difficult for a broad audience to use correctly.

- Allows using all the information available about a particular specimen, including morphology, color, distribution, habitat and so on. This is particularly key for northern climates where classes do fieldwork when few plants are in flower. Our guide should help ID species in all seasons of the year.

- Students or teachers can classify or group species by habitat, medicinal uses, flower type or other characteristics.

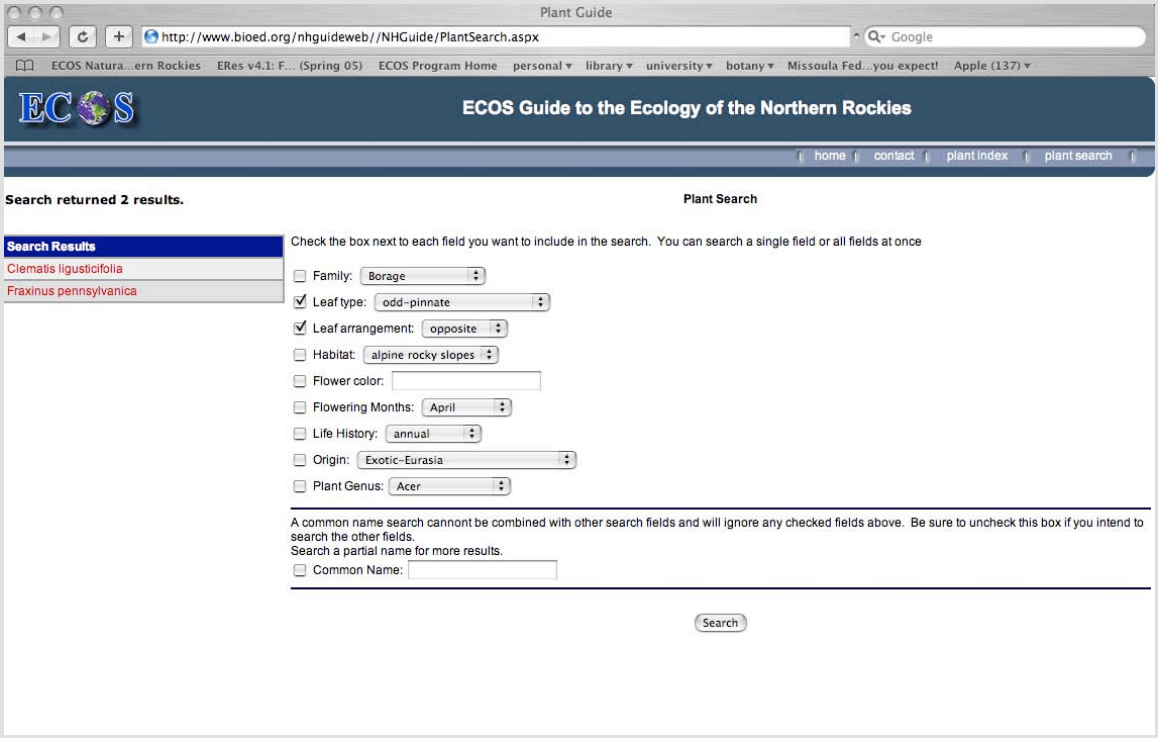
How is the Ecology Guide Linked to ECOS activities?

- Students need to develop observational skills for schoolyard habitats and species, which requires understanding what you are looking at, and how to identify species.

- Students and Teachers are involved in developing better natural history information for species in their schoolyard. Information is constantly updated as students and fellows discover new things. The guide can easily be adapted so that it serves as a guide to just the species known to occur in any given schoolyard.

- Students can develop their own tools for identification or adaptive characteristics of plants or animals with the customized interactive searches and keys.

Search page for plant guide section of ecology guide. In this example two species were found which shared the characteristic of odd-pinnate compound leaves and opposite leaf arrangement.



New features and information to be added to the ecology guide during the next year

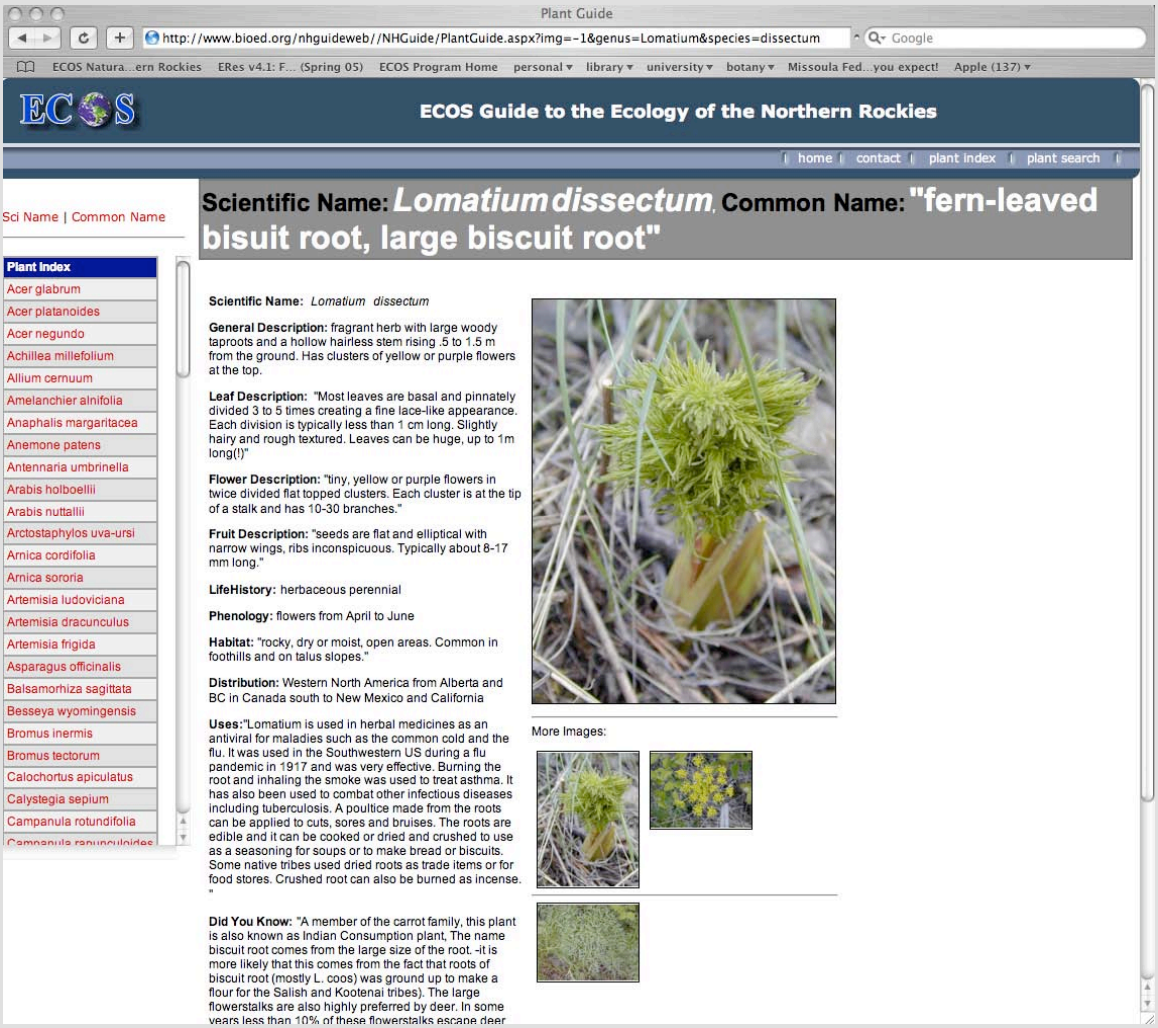
There are several projects now underway that should substantially add to the utility of the nature guide, and will also allow for testing and evaluating new ways of teaching about natural history. We are particularly excited about the development of color illustrations for all plant characteristics for the guide. Users can easily find definitions of each characteristic used in the guide with a cross-referenced glossary text, but also with labeled watercolor illustrations developed by ECOS fellows. In addition we will expand the interactive keys so that they can be used in a visual mode, so that users can simply select the drawings that best represent each of the characteristics of the plant, thus avoiding problems with using technical botanical terms. As soon as we have thoroughly tested and evaluated the plant section of the guide, we will develop interactive keys for all the other species groups to be covered in the guide.

We are also developing extensive graphic and summary textual information on the geology of western Montana which can be integrated with all our other spatial information. Animations are being developed to illustrate several of the key processes that explain the history of this geologically diverse and active area. Maps and digital spatial data are being added to the guide as well, which will eventually include interactive maps so that teachers or students can develop their own maps of species and environmental variables across different landscapes in our large mountainous region.

Outreach and broader impact of ECOS ecology guide

While the ECOS guide has only been under development for a year, already it is being used by a wide audience both within the ECOS program and its schools as well as classes at the university, and even from researchers across the country. We have had several inquiries from these users and have had a lot of good feedback on how to improve the guide. Several university classes outside of ECOS are getting involved in the guide project as well. The interdisciplinary wilderness and civilization program has their students developing plant species descriptions and interactive key development as part of student projects for this semester. A forestry ecology class is using the plant guide as a resource for class field trips and for student exercises. We are working to involve a wide variety of classes and local organizations with natural history expertise in the continuing evolution of the guide.

Example page from plant guide section of ECOS ecology guide.



How to Use ECOS guide to the ecology of the northern Rockies.

How to Use ECOS Plant Guide

Starting Guide:

1. Start internet browser and go to the ECOS website (www.bioed.org/ecos). Click on ECOS ecology guide at bottom of screen.
2. Click on " go to plant guide ". A list of species described so far appears on left side of screen. To look at common names click on "common name" at top of species list. To go back to scientific names click on "sci name" at top of screen.

To View a Species Description:

1. Click on a species name.
2. Scroll screen to view all the information about this species.

To View Photos:

1. To increase the size of the photo click on large photo. To return to normal size click on back arrow of browser.
2. To view other photos click on their thumbnails (the small photos below the large one). The other photo selected will now appear in the larger window. You can click on this larger photo again to enlarge the photo to see it more clearly.

To Search for a plant species (scientific name):

1. Click on button towards top of screen called "plant search"
2. Click on a plant characteristic that you have information about, such as "leaf type",
3. Click on item in list that best describes your plant. For a ash tree, for example this might be "odd-pinnate".
4. Click on box to right of this characteristic so that a check mark appears. This means when a search is done it will only list plants with this type of leaf.
5. Repeat for as many characteristics as you have information about your plant.
6. Click on "search" button towards bottom of screen. All the species sharing all the characteristics you selected are listed on the right hand side of screen. Click on each of the species and examine the description and photos until to you find the one that best describes your plant.
7. If too many species are listed, then you should add more characteristics so a smaller number of species will be listed, Select another characteristic, Click the check box of this new characteristic, and search again.

To search using common names of plant species:

1. Enter either whole name or a word of the common name in the "common name" field at the bottom of the search screen.
2. Note that computer will search for the words anywhere in the list of common names given for each species. Since there are many different common names often given for each species we have included all commonly used ones so that if a person knows a plant by a particular name they should be able to find it. This also allows searching for groups such as "ash" which would include all the mountain ashes (Sorbus spp.), ash-leaved maple and true ashes (Fraxinus spp.).

To print out the description of a plant species:

Click on box "printer friendly version" then click on file menu and print from your browser.

Building Community Awareness of ECOS

Carl Rosier is dedicating his second fellowship year to increasing the awareness of ECOS at the university, school district and community level. Various activities will combine to make ECOS even stronger within the University and Missoula communities. Establishing a volunteer program

to place University students in the classroom, raising the University's awareness of the demonstration projects, and informing advisors and other University faculty of the impact of ECOS in the community are the means by which Carl will achieve his goal.

Carl will help last year 1 fellows to lead occasional inquiries in schools that are not yet participating in ECOS, both to expand the footprint of ECOS and take advantage of these fellows' experience. To recruit fellows for next year, Carl plans to invite PhD students to assist him in developing and leading inquiries. This would allow PhD students to understand what ECOS is all about, while at the same time insuring strong applicants for the upcoming year. Involving student teachers from the School of Education in the schoolyard Demonstration projects will also bring in extra hands, while providing them with a vital experience towards their certificate.

Citizen Science and Mapping Spread of Invasive Species

Rachel Loehman is developing two special projects during her second year as a fellow. The first is a Knapweed Biocontrol Project and the second is the Development of a Spatial Component to the Montana Natural History Guide. Her incentive for both of these projects is to increase her skill set, foster sustainability at school and program levels, enable mentoring of GK-12 students and new fellows, and facilitate cooperation with community and university partners.

The knapweed biocontrol project began in February of 2004 when the Missoula County Weed District proposed to establish an insectory, which would house insects that predate on the exotic knapweed. Rachel supported this project by developing relevant inquiries with the students, while leading data collection and analyses. As an at-large fellow, Rachel has expanded this project to Hellgate Elementary.

Due to the seasonal nature of the knapweed biocontrol project, Rachel will have time to develop a series of GIS-based distribution maps to complement the species descriptions provided within ECOS' Montana Natural History Guide. These maps will provide a key to understanding the complex relationships between biotic and abiotic components of ecosystems, as well as complement Rachel's dissertation within the Numerical Terradynamic Simulation Group at the University.

Creating a Traveling Herbarium for ECOS Schools

Jeff Piotrowski's will also make the most of the hard work of last years' Undergraduate fellows, by laminating and categorizing their local plant species collection. He will then create a "traveling herbaria", which will then be loaned to schools as teaching aids. This teaching aid will also motivate the schools and fellows to add to the collection.

5. Second Cohort of ECOS Teachers and Fellows

The second cohort of ECOS fellows and teachers began their fellowship year in July 2005. Fellows expertise ranges for biology, forestry and wildlife management to environmental chemistry and geology. They used the summer to plan demonstration projects for their schools and began work to put these teaching laboratories onto the school grounds.

NAME	ROLE	YEAR IN SCHOOL OR WORK	ECOS TEAM	TIME IN ECOS (MO)	BRIEF DESCRIPTION OF ROLES AND INTERESTS
ECOS Fellows 2005-2006					
Sam Stier	PhD Fellow	2 years	Florence Carlton	3	PhD student in Forestry, studying the opportunities and constraints to biodiversity conservation within the carbon credit market.
Bruce Threlkeld	PhD Fellow	2 years	Lewis and Clark	3	PhD student in Forestry, researching herbaceous layer response to disturbance in mesic forests of northern Idaho and western Montana
Alison Perkins	PhD fellow	<1 year	Hellgate Elem	3	PhD student in Forestry, studying the opportunities for ecological education through television and other informal communication channels
Brooke McBride	PhD fellow	1 year	Target Range	3	PhD student in Integrative Microbiology and Biochemistry, studying the structure and function of arbuscular mycorrhizal fungi.
Joseph Fontaine	PhD fellow	2 years	Florence Carlton	3	PhD student in Fish and Wildlife Biology, researching the influence of juvenile mortality risk on life history, parental care, physiology and population demographics of a song bird community
John S. MacLean	PhD Fellow	1 year	Hellgate Elem	3	PhD student in Geology, documenting the continuation of the Rocky Mountain foothills triangle zone into Montana along the Rocky Mountain Front
Michael Machura	PhD Fellow	1 year	Target Range	3	PhD student in Integrative Microbiology and Biochemistry, studying the effect of habitat disturbance on amphibian populations.
Katie Hailer	PhD Fellow	4 years	Lewis and Clark	3	PhD student in Chemistry, researching changes in cellular processes brought about by chromium oxidized lesions
Carl Rosier	2nd year PhD Fellow	3 years	At-large fellow	15	PhD student in Integrative Microbiology and Biochemistry, researching arbuscular mycorrhizal fungi and working towards expanding ECOS in the University community
Rachel Loehman	2nd year PhD Fellow	5 years	At-large fellow	15	Department of Ecosystem and Conservation Sciences PhD student studying remote sensing to predict vector-borne diseases and working to include geospatial technologies in science education.

Jeff Piotrowski	2nd year PhD fellow	3 years	Special Projects	15	Integrated Microbiology and Biochemistry PhD student working on the ecology of arbuscular mycorrhizal communities and developing curriculum and serving as a mentor for ECOS
ECOS Undergraduate Fellows					
Corissa Crowder	Undergrad Fellow	3 years	Lewis and Clark	3	Biology major whose goal is to conduct research in conservation biology
Hannah Elliott	Undergrad Fellow	5 years	Hellgate Elem	3	Biology major with a concentration in biology education
Andrew Hoye	Undergrad fellow	3 years	Hellgate Elem	3	Biology major with lab experience in soil ecology
Allison Greene	Undergrad fellow	3 years	Target Range	3	Biology major with an emphasis an Ecology and experience in various field work projects in western Montana
Melissa Maggio	Undergrad fellow	4 years	Florence Carlton	3	Biology major with an emphasis in Botanical Sciences with field experience working with BLM in western Montana.
ECOS Partner Teachers 2005-2006					
Mike Plautz	Teacher and CO-PI	15 years	Hellgate Elem	3	BS in Biology, currently teaching 7th grade general science and enrolled in graduate school of education at UM.
Jo Fix	Teacher	20 years	Hellgate Elem	3	BA in Elementary Education, currently teaching 3rd grade and assisting other elementary teachers in environmental subjects.
Julie Greil	Teacher	17 years	Lewis and Clark	3	BA in Elementary Education, with experience teaching 1st and 2nd grade.
Carol Reeves	Teacher	21 years	Lewis and Clark	3	BS in Elementary Education with a certification in special education, currently teaching 5th grade
Peggy Purdy	Teacher	26 years	Target Range	3	BA in Elementary Education, currently teaching 4th grade.
Debbie Caron	Teacher	27 years	Target Range	3	BA in Elementary Education, currently teaching 4th grade with experience in 2nd through 8th grade teaching
Byron Weber	Teacher	27 years	Florence Carlton	3	BS Biology, with teaching experience ranging from Kindergarten to Highschool
Brent Heist	Teacher	4 years	Florence Carlton	3	BA in Elementary Education, currently teaching 8th grade physical science, reading and art

ECOS schools for the 2005-2006 schoolyear are suburban and rural.

School	Grade Range	Rural Suburban or Urban	Ethnicity*	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school or district and met AYP***
Lewis and Clark Elementary	K-5	Suburban	AA <1% AI 4.5% H 2.1% W 90% AS 2.3%	473	29%	Reading 89% Math 64% Met AYP
Hellgate Elementary /Middle School	PK-6/ 7-8		AA <1% AI 3.5% H 1% W 91.5% AS 3%	1197	40.7%/ 36.6%	Reading 77%/77% Math 72%/83% Met AYP
Florence Carlton Elementary/Middle	PK-6/ 7-8	Rural	AA 1% AI 1% H <1% W 97 % AS 1%	625	19.9%/ 20.4%	Reading 89%/71% Math 69%/62% Met AYP
Target Range Elementary	PK-6	Rural	W 94 % AS 3.7 %	291	25.7%	Reading 71% Math 66% Met AYP

All data is for most recent year information available 2003-04; Data taken from the Missoula office of public instruction website, www.opi.state.mt.us/

**AA= African American, AI= American Indian, H=Hispanic, W= White, AS= Asian*
***Indicator of Socioeconomic Status*
****AYP= Adequate Yearly Progress per No Child Left Behind*

The ECOS teams for the current academic year already have identified the themes for their Schoolyard Demonstration Projects. Work has begun to put them in place.

Exploring Ecological Diversity in our Community
Hellgate K - 8 School

The demonstration project at Hellgate School provides students and teachers an opportunity to observe and learn about the variety of ecological systems in and around their schoolyard. The project will consist of four learning centers, each focusing on a separate aspect of western Montana ecology. The learning centers will include: 1) a Native Medicinal Garden, 2) a Behavioral Ecology Center, 3) an Insectory, and 4) a Rock Walk. The learning centers correspond to the specialties of the ECOS fellows, while providing an important resource for the ECOS teachers.

This project aligns with the ECOS objectives by providing several outdoor opportunities in which teachers can design and implement a variety of "learn-by-doing" inquiry lessons for all the K-8 classes on campus. The purpose of providing several outdoor classrooms is to offer specific settings for inquiry lessons that will include diverse subjects including microbial studies on soils, plant form and function, rodent behavior and the geologic effect on macro-ecosystems. The project design allows for sustainability and improvement in future years, while also providing opportunities for "citizen science" research.

Rediscovering the Discovery Core: Exploring the Outdoors like Lewis and Clark.
Lewis and Clark Elementary School

The demonstration project at Lewis and Clark will focus on the existing garden (officially called the outdoor discovery core, or ODC). The ECOS team will be identifying and labeling the existing plants in the ODC; and then producing a color, laminated tri-fold identifying the most common plants in the garden. Each student in the ECOS classes will receive a tri-fold. Throughout the rest of the school year, we will be working on a full length, color, laminated nature guide identifying all of the plants in the ODC. Every teacher in the school will receive a copy of this full-length nature guide. By learning identification skills and drawing maps of the ODC, the ECOS classes will be highly involved with this project.

The goal is to encourage every teacher at Lewis and Clark to utilize the outdoor teaching environment of the ODC. The comprehensive nature guide will give the teachers at Lewis and Clark the means to use the ODC to its full potential and create lessons in the outdoor discovery core as part of every their curriculum for years to come.

Birds, Bats, Bees and Blossoms: Improving Florence Carlton's Outdoor Classroom
Florence Carlton School

Florence-Carlton school is fortunate to have a relatively large outdoor classroom (OC, or the "Lyceum") immediately adjacent to the school, which supports relatively intact native woody vegetation and a variety of grass and herbaceous species. The OC, designated as a Schoolyard Habitat by the National Wildlife Federation, is a unique resource for the school, though it remains under-utilized and underdeveloped. In order to develop the educational infrastructure of the OC and incorporate the area into the school's curriculum, the ECOS team has proposed an improvement to the OC.

Proposed improvements to the OC include: 1) Construction of an all-weather, wheelchair accessible nature trail, (2) Development and installation of 4 to 8 inquiry-based nature stations at strategic locations along the trail, (3) Lyceum Discovery Booklets, which contain relevant ecological questions, references and resources for developing inquiries in the OC, (4) Development, compilation, and printing of Inquiry Binders, containing relevant curriculum referenced by station, grade, and season, (5) Development and installation of an entrance kiosk with a trail map, basic safety information, recognition of community participants, and a short

narrative of the history, purpose, and goals of the Lyceum, and (6) Development and installation of approximately 40 aluminum plant identification signs. To date the team has met with a number of contractors for the construction of the trail. We have also secured a large kiosk from the BLM and we plan to have a school wide weed pull in the outdoor classroom to help control the extensive weed problem that exists there.

An Outdoor Eco-Classroom
Target Range School

The 2004-2005 ECOS team and students at Target Range planted a beautiful native plant garden at the southern end of the schoolyard. The current ECOS team plans to continue this project by expanding the outdoor classroom to include a cottonwood grove adjacent to the garden. The cottonwood grove has enormous potential as an educational resource for the entire school. It is a stand of about 15 adult trees located in a rocky depression near the native garden and is the last remnant of the cottonwood forest that once covered the schoolyard. Currently, it is a neglected, littered, and poorly used resource. In addition, with its steeply eroded sides and dead branches in the canopy, it is a relatively unsafe area of the schoolyard. The ECOS team has chosen to clean up and enhance the grove for wildlife habitat, and to stabilize it for safe use by Target Range teachers and students.

Once its condition is improved, the grove will be a wonderfully shaded gathering place well suited for leading ecological inquiries and nature journaling. It is an area of excellent wildlife habitat for species such as kestrels, songbirds, insects, small mammals and deer. Its exceptional ecological qualities will create an outdoor observatory and laboratory. In order to promote the use of this area, Ecology Field Kits will be assembled. These kits will contain items such as binoculars, compasses, trowels and bug boxes that teachers and students may use for ecological inquiries. The ECOS team has received enthusiastic support from Target Range administration, and has already secured community donations and volunteer time for the project.

6. ECOS Training and Institutes

During the last year, ECOS staff and collaborators have offered a variety of training and professional development opportunities for teachers and fellows. Each fellowship year begins with a 4 day orientation where the ECOS program was described in more detail and expectations were discussed. During these orientations, fellows were introduced to ECOS Program projects, such as the Natural History Guide for Schoolyards in the Northern Rockies and the ECOS curricula.

New fellows and teachers attend two one-week training institutes during the summer. The goals of these institutes were to build the school teams, introduce the teams to inquiry investigations in Ecology, and to plan for the upcoming school year. During the first institute in July, school teams were formed. Each was comprised of two teachers, two PhD fellows, and one undergraduate student. As part of the institute kick-off, each fellow prepared a poster to describe their research to the ECOS teachers and fellow students. Then student teams made PowerPoint presentations illustrating how their expertise could be linked to the national science standards.

The institute also featured extensive field experiences. One day was spent conducting an open inquiry in a local natural area near Missoula, MT. Each school team developed a researchable question, devised a plan to collect preliminary data, conducted the investigation, and then presented their results at the end of the day. During the remaining days of the institute, ECOS leaders led investigations with all the fellows in each participating schoolyard. Throughout the institute, teams planned for the upcoming schoolyear. During the second institute in August, each team presented an investigation they had designed for their schoolyard. Teams also had planning time each day, and by the end of the institute, teams presented a proposal for an ecological teaching demonstration project for their school.

Biology 595 – Conservation and Ecological Education Seminar: During the academic year, ECOS fellows are required to take a graduate seminar on conservation and ecological education. The seminar meets for two hours once per week for the entire academic year. The objectives of the seminar are to: 1) Determine the status of education about issues in conservation biology, ecology, and biodiversity, at all levels of education, from k-12, university, graduate, and adult education; 2) Explore appropriate teaching strategies for ecology and conservation education; 3) Review the literature to assess what strategies in conservation and ecological education have and have not worked by looking at selected case studies from local, regional, national and international scales; 4) Explore the roles of scientists and science educators in developing ecological and conservation literacy; and 5) Outline opportunities for improving the status of conservation and ecological education. The format is a combination of lectures and student-led discussion. Each week, the discussion leader(s) prepares an outline based on a short review of the recent literature. After a 20 – 30 minute overview of the topic, the presenter leads a discussion of the papers with all seminar participants. The last hour of each seminar is reserved to talk about ECOS implementation in local schools.

The institutes, workshops, in-service meetings and special events hosted by ECOS since September 2004 are listed in the two tables below.

ECOS-Wide Events AY 2004-2005, summer 2005				
Event	**Date**	**Location**	**Participants**	**Brief Agenda**
In service Meeting	11/4/04	UM	fellows, teachers and staff	Team updates Dave Oberbillig: "New approaches to Curriculum" Team planning time Carol Brewer: Classification Curriculum idea Paul Alaback: Presenting the ECOS guide
In service Meeting	2/4/05	UM	fellows, teachers and staff	Alison Perkins: "Nature of Science" Janine Benyus: "Biomimicry"
In service Meeting	5/16/05	UM	fellows, teachers and staff	Reflection on the ECOS year Presentation of one inquiry per team

New Fellows Reception	4/13/05	UM	04-05 and 05-06 fellows, teachers and staff	Carol Brewer: Welcome to ECOS
Writing Retreat	5/23/06-5/26/05	Flathead Bio Station	04-05 fellows	Led by Diane Smith, science writer, who intensely mentored manuscript writing by ECOS fellows
Orientation	6/5/05-6/8-05	UM	05-06 fellows and staff	Introduction to ECOS Program Melodee Burreson- "Teaching in a K-12 classroom" Dave Oberbillig- "Interacting well in the classroom" Time management Interaction with 2004-2005 fellows ECOS assessment
Institute 1	7/18/05-7/22/05	Greenough Park, UM, Demonstration project sites	05-06 fellows, teachers and staff	Pre-fellowship assessment Ecological Investigations Group discussion ECOS and National Science Standards PhD Fellows present research Natural History Guide Team planning
Institute 2	8/15/05-8/19/05	UM, Hellgate and Florence Carlton	05-06 fellows, teachers and staff	ECOS curriculum templates Nature Journaling Team planning and presentations

ECOS Special Events at schools AY 2004-2005				
Event	**Date**	**Location**	**Participants**	**Brief Description**
Earth Month	April 2005	Target Range	5th grade students, teachers and team	Students created committees to work on various environmental issues, including composting, recycling, energy conservation and water pollution.
NWF Schoolyard Habitat Certification	4/19/05	Florence Carlton	Students, teachers and team	Open House to introduce parents to the newly certified schoolyard habitat
Insectory and weed control	Ongoing project, began in April 2005	Target Range	5th grade students, teachers and team	Students collected plant distribution data, established a weevil insectory and released the weevils in August of 2005. In the Spring of 2006, the students will collect data to determine the effect of releasing weevils in the schoolyard.
Bancroft Pond Cleanup	4/22/05	Near Lewis and Clark	Students, teachers and team	Lewis and Clark celebrated Earth Day by restoring the nearby Bancroft Pond and making signs to remind the community to use the pond area responsibly
Ecology Week	5/2/05-5/6/05	Sussex	All students, teachers and team	The entire week was dedicated to Ecology. Activities included field trips, guest speakers, games, crafts, experiments and work on their demonstration project

7. Outreach through ECOS Web Site, Publications, Newsletters, and Brochures

A goal of ECOS is to broadly disseminate the results of our GK-12 project. To accomplish this goal, fellows have been mentored in writing a chapter of their dissertation for an education audience, and to prepare them for presentation at national conference and publication in education journals. First year fellows began presenting and publishing their work this past summer. ECOS staff also have contributed to the dissemination of the ECOS project through brochures, posters, and a regular newsletter. ECOS presentations are listed in the following table.

Posters, presentations and articles

Title	Date	Authors	Journal or Meeting	Brief Description
Poster To Burn or not to Burn: What is the Question?	07/2005	J.C. Woolf, A.R. Whiteley & C.A. Brewer	Society for Conservation Biology	As a demonstration project at a local high school, an experimental burn was conducted. The project successfully taught students about the scientific process and ecology by having them participate in a field experiment.
Article Classroom mark and recapture with crickets	08/2005	Whiteley, A., J. Woolf, K. Kennedy, D. Oberbillig, & C. Brewer	Submitted to American Biology Teacher	This paper describes an investigation designed to teach mark-recapture techniques using crickets in 10 gallon aquaria.
Poster Ecologists, Educators, and Schools: No Child Left Indoors. Poster presented at the Annual Meeting of the Ecological Society of America, Montreal, Canada.	08/2005	C. Brewer, P. Alaback, M. Kinnersley, R. Loehman, T. Mildenstein, D. Nichols, M. Parker, J. Piotrowski, W. Ridenour, C. Rosier, A. Whiteley, and J. Woolf.	Ecological Society of America	This poster describes the ECOS project and the demonstration projects of the 2004-2005 fellows.
Winter 2005 Newsletter	02/2005	ECOS staff		Newsletters include Schoolyard updates, curriculum ideas and news from the staff
Spring 2005 Newsletter	05/2005	ECOS staff		See above
Late Summer 2005 Newsletter	9/2005	ECOS staff		See above
Brochure 1st edition 2nd edition	 6/2004 2/2005	ECOS staff		Defines ECOS objectives, mission statement and the role of fellows

The ECOS Web Site: An important dissemination tool is the ECOS website. At www.BioEd.org/ECOS, one can find information about ECOS, bios of fellows and teachers, descriptions of ECOS schools and the demonstration projects, and all the forms and assessment tools we have developed. Of broad interest is all of the curriculum materials fellows have created to lead ecological inquiries in the schoolyard. A list of all the curriculum materials created in the first year of ECOS is listed below.

Title	Grade Level	Inquiry Questions	Ecological Themes	General Goal	Contributor
Winter Entomology Investigation	5	What are insects? How do insects survive the winter? Where can we find insects during winter months?	Adaptation, Survival, Community Ecology	Demonstrate that adaptations allow organisms to survive harsh environments, Winter is not a "dead" season	Rachel Loehman
A Tour of Soils	1-2	How many soil types can be found in the schoolyard	Diversity of soil types results in diversity of plants	Discovery and name five different soils types around the schoolyard	Jeff Piotrowski
Adaptations: How do plant and animal adaptations from the tropics compare to organisms from here in Montana?	5	What is an adaptation? How do adaptations benefit an organism?	Natural Selection, Adaptation	To get students to think about how different traits allow organisms to survive in specific habitats, and why these qualities promote greater fitness for that species.	Lauren Priestman
Composting 101: It's the Microbes	1-4	What is composting and what causes decomposition?	Nutrient cycling	To understand the process of decomposition	Jeff Piotrowski
Why are There Seasons?	1-8	Why are there seasons?	Seasonality is the driving force behind the majority of ecological cycles on the earth.	Student understanding of the causes of seasonality.	David Nicholas
Creating a miniature Grand Canyon: Demonstration of soil erosion by water.	1-2	What causes soil erosion?	Conservation of soil	Understand soil erosion, its causes, and solutions	Jeff Piotrowski

Investigating Use of Biocontrol Agents to Control Spotted Knapweed	5	Are biocontrol agents (insects) present in spotted knapweed plants in the schoolyard? What species of insects are present? Where in the plant do they live, and how do they help control noxious weeds? Do we need to release more insects this spring and summer to control spotted knapweed?	Density and distribution of organisms. Use of biocontrols to control invasive weeds. Sampling and hypothesis testing. Sustainable population concepts.	Formulate and test ecological hypotheses. Hands-on exploration of a relevant real-world question. Better understanding of schoolyard community ecological interactions. Student investment in restoration garden.	Rachel Loehman
Knapweed in the Web	2-5	What are food webs? Can you provide examples of local food webs? Can food webs be altered by the introduction of non-native species?	Students learn about a local Missoula, Montana example of a food web altered dramatically by the introduction of exotic species.	Students will become familiar with the concept of food webs and some of the ecological problems associated with invasive species and their control.	Wendy Ridenour
Lunar Ecology	3-5	Design an animal adapted to the moon's environment.	Adaptation, energy cycling.	To broaden student's appreciation of animal ecological adaptation.	Megan Parker
Isolation of Microbes from the Environment	5	Where do microorganisms grow? Are there areas where microorganisms will not grow? How does the surface of an area influence microorganism growth?	Microorganisms are everywhere in the environment. Certain surfaces will maintain greater diversity of microorganisms (i.e. Soil vs. Bathrooms).	Demonstrate that microorganisms are everywhere. Introduce students to microorganisms. Introduce the potential benefits of microorganisms (i.e. not all bacteria are pathogenic).	Carl Rosier
Mystery Scat	5	describe the ecology of this animal through dissection of its scat.	diet, habitat, scientific method	To start students at the final product and move back to the bigger picture.	Megan Parker

Do Bacteria (Microorganism) Enhance Plant Growth?	5	Are there microorganisms that limit plant growth? Are there microorganisms that enhance plant growth? If a microorganism does enhance plant growth, can all plant species take advantage of this? How would a microorganism enhance plant growth (i.e. what would the bacteria do for the plant)? If a microorganism does help plants grow is there a cost to the plant?	That some microorganisms are beneficial to plant growth and form symbiotic relationships with certain species of plants. The relationship between plant and microorganism can impact where certain plants are found.	Introduce the concept that microorganisms can enhance plant growth. Discuss how microorganisms help plants gain nutrients.	Carl Rosier
The Benefits of Soil Organic Matter (aka "The Radish Party")	1-2	What makes a soil "good" for plant growth? What are the functions of soil?	Soil conservation/ beginning soil ecology	Understand the importance of organic matter in soil.	Jeff Piotrowski
Brewing Rootbeer	5	What is your hypothesis for each of the treatments? What is the purpose of the yeast? What would happen if we placed a lot of yeast in the bottles? What if no yeast was used?	Yeast are able to fill several niches due to their different respiration systems. Anaerobic conditions select for only certain types of microorganisms.	Demonstrate beneficial uses of microorganisms. Introduce different respiration pathways of microorganisms. Compare modern brewing (via CO_2 injection) verses how yeast were once used to carbonate soda.	Carl Rosier
Sussex School Spider Investigation	4-5	Form hypotheses about what types of spiders are found in the schoolyard and where in the schoolyard they will be found.	By surveying spiders in the schoolyard, students will gain an understanding of the diversity of the resident spiders and their specific habitat requirements.	Science as Inquiry; Life Science (characteristics of organisms, organisms and their environments, classifying organisms).	Margie Kinnersley

Water Bottle Rockets: an Exploration of Newtonian Physics	5	What water to air ratio is needed to achieve maximum height? How do Newton's laws of motion explain and influence a rocket's flight? What forces keep a rocket from reaching maximum height? How are rockets designed to overcome these limitations?	How do laws of physics apply to the field of ecology? Are there fundamental laws of ecology? Why or why not?	Introduce Newtonian physics. Discuss how Newtonian physics influences rocket flight. Discuss how rockets are engineered to overcome forces acting upon them.	Carl Rosier, Rachel Loehman, and Lauren Priestman
Animals Prepare for the Winter	1-5	Is weather important to animals? Do animals think about the weather or prepare for the weather?	Weather, habitat, ecological connectivity	To help students understand how animals and weather events are connected.	Hollie Sexton and Tammy Mildenstein
What Is This Beak For?	1-5	How does beak form define beak function? How are beak differences adaptive for exploiting different food sources?	Adaptation; Food Specialists vs. Generalists	To help students think about phonological adaptations in animals.	Tammy Mildenstein
Classroom Mark-Recapture with Crickets	9-12	How do we estimate the size of animal populations in the wild?	Population ecology, population estimation, and sampling.	To provide a guided inquiry that builds on previous population ecology lessons and teaches mark-recapture theory and techniques.	Andrew Whiteley, Jennifer Woolf, Frank Janes
Sampling Safari	9-12	How to biologists accurately count organisms? How to estimate population size?	sampling design, population monitoring, population increase/decline, field biology in practice	The goal of this exercise is teach students that sampling design can affect the accuracy of an estimate.	Andrew Whiteley, Jennifer Woolf, and Frank Janes
Scratching Your Head Over Itchy Weeds: A Population Activity	9-12	What is a population of knapweed/cheatgrass? How can we estimate population size of a plant population?	Population ecology, species interactions, and sampling.	To provide a semi-guided inquiry that builds on a previous sampling activity and has the students think how to define a population in a real ecological situation.	Jennifer Woolf, Andrew Whiteley, and Frank Janes

Fishes of Sleven's Island	9-12	How does the morphology of fish relate to the habitat in which they are found?	Aquatic ecology, niche partitioning, morphological adaptations.	To implement an outdoor guided inquiry on the relationship between fishes and their habitat	Andrew Whiteley, Jennifer Woolf, Frank Janes
Effect of Acid Rain on the Ability of Soil Microbes to Decompose Organic Matter	9-12	How does changing environmental parameters influence essential processes such as nutrient cycling.	Nutrient cycling, environmental change	Provide a hands-on activity that demonstrates the ecological themes stated above and how microbes are essential to the process of nutrient cycling.	Andrew Whiteley, Jennifer Woolf, Frank Janes

8. ECOS Staff and Resources

ECOS is being directed by Drs. Carol Brewer (Division of Biological Sciences) and Paul Alaback (Department of Forestry), PI's on the grant. ECOS started with an excellent staff, many of whom had worked on previous ecology education programs at the University of Montana.

Jen Marangelo, ECOS Coordinator: Jen is a first year M.I.S. student focusing on museum exhibit design and curriculum development. She wants to create exhibits and educational programs utilizing live insects. After working as a research specialist at UM for ten years, she is now learning more about ecology education as the ECOS program coordinator.

Josh Burnham, ECOS Web Master: Josh is responsible for the design, management and maintenance of the ECOS website. This includes programming the ECOS assessment log, the online Natural History Guide, and the Ask An Ecologist programs. He also provides technology support to ECOS staff, fellows, and teachers. Over the last four years, Josh has worked as a web developer for numerous NSF funded programs at the University of Montana.

Kim Failor, ECOS Administrative Assistant: Kim is a first year Masters student in the College of Forestry and Conservation under the direction of Carol Brewer. She plans to focus her thesis on conservation efforts in Latin America. ECOS is providing part time work as well as a valuable experience in ecology education.

NAME	ROLE	YEAR IN SCHOOL/ WORK	ECOS TEAM	MONTHS IN ECOS	BRIEF DESCRIPTION OF ROLES AND INTERESTS
ECOS STAFF					
Carol Brewer	Project Director and Associate Professor of Biology	12 years at UM	Office staff	22	PhD in Botany. Her areas of research are plant physiological ecology and functional plant morphology; and ecological and conservation education.
Paul Alaback	Project Co-director and Associate Professor of Forestry	12 years at UM	Office staff	22	PhD in Forest Science. His research centers on structure and function of forests and their relation to wildlife across a range of scales.
Dave Oberbillig	Co-PI	10 years	Big Sky High School	22	10th thru 12h grade teacher at Big Sky High School. Holds a BS in Biology and M Ed; currently he teaches Integrated Biological and Ecological Sciences and Ecology
Jen Marangelo	Program Coordinator	1month/10 years at UM	Office Staff	10	Master's student in Interdisciplinary Studies, studying museum exhibit design and curriculum development
Josh Burnham	Web development & Technology support	7 years	Office staff	22	BA in Political Science, he currently works as a technology specialist.
Kim Notin	Office assistant and graduate student in Forestry	1 year	Office staff	9	MS student in Department of Society and Conservation, studying conservation communication in Latin America

Technical Support: ECOS participants have three computer stations for their use in the ECOS office. These computers are networked to the internet and have a broad array of software available. ECOS participants also have access to a slide scanner and a document scanner at the computer stations, poster printer, and color printer. ECOS also purchased two new Macintosh computer with software for capturing video images so that fellows can create video clips illustrating their work in the participating schools. Moreover, we purchased a video projector for use in making presentations about ECOS, and for use in ECOS related courses and institutes.

Equipment and Supplies: The ECOS office maintains a wide assortment of supplies and equipment for loan to fellows and local schools. This equipment has been collected through the support of past ecology education grants and a grant from the Howard Hughes Medical Institute. Fellows, teachers and students can use a variety of weather sensors, field microscopes, general ecology field gear (tapes, compasses, etc.), and some specialized instrumentation such as portable infrared gas analyzers. We plan to continue to enhance the equipment available for ecological investigations throughout our project.

9. Donations from Community Members

Many members of our community contribute to the high quality science education of children, helping us insure that no child is left indoors.

Rocky Mountain Research Station Fire Sciences Lab Mick Harrington *Thank you for helping in the design of the Big Sky high school burn experiment*	
Montana Department of Natural Resources Sue Clark Rob Gustafson and Ken Parks MT DNRC Firefighters *Thank you for donating your time and expertise to the Big Sky high school burn experiment.*	
Missoula County Extension Service Helen Atthowe -Horticultural Extension Agent Bill Otton - Weed Supervisor Marijka Wessner - Weed Education Coordinator Conor Gelderman – intern *Thank you all for your cooperation on the Target Range School native plant restoration, knapweed biocontrol monitoring and sampling, and garden construction.*	
Bitterroot Restoration Inc Len Balleck *Thank you for donating materials for the restoration of Target Range's garden.*	
Lisa Mills *Thank you for your consultation on the garden plan at Target Range School.*	

National Wildlife Federation *Thank you for working with Florence Carlton in developing their Schoolyard Habitat.*	
Missoula County Commission *Thank you for your kind donation towards the development of Florence Carlton's Schoolyard Habitat.*	
Madeline Mazurski Member of the Missoula Native Plant Society *Thank you for providing landscaping advice at Sussex School.*	
EKO Compost *Thank you for donating compost to Target Range School.*	
JTL Group, Inc. *Thank you for donating a truck and driver to deliver compost to Target Range School.*	
Rainmaker Sprinkler Supply, Co. *Thank you for providing irrigation equipment to Target Range School*	

9. Assessment

2004-2005 ECOS participants
End-of-year interview results summary

ECOS assessment activities have been ongoing since the first fellows were recruited. Tools were developed that asked all participants to report on their comfort with various science topics, and to describe their goals for participating in ECOS. An end-of-institute reflection also was conducted. We have contracted with Dr. Deborah Morris, Director of Program Development at Florida Community College in Jacksonville, FL to be our external program evaluator. Dr. Morris has extensive experience in education assessment, having recently evaluated Workshop Biology at the University of Oregon (Funded by the Howard Hughes Medical Institute) and Project TIEE (Teaching Issues and Experiments in Ecology), a joint project of Hampshire College and the Ecological Society of America (funded by the National Science Foundation). Currently, data from the surveys are being entered into a database by staff at UM and will be forwarded to Dr. Morris for analysis in the coming months. All of the ECOS assessment tools are available on our website.

Report of Interview of all Participants
Prepared by Dr. Deborah Morris

In May and June 2005, ECOS teachers and Fellows (Ph.D. and undergraduate) were interviewed. Undergraduate Fellows were interviewed by telephone prior to the end of the school year in May. Ph.D. Fellows were interviewed in person at the May writing retreat. Teachers were interviewed by phone after the end of the school year in June. Interviews were semi-structured in that a set of similar questions was asked of each individual, but all respondents were also encouraged to expand on their comments and add additional comments on other topics as they wished. Questions addressed both the processes experienced or created by participants to implement ECOS activities, and the impact and value of participating in ECOS. The following is a summary of respondents' comments on their ECOS experience.

Summary

Clearly, the central concept of ECOS – putting developing scientists in schools to work with teachers on inquiry-oriented activities – is working well. Teachers are gaining curriculum they can use, and Fellows are gaining a sense of the importance of K-12 education and the desire to stay connected with it. The project staff are already implementing changes in project activities designed to get the Year 2 teams off to a faster start, and to develop as teams more fully. What needs to be addressed continually throughout the coming year is encouraging the teams to have greater shared responsibility for implementing inquiry activities, which will build the potential for sustainability in the schools.

Key findings from the post-Year 1 interviews can be summarized as follows:

- While teachers and Fellows did work together to develop inquiry activities in most cases, Ph.D. Fellows, and to a lesser extent, undergraduate Fellows, were responsible for actually leading the activities while the teachers either participated, watched, or remained available for assistance with classroom management
- Roles within the teams took a long time to get worked out, and while some teams developed strong working relationships, others never really became as collaborative as the members hoped
- Ph.D. Fellows felt, for the most part, that teachers gained a lot of science inquiry knowledge from their participation in ECOS, but teachers were more optimistic than the Fellows about their ability to do inquiries on their own in the future
- Teachers felt that their students gained a great deal of ecological knowledge and scientific investigation skills, appropriate for their grade level, but only a few have strong assessment evidence to support their conclusions
- Ph.D. Fellows encountered little resistance, but also little interest or support, from their doctoral advisors and committees regarding their participation in ECOS and their investigations into student learning
- None of the Fellows reported any desire to substantially change their career goals, but most said they now hoped to keep education and outreach a central part of their career, and had gained the skills and confidence they need to follow through on this goal