UNIVERSITY OF MONTANA GK-12 PROGRAM
Annual Report for 2007

Prepared by:

Carol Brewer, ECOS Director

And with contributions from the 2006 cohort
of GK-12 fellows and teachers at The University of Montana

1. HIGHLIGHTS AND ACCOMPLISHMENTS OF THE UNIVERSITY OF MONTANA ECOS (ECOLOGISTS, EDUCATORS, AND SCHOOLS) PROGRAM FROM SEPT 2006 – SEPT 2007.

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 this report, we detail the activities and accomplishments since September 2006 of the cohort of ECOS Fellows and teams who participated from June 1, 2006 – May 31, 2007.

2. ECOS FELLOWS AND TEACHERS, AND TRAINING DURING SEPT 2005 – SEPT 2006

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 Geosciences in year 3. 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. We also asked year 1 and 2 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 3, current 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 year three of the GK-12 program at the University of Montana, we successfully recruited a very strong pool of PhD 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 department of Geolosciences from the College of Arts and Sciences, and from the Departments of Ecosystem and Conservation Sciences and Wildlife Program (College of Forestry and Conservation). This year was were able to reallocate funds from the undergraduate program to recruit two master's level fellows to work on special projects associated with making our on-line tools more accessible for teachers and their students. The teacher participants in year 3 have between 5 to more than 30 years of teaching experience.

AY 06-07 was our last year of funding for 10 (plus two MS) fellows and 10 teachers. As in the past years, ECOS staff and collaborators have offered a variety of training and professional development opportunities for teachers and fellows. The fellowship year began with a 3 -day orientation for fellows where the ECOS program was described in more detail and expectations were discussed. During the orientation, 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 school year. 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.

Part of the ongoing professional development for fellows is a year-long seminar that culminates in a weeklong writing retreat with a professional science writer. The seminar, called Biology 595 – Conservation and Ecological Education 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. This year we experimented with instructors. Our assessment last year suggested that the fellows would like to have a teacher lead the seminar. For the fall semester, Dave Oberbillig, our ECOS lead teachers was in charge of the seminar. Carol Brewer, the ECOS Director, was responsible for the course during the spring semester. Diane Smith, the contracted science writer, led the writing retreat in May.

3. ECOS OVERVIEW AFTER THREE YEARS

In a Nutshell

ECOS is a partnership program for enhancing teaching skills of graduate students in the sciences and promoting hands-on science education in K-12 schools. We use the schoolyard and adjacent open areas in western Montana as outdoor laboratories for learning about the environment.

Ecology and environmental sciences 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 in their schoolyard and classroom laboratories.

FUNDED GRADUATE STUDENT FELLOWSHIPS:	30 PhD students at $30,000 + up to $10,500 tuition 2 MS students (from reallocated funds) 1 supplement at $7,000 (PhD student)
FUNDED UNDERGRADUATE FELLOWSHIPS:	10 at $10,000 each
NUMBER OF SCHOOLS PARTICIPATING:	2 high schools 1 K-12 school 4 K-8 schools 2 K-5 schools with $1,500 for schoolyard enhancements
NUMBER OF TEACHERS	28 at $4200 each 1 lead teacher at up to $6,000 ~20 additional teachers attended institutes
STUDENTS IN WESTERN MONTANA WITH REGULAR CONTACT WITH AN UM GK-12 FELLOW	well over 1,000
RESOURCES CREATED FOR SUSTAINING ELEMENTS OF ECOS	→ Enhanced areas in schoolyards for teaching Ecology and Science → Scores of curriculum pieces for teaching environmental science in a schoolyard → Web-based “Field Guide to the Northern Rockies” → Volunteer scientist database

4. ECOS PARTICIPANTS FOR AY 2006-2007

Arlee Elementary School
72220 Fyant ST;
P.O. Box 37
Arlee, MT 59821
406-726-3216

Teachers:
Ronda Howlett & Bonnie Barger

School	Rural Suburban or Urban	Ethnicity* (% of student enrollment)	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school
Arlee Elementary	Rural	AA 0 AI 70.6 H 0 W 29.4 AS 0	228	67.98	Reading 71 Math 68

Most data is for most recent year information available 2005-2006; 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*
****Combined Percentage Proficient and Advanced in each subject. Data from 2004-2005 AY*
All schools met Adequate Yearly Progress per No Child Left Behind

Matt Corsi, Fellow from Organismal Biology and Ecology

My interest in ecology was sealed as a five year-old when I landed my first fish, a Yellowstone cutthroat trout in Willow Creek, Idaho. Since then, favorite recreational pursuits such as fishing, duck hunting, canoeing, and rafting, have always drawn me to aquatic ecosystems. I became intensely curious about the interactions of organisms in aquatic and riparian habitats on cold mornings in duck blinds and quiet evenings waist deep in trout streams.

Since graduating high school, I have studied freshwater fish ecology in habitats as diverse as the Frank Church River of No Return Wilderness and the lower Snake River Reservoir complex. I completed a bachelor's degree in Fisheries Resources from the University of Idaho in 2003. I came to the University of Montana in 2005 to begin my graduate work studying the management and ecological consequences of hybridization between

native westslope cutthroat trout and introduced rainbow trout. I take an applied approach to ecology comes from the desire to answer practical questions necessary for conservation of native species. My position in the Montana Conservation Genetics Laboratory working with my advisor, Paul Spruell, provides me with an excellent venue to explore my applied and theoretical interests.

I strongly believe fostering ecological literacy can do the greatest good for conservation of the ecological diversity that makes the Intermountain West such a wonderful place to live and work. That is why I am so excited to be an ECOS Fellow. I have an excellent opportunity to pass on some of my passion for science and nature as it was passed to me when my father handed me that fishing rod on Willow Creek 20 years ago.

Flo Gardipee, Fellow from Wildlife Biology

Clinton School
19075 E Mullan RD
Clinton, MT 59825
406-825-3113

Teachers:
Kathy Kaiser & Amanda McGill

School	Rural Suburban or Urban	Ethnicity* (% of student enrollment)	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school
Clinton School	Rural	AA 0 AI 2.1 H 0 W 95.9 AS 2.1	146	43.84	Reading 87 Math 86

Most data is for most recent year information available 2005-2006; 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*
****Combined Percentage Proficient and Advanced in each subject. Data from 2004-2005 AY*
All schools met Adequate Yearly Progress per No Child Left Behind

John MacLean, Fellow from Geosciences

I spent my youth desperately trying to get out of Nashville, TN, and into the western mountains. I fell in love with the Sierra Mountains, CA, at a young age, and I returned as often as I could. When I was completing my BS degree at Furman University, SC, I realized that a great way to be in the mountains more was to study earth science. I went on to earn my MS degree in earth science from Syracuse University, NY, and then I taught earth science at a high school in Elon, NC. Finally, I made it to the mountains of western Montana to work on a Ph.D. in earth science. My specific interests include implementing geochronology techniques to test a Precambrian plate reconstruction. So, what does that have to do with ecology? Earth science processes provide the framework and foundation on which ecosystems are developed. An understanding of the earth science behind the life science is essential in a well-rounded ecological study. Hopefully I can contribute some sort of geological expertise to the ECOS team. My personal interests include most activities in the mountains. I've always been an avid hiker, I've picked up mountain and road biking, and I've begun learning to kayak.

Joss McKinnon, Fellow from Forestry

When I was a young child in southern New Mexico, my parents were avid outdoor enthusiasts. We would take hikes often, though we would never get quite as far as they planned. They tell me that I would take a couple of steps, see something new and interesting, and sit down on the trailside to take a closer look. Even at the age of three I was exceedingly interested in understanding the beauty and complexity of the world around me. More recently I have developed the desire to pass along the information that I have gained, and to assist in the training of tomorrow's ecologists. To this end the ECOS program will require me to present complex concepts in a comprehendible manner. In addition, the opportunity to interact with elementary aged students should prove to be very rewarding. Outside of my studies I enjoy almost anything involving the outdoors, especially snowboarding, rafting, biking, climbing and hiking. Though I return infrequently these days, and doubt that I will live there again, I still consider Santa Fe to be home.

Hellgate Elementary School

2385 Flynn Lane
Missoula, MT 59812
406-728-5626

Teachers:
Kathy Meyers & Colleen Cooper

School	Grade Range	Rural Suburban or Urban	Ethnicity* (% of student enrollment)	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school
Hellgate Elementary	PK-6	Suburban	AA 1.0 AI 3.7 H 1.7 W 90.1 AS 3.0	393	30.3	Reading 79 Math 82

Most data is for most recent year information available 2005-2006; 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*
****Combined Percentage Proficient and Advanced in each subject. Data from 2004-2005 AY*
All schools met Adequate Yearly Progress per No Child Left Behind

Mary Bricker, Fellow from Organismal Biology and Ecology

The first natural communities I knew were mossy green forests and the fields of western Oregon. I enjoyed exploring and observing them while growing up on my family's farm in the Willamette Valley, but it wasn't until high school and college that I was encouraged to start looking at these surroundings in a more scientific way. I was fortunate enough to have high school teachers willing to venture out on field trips with a busload of teenagers, and later to attend a college that encouraged biology students to ask their own questions and design ways to find the answers. When I discovered that one could make a career out of this observing and questioning, I was hooked. I worked various outdoor education and biology research jobs for several years after graduating, and then entered the PhD program in ecology at the University of Montana. I am now starting my fourth year here, and my research focuses on how interactions between plant and animal species can influence plant communities. My career plans are to continue doing research that can keep me out in such beautiful places as Montana's Blackfoot Valley where I currently work, and to teach in an environment that helps students learn to ask and test their own questions. I was drawn to the ECOS program for the opportunity to practice that sort of teaching and to work with people outside of the university setting to bring science to a more general audience.

Mike Machura, Fellow from Organismal Biology and Ecology

I am in my second year of a PhD program, and am starting up new research to examine breeding and movement of boreal toads at different altitudes and habitats in Glacier National Park. I am originally from Chicago, but have also lived in upstate New York, Laramie, Wyoming, and the East African country Tanzania.

While I have been interested in the natural world for as long as I can remember, it was not until I had the opportunity to live for two years in Tanzania that I was able to witness first hand the interactions that occur between humans, plants, animals and the landscape, and truly develop a passion for ecology. Through my immersion in an African culture, I developed a unique perspective that not only considered the interactions of particular organisms, but also the broader picture of how those interactions play out on a larger landscape in the context of everyday human activities. In other words, although my research by necessity tackles precise, manageable questions, I am very interested in the "big picture." I believe the ECOS program will help foster an appreciation for our environment among school-aged children, and will also help build thinking and reasoning skills through the hands-on activities that are a part of doing science.

In addition to my research, I also have several outside interests including photography, traveling, and reading. Ultimately, I hope to work internationally in a position to implement grassroots conservation strategies in developing nations.

Lewis and Clark Elementary School
2901 Park
Missoula, MT 59801
406-542-4035

Teachers:
Betsy Sharkey & Christy Meurer

School	Grade Range	Rural Suburban or Urban	Ethnicity* (% of student enrollment)	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school
Lewis and Clark Elementary	K-5	Suburban	AA 1.3 AI 9.8 H .4 W 84.7 AS 3.7	457	38.95	Reading 82 Math 77

Most data is for most recent year information available 2005-2006; 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*
****Combined Percentage Proficient and Advanced in each subject. Data from 2004-2005 AY*
All schools met Adequate Yearly Progress per No Child Left Behind

Nathan Gordon, Fellow from Integrative Microbiology & Biochemistry

I spent the early years of my life in Bloomington, Indiana. I grew up tending a large vegetable garden and playing for hours in the woods near my house. During that time, I developed a fascination with the natural world, but I never really imagined that I would study ecology. I moved to Missoula in 1994 to be near the mountains and attend the University of Montana. I studied biology as an undergraduate and became very interested in bacteria and the roles they play in the environment. Currently, I am pursuing a Ph.D. in microbial ecology. I study the diversity of bacterial communities and processes on a river floodplain near Glacier National Park. These bacteria are important members of the ecosystem that recycle nutrients and act as a food source to hungry insects that live in and around the river. I really enjoy teaching others about the wonders of nature, and I'm eager to gain the experience that a year with ECOS will provide.

I got married in 2004, and my wife and I share many interests including backpacking, mountain biking, snowboarding, gardening, and walking our dog. We love living in Missoula and hope to remain here for many years.

Alison Perkins, Fellow from Society and Conservation

I didn't realize I was interested in ecology, in fact, I didn't even really know what it was, until I was in college. I grew up in the city, doing "city" kinds of things. St. Louis : home of the baseball *and* football Cardinals (back then), the Blues (both the music and the hockey team), the St. Louis Symphony, and the St. Louis Zoo. I spent most of my summers swimming and waterskiing - I liked being outside - and I chose my college major, Wildlife Management, for no other reason than it sounded fun. I was right. I discovered the world outdoors, and I discovered a passion for ecology that's been growing ever since. I love hiking, birding, and hunting, plus the sports, music, and museums of the "city." I really enjoy traveling (local, national, and international), seeing the diversity this world has to offer. My career interests have evolved from Research Scientist to Television Producer. I still love wildlife research, especially ducks; I just would prefer to share the really cool things about ecological research through television programs. I hope ECOS will help me learn to communicate with all ages and all learners more effectively, and I hope to learn to teach for life-long learning.

Target Range K-8 School
4095 S Ave West
Missoula, MT 59804
406-549-9239
Teachers:
Randee Stephens & Tara Barba

School	Grade Range	Rural Suburban or Urban	Ethnicity* (% of student enrollment)	# of Students	% Free/ Reduced Lunch**	Academic Standing % Proficient by school
Target Range Elementary	PK-6	Rural	AA .4 AI 2.8 H 0 W 95.4 AS 1.4	283	35.69	Reading 86 Math 71

Most data is for most recent year information available 2005-2006; 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*
****Combined Percentage Proficient and Advanced in each subject. Data from 2004-2005 AY*
All schools met Adequate Yearly Progress per No Child Left Behind

Jeff Piotrowski, Fellow from Integrative Microbiology & Biochemistry

I was raised in the Salt Marshes of coastal Georgia and from an early age had a strong interest in the natural world, in particular plants and fungi. Southeastern salt marshes are among the most productive systems on earth. At age 13 I would peddle my bike to across the island at midnight to look for sea turtles or the rare Green fly orchid. It was this environment gave me an appreciation for the natural world. I received my undergraduate degree from the University of Georgia in Botany. UGA was home to the late Eugene Odum, a pioneer of ecological research, who gave several lectures to my introductory Ecology class. He always stressed the importance of teaching more comprehensive ecology to students at the pre-college levels. I worked in the fungal ecology lab of Dr. David Porter on the decomposer communities of the salt marsh. David Porter was a great mentor who encouraged me to follow my interests no matter how obscure. During my time in there I spent most weekends in the southern Appalachian Mountains, an environment with some of the greatest deciduous tree diversity and the greatest amphibian diversity.

Upon graduation from Georgia I took a position at the University of Maine with Dr. Joyce Longcore studying a fungal pathogen of amphibians responsible of several extinctions. I studied the environmental conditions of the fungus to help amphibian biologists predict and model outbreaks and I studied the enzyme production of the fungus to learn how it kills its host. Maine is a pristine state that is 20% wetlands, which I explored with all my free time. After receiving my Master's in Botany/ Plant Pathology from Maine I worked at the University of Georgia 's Herbarium where I gained a greater appreciation for plant diversity. Before taking my current position at the University of Montana I traveled through Europe working on organic farms with my fiancé and learning the importance of sustainable agriculture. I am currently working with Dr. Matthias Rillig where I am studying the ecology of arbuscular mycorrhizal communities for my PhD.

Rebecca Wahl, Fellow from Wildlife Biology

I grew up in Seattle, Washington, and had the wonderful fortune of having parents who took me out rambling in the Cascade Mountains and the Pacific Coast starting from before the time I could walk. I was instilled with a love for and respect of the natural world from an early age, which was reinforced by a couple of wonderful teachers in elementary and high school. By the time I went to university at Lewis and Clark College in Portland, Oregon, I knew that I wanted to study biology. My studies brought me a host of new opportunities: a study abroad trip to eastern Australia, scientific research assistant jobs in Washington and the Caribbean, and the opportunity to conduct my own independent research. After graduating, I completed an internship at the Pacific

Biodiversity Institute in the North Cascades, worked for the Nature Conservancy, and completed an AmeriCorps service project (developing a volunteer wildlife monitoring program on Portland's greenspaces) before beginning graduate school in the Wildlife Biology program here at the University of Montana.

My research focuses on amphibian population dynamics, with projects on both the boreal toad (*Bufo boreas*) and the Columbia spotted frog (*Rana luteiventris*). I am examining annual fluctuations in populations of these species to understand how they relate to our understanding of longer-term growth and decline in amphibian populations. Some of my other interests include biking, running, camping, hiking, traveling, baking/cooking, reading, and playing the piano.

Upon graduation from Georgia I took a position at the University of Maine with Dr. Joyce Longcore studying a fungal pathogen of amphibians responsible of several extinctions. I studied the environmental conditions of the fungus to help amphibian biologists predict and model outbreaks and I studied the enzyme production of the fungus to learn how it kills its host. Maine is a pristine state that is 20% wetlands, which I explored with all my free time.

After receiving my Master's in Botany/ Plant Pathology from Maine I worked at the University of Georgia's Herbarium where I gained a greater appreciation for plant diversity. Before taking my current position at the University of Montana I traveled through Europe working on organic farms with my fiancé and learning the importance of sustainable agriculture. I am currently working in the lab of Dr. Matthias Rillig where I am studying the ecology of arbuscular mycorrhizal communities for my PhD.

Special Projects Fellows

Sarah Bisbing, Fellow from Forestry

Though my heart now lies in the mountains of western Montana, I am a tried-and-true city girl from the bustling metropolis of Chicago, Illinois. As a child of the inner-city, my only real exposure to the natural world was mother's and grandmother's gardens. Even with my lack of exposure to nature, the experience of gardening with these two fabulous women gave me a keen understanding of plant communities and a constant desire to dig in the dirt (dirt being the four letter word I used until I was properly instructed on the appropriate terminology of SOIL science). Although I spent much of my summers as a child running around my neighborhood (yes, we do have trees and grass) and gardening with my family, I never in a million years would have guessed that I would go on to pursue a career in forest ecology. The only forests exposed to me in my early years were those whizzing by as my family drove through Wisconsin. In the end, however, a high school job in a nursery and greenhouse quickly strengthened my desire to work with plants in some manner.

After high school, I attended the University of Illinois, Urbana-Champaign, on a full scholarship from the Illinois House of Representatives. Though the state covered the tuition, U of I was not the ideal place for pursuing a degree in forest ecology. While on a National Parks "Tour of America," as my friends and I coined the excursion, I stumbled upon Missoula and the

University of Montana. I immediately fell in love and began the process of transferring. I went on to finish my B.S. in Forest Resource Management through the College of Forestry and Conservation and am in the process of attaining my Master's in Forest Ecology. Though I adore the culture, music, food, and sports (Go Cubs!) of Chi-town, I would never move back. My experiences working with the USGS, NPS, and USFS in the western U.S. transformed me into a mountain girl. Stemming from these experiences and from my lack of exposure during childhood to such wild lands, my true passion is plant community dynamics and the protection of these communities within our public lands system. Preservation and conservation of our nation's fading resources are the main drivers of my pursuit for degrees in forest management.

I am ecstatic to be a new member of the ECOS family. I have a lot of experience working with children of all ages but never received any formal training in the art and science of teaching. My career goal is to become a professor of forest ecology, with a curriculum geared toward outdoor labs and field-based classes in plant identification and community ecology. Through my participation in the ECOS program, I hope to develop the communication skills and confidence necessary to be an effective teacher. My goal is to learn to create curricula and inquiries that are valuable learning tools for students of all ages.

I have a wide range of hobbies, including backpacking, hiking, canoeing, photography, cross country skiing, and gardening. I do have to admit that I love any arts-and-crafts project and frequently go on plant phenology hikes (yes – a geeky hobby, but nonetheless a hobby).

Jen Marangelo, Fellow from Organismal Biology and Ecology

I was born in Illinois and attended high school and college in Alabama. However, my childhood experiences and education did not uncover my interest in ecology (I didn't have an ECOS program!). It wasn't until I randomly fell into a position as the ecology director at a Boy Scout camp that my love and fascination with the natural world evolved. I went back to school and got a second bachelor's degree in wildlife biology at the University of MT and worked as a research biologist for 10 years. With a desire to combine my interest in ecology and education, I am now pursuing a master's degree in interdisciplinary studies in museum exhibit design and curriculum development. I'm interested in providing informal educational experiences in insect biology and ecology for kids and adults. I'm excited to be on this path and participate in ECOS so I can provide experiences that will allow children to uncover their innate interest in the natural world. In addition to ecology and education, I enjoy hiking (but I travel at a snail's pace because I stop to look at all the insects), reading, birding, snowshoeing and canoeing.

5. ECOS PRODUCTS IN THE 2006-2006 ACADEMIC YEAR.

→2006-2007 DEMONSTRATION PROJECT PLANS

Native Plant Garden
Hellgate Elementary

Teachers: Colleen Cooper, Mike Machura

Ecologists in Residence: Mary Bricker, Nathan Gordon

Demonstration Project: Hellgate has completed its second year as an ECOS school. Last year's fellows worked with 3rd and 7th grade classes to establish four learning centers on the schoolyard. This year's demonstration project was designed to build upon one of those learning centers – a native medicinal plant garden – to create an exciting outdoor learning environment in the 3rd -5th grade building's entry courtyard. In order to accomplish this task, our original proposal consisted of three primary goals:

1. Enhance and build upon the native medicinal plant garden established last year by third-grade ECOS teacher Jo Fix by relocating the garden to a more suitable location at the entryway of the school and planting additional plant species.
2. Install student work stations to make the courtyard usable as an outdoor classroom.
3. Create a **guide** (pdf format) appropriate for all grade levels that includes ecology investigations designed for the garden and outdoor classroom.

In order to enhance the courtyard's infrastructure, we proposed to build two 3.5 x 3.5 foot tables in the courtyard where students can sit, sort plants, and work on data sheets. When combined with a new picnic table purchased with PTA money, we were confident that this would create enough workspace for an entire class to use the garden area any time of the year.
A central goal of our demonstration project was to ensure that the garden becomes a usable resource for other teachers in the school, whether they have been involved in ECOS or not. To accomplish this, we proposed to produce educational materials including signs (showing common and scientific names), field guides and lesson plans as complements to the garden.
As an educational component to the native plant garden, we proposed to create a series of scientific lesson plans and student-friendly plant guides. These would include student-written descriptions of each species. In order to do this, our fifth grade students would research other published plant guides and the ***ECOS Guide to the Ecology of the Northern Rockies***. We planned to work with teachers and students to write species descriptions in language accessible to students in the 3rd -5th grade age groups. This guide would also include inquiry-based lesson plans to be used in the garden and surrounding schoolyard. Some of these lessons were also intended to focus on the ways these plant species are and have been used by Montana's Native American tribes, making it an excellent resource for helping meet the goals of Montana's Indian Education for All Act.

Change on the Range
Target Range School

Teachers: Tara Barba, Randee Stephens

Ecologists in Residence: Jeff Piotrowski, Rebecca Wahl

Demonstration Project: We built upon the foundation of the two previous years of ECOS involvement at Target Range School by tying together and adding to the previous demonstration projects. To do this, we outlined four main components to our demonstration project:

1. To complete a gravel path connecting the two existing demonstration projects and install four student work tables in the native plant garden;
2. To restore and fence in the native plant garden (1st year ECOS demonstration project) with the consultation and assistance of the ECOS teachers and fellows who installed it;
3. To finish terracing and construction of the cottonwood grove amphitheatre (2nd year ECOS demonstration project) in consultation with the second-year ECOS teachers and fellows, and
4. To construct a permanent, interpretive sign describing the entire demonstration project.

Items (1) and (4) are the specific contribution of this year's teachers, fellows, and students, and will be acknowledged as such. Items (2) and (3) are designed to help make the previous ECOS projects at Target Range sustainable in the long-term.

To compliment these construction projects, we developed and compiled a series of ecological inquiries that specifically use these outdoor areas. We are collating these inquiries and presenting them to the teachers at the school so that future classes can use the outdoor classroom. Along with these inquiries, we will leave guidelines for maintaining the areas so that they do not fall into disrepair over time.

No Teacher Left Indoors
Lewis and Clark Elementary School

Teachers: Christy Meurer, Betsy Sharkey

Ecologists in Residence: Alison Perkins, Nathan Gordon

Demonstration Project: The Lewis and Clark Elementary ECOS team wanted to focus on providing resources for the entire school, hence the project theme No Teacher Left Indoors. The aim was to help the students and teachers at the school better utilize their schoolyard habitat. Lewis and Clark transformed a wonderful portion of the schoolyard into the Outdoor Discovery Core (ODC), containing a butterfly garden, sensory garden, bird habitat, hummingbird garden, native grass mound, and a flowing stream/pond feature. The site was dedicated as an official National Wildlife Federation Schoolyard Habitat Site. We found that the main obstacle to outdoor science education was curriculum. Teachers wanted to know how and what to teach

outdoors. The goal of this project, then, was to provide all teachers with materials and inquiry experiences to empower them to use Outdoor Discovery Core to enrich and expand their science curricula. The project was designed to align with ECOS objectives by providing permanent resources teachers could use to enhance a variety of "learn-by-doing" inquiry lessons in the schoolyard and adjacent habitat areas. Our specific purposes were to enhance the Outdoor Discovery Core by adding equipment to broaden the scope of ecological inquiries and by providing support and additional materials to help teachers sustain the goal of "No Child Left Indoors."

This project provided Lewis and Clark Elementary School with several different resources that focused on enhancing outdoor ecological education. These resources included a weather station, environmental temperature data loggers, personalized scientific inquiry CDs for teachers, and a new utility shed. These resources addressed science standards across grade levels (e.g., weather is a curriculum topic throughout K-5), and provided science data for long-term local and global study. They also equipped all Lewis and Clark teachers with additional information, methods, and resources for enriching and sustaining the ODC as a schoolyard laboratory. The project also aligned with the specialties of the ECOS fellows, providing an important resource for engaging teachers, parents, and students for lasting impact. Moreover, this year's demonstration project built on the two previous demonstration projects in order to leave a lasting resource for the entire school community.

Project T.E.D (Teaching Ecological Diversity)
Arlee Elementary School

Teachers: Bonnie Barger, Ronda Howlett

Ecologists in Residence: Matt Corsi, Florence Gardipee

Demonstration Project: We proposed that Project TED would conform to a theme to teach ecological diversity. In order to match that theme, we determined the garden would consist of native plant life that was culturally important to the Salish and Kootenai peoples. We also determined that Project TED should serve as a functional outdoor classroom where teachers could conduct science education and other curricula in an aesthetically pleasing environment. To create that functional classroom, our proposal called for installation of four all-purpose tables that students can sit, stand, or run experiments on.

We designed the garden with plantings to attract local birds and insects so the classroom will provide constant natural stimulation. The proposed interpretive infrastructure of Project TED will be focused towards promoting ecological and cultural literacy. All plant species in the garden will have an associated informational placard. We also proposed the placement of cement casts of common animal tracks along the primary path of the garden with associated placards. All placards will include the common name, the Latin name, and the traditional Salish name of the organism. We originally proposed to build four small signs for each of the four cardinal directions visible from the edges of the garden. On each of these signs will be an artist's rendition of the mountain view behind the sign with short descriptions of geologic, ecological, and cultural history of the mountains in the view.

ESCAPE (Energized Students at Clinton Applying Principles of Ecology)
Clinton Elementary School

Teachers: Kathy Kaiser, Mandy McGill

Ecologists in Residence: John MacLean, Joss McKinnon

Demonstration Project: The theme of our demonstration project was ESCAPE—Energized Students at Clinton Applying Principles of Ecology. Our goal was to bring students into the beautiful outdoor setting surrounding the Clinton school to let them pursue inquiries regarding ecology. As part of this goal, we built a new greenhouse available to all grade levels at the school (K-8).

This structure provides an outdoor laboratory that will engage students in several energy concepts, including solar energy, photosynthesis, and biodegradation. The greenhouse will be available for years to come as an environment in which students can conduct experiments to discover energy relationships in the natural world.

Ecos for Kids!
Masters Special Project Fellow
Sarah Bisbing

The overriding goal of Sarah Bisbing's project is to expose children to ecological processes and skills at the earliest possible point in their education by developing and
ECOS for Kids! traveling test kit and website. As it stands, the online ECOS Natural History Guide is extremely comprehensive, easy to access, and easy to follow. The guide, however, is not geared toward early elementary students (K-3). Sarah will begin her project be creating a series of test kits for use in the classroom. These kits will be interactive displays, posters, and worksheets that would allow early elementary children to learn about ecology and natural history in a manner more accessible to their age group. The kits will then guide Sarah in the creation of kids portion of the ECOS Natural History Guide website. The ECOS for Kids! section of the Guide will be interactive, colorful, and more basic in its means of identifying a plant.

Insect Key
Masters Special Project Fellow
Jennifer Marangelo

Demonstration Project Proposal: I developed the insect section of the ECOS Guide to the Ecology of the Northern Rockies, an on-line field guide. This involved developing a key, selecting the species to be drawn for the key, writing descriptions for 15 insect orders and 10 families, developing introductory sections on arthropods in general, why we should care about insects, what is an insect?, how insects develop, how to find and observe insects in the field, a glossary and instructions on how to use the key.

Insect identification can be a challenging task. Even the "easiest" keys use confusing terminology and require the user to look for characteristics on insects that are difficult, if not impossible to see. In order to simplify the task I've combined two methods of identification: a dichotomous key and matching the organism with a picture.

→ DISSERTATION CHAPTERS FROM ECOS FELLOWS TO DATE:

Rachel Loehman. Ph.D. Fellow 2004-2006. **Ecological Footprint Analysis as a Tool for Environmental Education** *in* Modeling interactions among climate, landscape, and emerging diseases: A hantavirus case study.

Katie Hailer. Ph.D. Fellow 2005-2006. **Identifying Common Science Misconceptions in 5th Grade Science Classes at Lewis and Clark Elementary School** *in* Damage, recognition, and repair of oxidized guanine lesions induced by chromium exposure.

T.J. Fontaine. Ph.D. Fellow 2005-2006. **Using Microclimate to Predict Schoolyard Plant Distribution** *in* Physiological, life history, and behavioral responses of a breeding bird community to experimentally reduced nest predation risk.

Andrew Whiteley. Ph.D. Fellow 2004-2005. **Classroom Mark-Recapture with Crickets** *in* Genetic and morphological diversity in the mountain whitefish, *Prosopium williamsoni*.

Johnny MacLean. Ph.D. Fellow 2005-2007. **Connecting textbook facts to geologic research methods in middle school science using Arc9 GIS, plate tectonics data, and beach sands** *in* New Insights on the SE Siberia - SW Laurentia Rodinia Reconstruction from Detrital Zircon Analyses.

→ PRESENTATIONS AT CONFERENCE AND MANUSCRIPTS PUBLISHED:

Posters, presentations and products				
Title	**Date**	**Authors**	**Journal or Meeting**	**Brief Description**
Manuscript Plants on the Move--Testing Wind-dispersed Seeds in the Classroom	200(8?)	Bricker, M.	Science and Children (accepted)	
Manuscript Classroom Mark-Recapture with Crickets.	2007	Whiteley, A., J. Woolfe, K. Kennedy, D. Oberbillig, and C.A. Brewer.	*American Biology Teacher*. 69:292-297.	
Manuscript The radish party: an exciting exploration of soil organic matter for K-2 students.	2007	Piotrowski, J.S., T. Mildenstein, K. Dungan, and C. Brewer.	*Science and Children* 45:41-45.	

Manuscript Connecting Textbook Facts to Geologic Research Methods in Middle School Science Using ARC9 GIS, Plate Tectonics Data, and Beach Sands	October 2006	John MacLean Mike Plautz	Geological Society of America	In an effort to introduce middle school students to geologic research methods concerning Earth's history, we developed an inquiry that combines current computer technology, hands-on laboratory experience, and constructivist education concepts.
Poster Plants on the move-testing wind-dispersed seeds in the classroom	August 2007	Mary Bricker	Ecological Society of America	This article describes an investigation designed to help students appreciate the relationships between the form and function of plant structures, and lets them experimentally test a plant adaptation.
Poster Transcending boundaries to improve science education: Legitimizationtion of TEK as a scientific way of knowing in a fifth grade classroom.	August 2007	Matthew Corsi and Florence M. Gardipee	Ecological Society of America	Traditional ecological knowledge can be used in the classroom as an avenue to demonstrate how science can be personally and socially relevant to students.
Poster Transforming the graduate school experience through the Montana GK-12 "Ecologists in residence" program	August 2007	Brewer, Paul Alaback, Sarah Bisbing, Mary Bricker, Matt Corsi, Flo Gardipee, Nathan Gordon, Mike Machura, Johnny MacLean, Jen Marangelo, Brooke McBride, Joss McKinnon, Alison Perkins, Jeff Piotrowski, and Rebecca Wahl	Ecological Society of AmericaCarol	To meet the need for enhanced understanding of environmental sciences in the Northern Rockies, the Ecologists, Educators and Schools (ECOS) Program promotes teaching practices focused on "learning by doing" and inquiry instruction for both teachers and University of Montana graduate student fellows.

Poster The traditional Native American "Winter Count Winter Count" as a model for as a model for teaching ecological observation and inquiry.	August 2007	Florence M. Gardipee	Ecological Society of America	The integration of Traditional Ecological Knowledge (TEK) into GK-12 science programs can allow us to bridge the gap between ecology, natural history, the scientific method, and indigenous cultures.
Poster Helping students explore the world of insect pollinators: "The Eyes Have it".	August 2007	Alison Perkins and Carol Brewer	Ecological Society of America	Although insects and plants are major units in the elementary school curriculum, not all teachers have the tools to investigate this important ecosystem service, particularly at the lower elementary level.
Poster Enhancing ecology education through international connections	August 2007	Rebecca Wahl	Ecological Society of America	International exchanges can help elementary school students understand concepts of biogeography, biodiversity, and natural history while enlarging their worldview.
Poster Investigations into the Microbial World: Introducing Middle School Students to Concepts in Microbial Ecology. A GK-12 Experience.	May 2007	Carl Rosier, Melodee Burreson, Jann Clouse, Carol Brewer, and Matthias C. Rillig	Soil Ecology Society	The purpose of this project was to develop three investigations that will aid middle school students (6th-9th) in gaining a greater understanding of the positive aspects of microorganisms.
Poster No Child Left Indoors! Partnerships Between Montana Ecologists, Educators and Schools	March 2007	2005-2006 ECOS Fellows and Directors	NSF GK-12 Education Meeting	To build partnerships for enhancing science education we have focused on 1) translating ecological research 2) matching teacher and fellow expectations to promote collaborations 3) building infrastructure and learning laboratories for teaching ecology in local schoolyards and open areas.

Be a Naturalist in 2007-2008	9/2007			Academic year nature art calendar featuring student and adult artwork along with monthly phenology information
Fall Newsletter	09/2006	ECOS staff		Newsletters include Schoolyard updates, curriculum ideas and news from the staff
Winter Newsletter	12/2006	ECOS staff		
Spring Newsletter	3/2007	ECOS staff		
Summer Newsletter	8/2007	ECOS staff		
Brochure 4rd edition	9/2007	ECOS staff		Defines ECOS objectives, mission statement and results of the program

→ INQUIRIES AVAILABLE ON THE ECOS WEBSITE AFTER YEAR 3

Title of Inquiry	Standards Category	Target Grade Levels	Authors
Classroom Mark-Recapture with Crickets	Science as Inquiry	9, 10, 11, 12	Andrew Whiteley, Jennifer Woolf, Frank Janes
Ecologists Make Careful Observations! A Color-Wise Scavenger Hunt	Science as Inquiry	K,1,2,3,4,5,6	Brooke Mcbride, Mike Machura, and Allison Greene
Estimation by Sampling	Science as Inquiry		Sam Stier
Mapping the Outdoor Discovery Core (ODC) at Lewis and Clark School	Science as Inquiry	1, 2, 3, 4, 5	Katie Hailer and Bruce Threlkeld
Sampling Safari	Science as Inquiry	9, 10, 11, 12	Andrew Whiteley, Jennifer Woolf, and Frank Janes
Scratching Your Head Over Itchy Weeds: A Population Activity	Science as Inquiry	9, 10, 11, 12	Jennifer Woolf, Andrew Whiteley, and Frank Janes

The Expert Naturalist: Experience Through Observing (A Treasure Hunt)	Science as Inquiry	3,4,5,6,7,8	Sarah Bisbing
What You See and What You Don't	Science as Inquiry	1,2,3,4,5,6	Rebecca Wahl
Saving Klondike and Snow: How Scientists Rescued 2 Baby Polar Bears	Science as Inquiry	K, 1, 2, 3, 4, 5, 6	Brooke Mcbride
Egg-streme Shapes	Physical Science	1,2	Alison Perkins
Water Bottle Rockets: An Exploration of Newtonian Physics	Physical Science	5	Carl Rosier, Rachel Loehman, and Lauren Priestman
Growing Borax Snowflake Crystals	Physical Science	K, 1, 2, 3, 4, 5	Katie Hailer
Phases of Matter: Understanding the Chemistry Behind Water Quality	Physical Science	1, 2, 3, 4, 5	Katie Hailer
Float or Sink?	Physical Science	3	Johnny MacLean
Energy in Suspension	Physical Science	4,5	Johnny MacLean
Why Is the Sky Blue?	Physical Science	5,6,7,8,9	Katie Hailer
Bird of the Week	Life Science	3,4	Alison E. H. Perkins
Busy Little Bees: Insects Working Hard in Your Schoolyard	Life Science	1,2	Sarah Bisbing and Jen Marangelo
Hamburger Habitat – Microbiology of Foods	Life Science	5	Nathan Gordon
Is That an Insect?	Life Science	K,1,2,3	Jen Marangelo
Plant Identification at the Lewis & Clark Outdoor Discovery Core	Life Science	1, 2, 3, 4, 5	Katie Hailer and Bruce Threlkeld
Plant Identification in the Schoolyard Using a Dichotomous Key	Life Science	5,6	Mike Machura
Tackling Taxonomy: Which One of These is not Like the Others?	Life Science	3,4,5,6,7,8	Sarah Bisbing and Jen Marangelo

The Trees in Our Schoolyard: A Growing Library of Information	Life Science	4,5,6	Brooke McBride, Allison Greene, Mike Machura
Tracking Mysteries	Life Science	1, 2, 3, 4, 5	Allison Greene, Brooke McBride, and Mike Machura
Trees Are Homes	Life Science	K, 1	Wendy M. Ridenour
What is This Beak For?	Life Science	1, 2, 3, 4, 5	Tammy Mildenstein
Who Is in Your Schoolyard?	Life Science	4, 5, 6, 7, 8	Allison Greene, Brooke McBride, and Mike Machura
Winter Animal Adaptations: What Body Shape Stays Warmest?	Life Science	K, 1, 2, 3	Hannah Elliott
Beneficial Burns?	Life Science	4,5,6,7,8	Joss McKinnon
What's Bugging You? An Introduction to Plant-Pollinator Interactions	Life Science	3,4,5	Sarah Bisbing and Jen Marangelo
Who Rules the Schoolyard?	Life Science	7,8,9,10,11,12	Sarah Bisbing
Winter Entomology Investigation	Life Science	5	Rachel Loehman
Insect Needs and Feeds	Life Science	1,2	Alison E. H. Perkins
Adaptations: How Do Plant and Animal Adaptations from the Tropics Compare to Organisms from Here in Montana?	Life Science	5	Lauren Priestman
Animals Prepare for the Weather	Life Science	1, 2, 3, 4, 5	Hollie Sexton and Tammy Mildenstein
Aquatic Macroinvertebrate Art	Life Science	2, 3, 4, 5	Wendy M. Ridenour
Do Bacteria (Microorganism) Enhance Plant Growth?	Life Science	5	Carl Rosier
Ecosystems are Everywhere!	Life Science	1, 2, 3, 4, 5	Corissa Crowder

Feeding the Hungry Stoneflies	Life Science	5	Nathan Gordon
Knapweed in the Web	Life Science	2, 3, 4, 5	Wendy Ridenour
Lunar Ecology	Life Science	3, 4, 5	Megan Parker
Mystery Scat	Life Science	5	Megan Parker
Not too Hot, Not too Cold: The Effects of Temperature on Soil Bacteria	Life Science	4,5	Nathan Gordon
Playground Food Webs	Life Science	6, 7, 8	Hannah Elliott
Sussex School Spider Investigation	Life Science	4, 5	Margie Kinnersley
Testing Hypotheses about Plant Diversity	Life Science	4	Mike Machura, Brooke Mcbride, and Allison Greene
The Benefits of Soil Organic Matter (aka "The Radish Party")	Life Science	1, 2	Jeff Piotrowski
Composting 101: It's the Microbes	Life Science	1, 2, 3, 4	Jeff Piotrowski
Investigating Use of Biocontrol Agents to Control Spotted Knapweed	Life Science	5	Rachel Loehman
Where is Knapweed Successful?	Life Science	5+	Jeff Piotrowski and Rebecca Wahl
Brewing Rootbeer	Life Science	5	Carl Rosier
Echolocation Marco Polo	Life Science	1,2,3,4,5	Matthew Corsi and Flo Gardipee
Fishes of Sleven's Island	Life Science	9, 10, 11, 12	Andrew Whiteley, Jennifer Woolf, and Frank Janes
Go Big or Stay Home? Simulation of Cutthroat Trout Life History Strategies As a Roll of the Dice	Life Science	5,6,7,8,9,10,11,12	Matthew Corsi and Flo Gardipee
Hopscotch Migration	Life Science	6, 7, 8	Hannah Elliott
Pipe Cleaner Animal Camouflage	Life Science	4	TJ Fontaine
Plant and Pollinator Adaptations	Life Science	7, 8	Alison E. H. Perkins

Plants on the Move – Testing Wind-dispersed Seeds	Life Science	5	Mary Bricker
Isolation of Microbes from the Environment	Life Science	5	Carl Rosier
Creating a Miniature Grand Canyon: A Demonstration of Soil Erosion by Water	Earth and Space Science	1, 2	Jeff Piotrowski
Microclimate in the Outdoor Classroom	Earth and Space Science	4, 5, 6, 7, 8	TJ Fontaine
Schoolyard Microclimates	Earth and Space Science	5	Mary Bricker
What is Winter	Earth and Space Science	4,5,6,7,8	Matthew Corsi and Flo Gardipee
Why Are There Seasons?	Earth and Space Science	1, 2, 3, 4, 5, 6, 7, 8	David Nicholas
Phases of the Moon	Earth and Space Science	3	Johnny MacLean
A Tour of Soils	Earth and Space Science	1, 2	Jeff Piotrowski
Comparing Gravels	Earth and Space Science	4,5	Johnny MacLean
Determining Soil Texture Using a Dichotomous Key	Earth and Space Science	5,6	Mike Machura
Go with the Flow: Sediments up against the Dam	Earth and Space Science	1,2	Nathan Gordon
Discovering Plate Boundaries	Earth and Space Science	7	Johnny MacLean
Geologic Framework of Missoula's Ecoregions	Earth and Space Science	6,7,8	Johnny MacLean
Mineral Scavenger Hunt	Earth and Space Science	5, 6, 7, 8, 9, 10, 11, 12	Johnny MacLean
So Many Soils - Why Are They Different?	Earth and Space Science	4,5	Joss McKinnon
Ecological Footprint	Personal and Social Perspectives	4, 5, 6, 7, 8, 9, 10, 11, 12	Sam Stier
Effect of Acid Rain on the Ability of Soil Microbes to Decompose Organic Matter	Personal and Social Perspectives	9, 10, 11, 12	Andrew Whiteley, Jennifer Woolf, and Frank Janes

What in the World Do Insects See?	History and Nature of Science	1,2	Alison Perkins
An Introduction to Dichotomous Keys and Classification: A Great Use for a Classroom Pet	History and Nature of Science	4	Mike Machura, Brooke Mcbride, and Allison Greene
Classification Using Insects	History and Nature of Science	5,6,7,8	Jen Marangelo

6. ECOS AY 2006-2007 REPORT FROM THE EXTERNAL ASSESSMENT CONTRACTOR

Report by Deborah Morris, Ph.D.

I. Introduction

In this final year of ECOS, evaluation focused on project impacts and achievements, addressing the following questions:

1. What has been the impact of the project on its participants, the Fellows and teachers?
2. How did project processes support achievement of project goals?
3. What products have been created, and what is their potential for future impact?

During Year 3 of ECOS, teams of Fellows and teachers worked in five elementary schools in the Missoula area. Each team consisted of two Ph.D. Fellows and two teachers. Four Fellows who had participated in one or more prior years continued into Year 3. Three of the five schools had participated in the prior two years of ECOS, while two were new to the project. As in the previous year, Fellows' responsibilities included working with the teachers to develop and implement inquiry-based lessons, creating or extending an outdoor classroom demonstration project at the school site, keeping logs and submitting reports, participating in regular ECOS Institutes and an education seminar at the university, and preparing a dissertation chapter that would potentially be publishable in an education journal. Teachers' responsibilities included working with the Fellows in their classrooms and on the demonstration project, keeping logs and contributing to reports, and participating in the ECOS Institutes. Additionally, two master's degree students joined the project as Fellows with responsibilities for special projects.

The successful strategies used in Years 1 and 2 were continued and enhanced in Year 3, enabling even schools that had not participated previously to achieve their goals.

II. Methods

Multiple data collection methods, including interviews, surveys, and analysis of project products were used to triangulate on the project outcomes and provide a complete picture of the participants' experiences and their impact. The project staff received relevant summaries of

evaluation data to supplement their observations and provide for ongoing process improvement. The following table summarizes the evaluation methods, populations, timelines, and process for establishing the reliability and/or validity of the data.

The project evaluator has no responsibility for implementation of any project activities and does not participate in project planning, but does discuss evaluation results and possible strategies for improvement with the project staff.

Evaluation Methods

	Method/instrument	**Population**	**When completed**	**Reliability/validity**
Interviews	Semi-structured telephone interviews	Fellows (n=12)	Post-Yr 3 (June 07)	Entire population interviewed; participants reviewed compiled results
		Teachers (n=8)	Post-Yr 3 (June 07)	
Surveys	Self-assessment of relevant knowledge and skills	Fellows (n=10)	Pre-Yr 3	Surveys administered and coded by project support staff; self-report data checked against staff observations
		Teachers (n=10)	Pre-Yr 3	
	Institute evaluation and mid-term project feedback form	Fellows (n=10)	March 07 Institute	
		Teachers (n=10)	March 07 Institute	
Analysis of products	Evaluation of lesson plans using an evaluator-designed rubric	School teams (n=5)	Ongoing	Content validity of rubric based on science education literature
	Review of demonstration project reports	School teams (n=5)	May-June 06	Sites observed by project staff

III. Results

This section provides a summary of Year 3 results incorporating evaluation data from all sources, organized according to the evaluation questions listed above: the impact of the project on the participants, effectiveness of project processes, and nature of the project products.

1. What has been the impact of the project on its participants, the Fellows and teachers?

Fellows

As in prior years, all Fellows said they had gained skills in communicating about science to non-scientists, an increased familiarity with the challenges and issues faced by schools, and stronger commitments to staying involved in science education and school outreach. Several also said they had learned new skills in planning, organizing, and keeping a major project on track. Many had thought carefully about the kinds of communication skills they were developing, and emphasized the fact that they had successfully learned strategies to communicate complex scientific concepts without "dumbing them down," but by focusing on fundamental ideas expressed in plain language. All felt that these skills and knowledge would be beneficial to them

in their future careers, particularly in terms of the teaching experience they gained. Some Fellows said they had been skeptical of how much their teaching skills would improve through working with young students, but this plus their work with the teachers proved to be an excellent experience. The teachers all agreed that their Fellows were excellent communicators and were extremely pleased to have them working with their students.

A significant theme this year among the Fellows was reflecting on and expanding their understanding of the process of inquiry. Many Fellows commented about how much they learned about their own approach to science from having to help others learn how to do it. When working with teachers who were new to teaching science as inquiry, they had to reflect critically on what it really means to do science and the defining characteristics of inquiry. One Fellow in particular really developed these ideas, saying that in the process of writing inquiry-based lesson plans, it was necessary to think about how to write them so that teachers would recognize the inquiry-oriented aspects of the lesson; similarly, in discussions with teachers about what inquiry is, it was critical to be explicit about what inquiry is and to provide a concrete model, which the teachers can then take and apply in other contexts. Several Fellows said that they were able to help teachers develop a process of moving from guided to unguided, open-ended inquiry throughout the school year, and felt that this practice would be useful in general in helping teachers see how to get started with inquiry.

Two of the Fellows had started out the year with K-12 teaching on their list of possible career options. These Fellows remained interested in K-12 teaching and felt they had learned some important skills that would be valuable if they decided to pursue this. The other Fellows remained focused on their initial career directions – primarily as college/university faculty – but several said they were now more interested in working in teaching-focused institutions rather than just research universities. A number of Fellows stated that they felt even more strongly that they could never do the job of a K-12 teacher, and emphasized the respect they now felt for these people who work so hard to help children learn.

Teachers

Teachers were unanimously positive about their ECOS experience, and described a number of areas in which they had learned and grown, including their ability to do science outdoors, to engage children in authentic inquiry, and to get their students excited about science. Several said that they had previously not spent much time on science in their curriculum, or stuck with standard texts and pre-packaged activities, but that they now had a new appreciation for the importance of science in the curriculum and the need to move to an inquiry-based model. Several commented that students who had not previously been very interested in school really got engaged in the ECOS activities, and that all of their students looked forward to "ECOS day." Many of the teachers felt good about their ability to prepare their students for the ECOS inquiries led by the Fellows, and follow up on these with further activities to reinforce what their students had learned or to connect ECOS activities with other areas of their curriculum. At least one teacher said that she "became a science teacher this year."

Teachers all said they were extremely glad to have the resources provided by ECOS, since these are things they would not have been able to develop on their own, and that they would use the inquiry-based lesson plans and the outdoor classroom sites in the future. As in previous years,

the Fellows were more skeptical about teachers' ability and willingness to do inquiry-oriented science in the future. Several Fellows made suggestions regarding teacher recruitment for these kinds of projects, saying that the very experienced teachers they had worked with seemed less likely to want to change, while at least one Fellow who had worked with a very new teacher said that it was difficult for her to integrate ECOS into her teaching at the same time she was learning the basics of her job. Those Fellows who worked with interested, engaged teachers felt very positive about the project's impact on their future practice.

2. How did project processes support achievement of project goals?

School teams

ECOS has always done an excellent job of forming teams to work in the participating schools, and this year was no exception. This year's team members commented almost unanimously on the positive interactions their teams enjoyed and their ability to work well together. Bringing Fellows from prior years back to work in teams with new Fellows and teachers was a new strategy this year, and proved to be highly effective. At the one school where both Fellows were new to ECOS – the school itself being new to ECOS as well – the Fellows did feel some "lack of mentorship" from prior-year Fellows that the other teams had, but this did not appear to be a major barrier to them. The Fellows who had participated previously all said that they were able to get even more out of their participation this year since they had learned to "do ECOS," what the expectations were and how to balance them with other responsibilities. Several said that they were able to focus more on fundamental issues of teaching and learning since they were practiced at other aspects of the project.

ECOS has been highly effective in helping teachers recognize the expertise and potential contributions of the Fellows, avoiding most tendencies to treat Fellows as glorified teaching assistants. The teams working in this final year of the project appeared to have been very collaborative and respectful of one another. At only one school did the Fellows report a lack of involvement on the part of the teachers during ECOS activities, as had been observed occasionally in prior years. All of the teachers commented on how much the Fellows had contributed to their classes and how wonderful it had been to have their expertise. While teachers commented consistently on how much they had learned about science from the Fellows, and the Fellows were quite aware of their influence, the teachers did not seem to realize how much the Fellows had learned from them. Many Fellows in fact saw the teachers as having a level of expertise similar to theirs, just in a different field, but this was not something of which the teachers themselves were aware.

A new pattern observed this year was that many Fellows said that they would have thought ECOS would have had a greater impact at higher grade levels. This view was not expressed in previous years, when ECOS did have teams in middle and high schools. With the focus on elementary schools in this final year, it became a question in Fellows' minds. Several said they would have liked to have worked with students who were on the verge of making career choices, to better influence them toward choices involving science. While they could see the value of getting young kids excited about science, they were concerned that ECOS' influence would "wear off" as the children grew older. They all agreed that working with younger children was extremely rewarding, but hypothesized that they might have been just as, or more, effective with

older students. As noted in previous evaluation reports, when ECOS was implemented in middle and high schools, it was more difficult to integrate new activities into the established curriculum; other projects facing these issues may want to discuss these with their participants to help them better understand the tradeoffs of working with various grade levels.

Institutes and seminar

All participants commented very favorably on the ECOS institutes held this year. The teachers in particular were very positive about these experiences, saying that they were some of the most valuable professional development opportunities they had ever participated in, and something they always looked forward to. Formative feedback from institute surveys bears this out, with high average ratings on all aspects of the institutes.

The Fellows were less positive about the education seminar they were required to take both semesters at the university. The project staff chose a new design and new facilitator for the first term of the seminar, and most Fellows felt that the seminar remained somewhat confused and did not result in a positive learning experience. Part of the problem may have stemmed from a desire to provide a new experience for the continuing Fellows, but still provide the new Fellows with similar kinds of learning opportunities that had been provided to previous groups. Most agreed that having some kind of seminar was a good idea, but would have liked to have spent more time sharing ideas and "lessons learned" from their work in the schools.

Dissertation chapters

The Fellows mostly agreed that writing a publishable paper for an education journal based on their ECOS work was an excellent idea, and would be a good addition to their CV. There remains disagreement, however, on whether this paper should be done as a chapter in their dissertations. Some saw this as needless hassle, particularly when their committee failed to even review their work, while others saw it as an opportunity to write a publishable paper as part of something they already have to do. Certainly this element of ECOS provides an opportunity to put educational research in front of "traditional" doctoral committees in the sciences, which over time should raise their awareness of and interest in this kind of work. Many Fellows also commented that they really needed more support in how to write a good educational research paper. Those who chose to write up an inquiry they had developed for their school (several of which have already been published or accepted for publication) found this to be less problematic.

3. What products have been created, and what is their potential for future impact?

Inquiry lesson plans

The classroom inquiry lesson plans developed by the Year 3 Fellows in collaboration with the teachers includes activities to be done both indoors and outdoors, including many that are designed to be conducted in an outdoor classroom developed or enhanced as a demonstration project. At least partly because of the focus on elementary schools in this year of the project, many of the activities emphasized observation, description, and classification of organisms in their natural environment, all highly appropriate activities for lower grades. Several of the

activities also got students engaged in asking questions and investigating phenomena outdoors, using strategies of their own choosing.

As in Year 2, each of the Year 3 lesson plans (*n*=18) was evaluated using a rubric that focused on four major issues: whether the activity was truly inquiry-oriented in the sense of allowing students to investigate real questions and not be overly directed or "cookbook;" whether it allowed student to gather and work with real data; whether it provided an authentic experience with core scientific principles; and whether it explicitly connected to students' prior knowledge and/or local or current ecological issues. Each lesson plan was rated as either "strong," "acceptable," or "weak" on each dimension. The table below shows the percentages in each rating category, compared with Year 2 (*n*=22). Appendix A provides the complete rubric with ratings for each inquiry activity.

	Inquiry-oriented			**Empirical**			**Authentic**			**Relevant**		
Year	Strong	Accept-able	Weak	Strong	Accept-able	Weak	Strong	Accept-able	Weak	Strong	Accept-able	Weak
2	41%	54%	5%	77%	18%	5%	73%	27%	-	82%	13%	5%
3	**50%**	**50%**	**-**	**78%**	**22%**	**-**	**78%**	**22%**	**-**	**61%**	**39%**	**-**

All of the lesson plans developed in Year 3 could be rated at least "acceptable" on all dimensions. Conducting truly inquiry-oriented activities with very young children is extremely difficult, so the fact that half of the year 3 inquiries – an even higher percentage than the previous year – can be considered such is outstanding. The percentages of activities rated "strong" in the data collection and authenticity categories went up this year as well. All of the Year 3 activities could be considered relevant, but the fewer of the lesson plans made this explicit – even so, all activities did engage students' prior knowledge and clearly addressed motivational factors. These findings indicate a very high quality set of educational materials that are now available for future use, not only by ECOS teachers but others as well.

Demonstration projects

All of the schools involved in ECOS this year completed a successful demonstration project – an outdoor classroom site – even those schools that were new to ECOS. Many of the Fellows and teachers said that even though the process of planning and implementing their project was a real challenge, they were very happy with the end product.

In this final year of ECOS, the sustainability of the demonstration projects became a key issue in participants' minds, particularly those of the Fellows. Teams at schools that had previously participated in ECOS focused on completing or expanding projects started in prior years. At the school where an established outdoor classroom had been in place even prior to ECOS, the team was able to implement some very positive enhancements to this site that should be fairly easy for the school to maintain. At the two other "continuing" schools, the teams found themselves having to fix problems in the projects that had been started in Years 1 or 2. These problems, in their view, arose at least in part from a lack of commitment on the school's part to take ownership of the classroom site. These Fellows remain very concerned that the results of their efforts will be sustained in the future. Some also commented that they felt that the work on the demonstration project took away from their work on developing inquiry-based lesson plans that

could be implemented whether a school had an outdoor classroom or not. While they could see the value of helping a school establish such a site, they wanted assurances that it would be maintained. One of the Fellows had thought deeply about these issues, and suggested that more attention be paid to assessing the schools' needs and interests and ability to maintain an outdoor classroom site. This Fellow and others also suggested that the scale of a demonstration project needed to be carefully assessed, and that schools without an existing outdoor classroom be encouraged to "start small" and develop a clear plan for sustainability.

At the beginning of both Year 2 and Year 3 of the project, teams toured the demonstration projects from the prior year. A number of participants this year, particularly the teachers, said they would have liked to have had updates on the progress of the demonstration projects at the other schools throughout the year, and to tour the completed projects at the end of the year, to help give some closure and sense of accomplishment to the project as a whole, not just at their own school.

Field guide

In this final year, ECOS brought on two master's degree students to work on special projects, one of these being the web-based field guide to Montana wildlife. Fellows in previous years of the project had contributed information to the field guide and most is now available on the web, with the plant and mammal guides being substantially completed and other guides (insects, fishes, etc) to be completed soon. The master's Fellows were charged with writing additional guide material to make it more user-friendly for teachers and K-12 students. When this guide is completed, it will provide an invaluable reference tool for students and teachers at all levels interested in Montana ecology.

IV. Summary and Recommendations

Key findings from Year 3 of ECOS can be summarized as follows:

- Both Fellows and teachers gained what they had hoped to gain from participating in ECOS, and worked effectively in teams to achieve the project goals, even at schools that had not participated previously in the project.
- Fellows all said they had gained skills in communicating about science to non-scientists, in learning how to put together effective learning experiences, as well as the value of these skills in their future careers.
- Fellows noted that the process of helping teachers learn how to do real inquiry with students caused them to reflect more critically on what scientific inquiry actually is, and what it takes for someone to learn how to do it.
- Fellows said they hope 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. Teachers felt that the Fellows had really gained a good understanding of the challenges facing K-12 schools and students today.
- Teachers felt that their students gained a great deal of scientific content knowledge and investigation skills, appropriate for their grade level, as well as a real excitement about science and ecology.

- Educational materials and resources developed by the project participants are of very high quality. Inquiry-based lesson plans, available on the ECOS website, are likely to be used in the future by both ECOS teachers and others. Outdoor classroom sites, if maintained, are also likely to be used in the future.
- Fellows were somewhat divided about the value of devoting a chapter of their dissertation to ECOS, although all agreed that being able to write a publishable educational paper was a useful experience. Fellows continued to encounter little resistance, and even a slight increase in interest and support, from their doctoral advisors and committees regarding their participation in ECOS and their investigations into student learning.

The ECOS project's accomplishments should make a lasting difference in the way all of its participants approach science education in the future. A highly successful project such as this one offers some important lessons for other initiatives that hope to achieve similar goals. Some recommendations for other GK-12 projects that arise from the ECOS experience include the following:

- Recruit teachers carefully. Although the primary goal of the GK-12 projects is to impact graduate students, the participating teachers must be strongly invested in the project in order to support effective implementation. As a general rule (though of course there will be exceptions to this), very new and very experienced teachers tend to be less effective team members – very new teachers are still struggling with unfamiliar responsibilities, while very experienced teachers "know it all." Teachers' level of science expertise, however, does not seem to be a factor; enthusiasm and a willingness to try new things is more important.
- Send Fellows into schools in teams, not alone. Teams of two can be highly effective; teams with more than three Fellows (used early in ECOS) can be unwieldy. If possible, pair a Fellow who has participated in the project previously with a new Fellow. This design will help the team get up and running quickly and allow them to support one another throughout the year.
- As much as possible, ensure participants are clear about their roles in the project. As the ECOS staff became more accomplished at communicating this, and as more participants became clear about their roles, the project's effectiveness increased. A GK-12 project can easily disintegrate into a group of teachers who think they have highly educated teaching assistants to teach science for them for the year. This never came close to happening in ECOS, as each participant group was encouraged to think of the other as an equal partner in the project, with something special to contribute. The participants each learned from one another and came to respect each other.
- Engage participants in discussion and reflection on the nature of scientific inquiry, and help them develop and share ideas about how to make this happen with students. If lesson plans are to be a product of the project, ensure that participants write about the inquiry-oriented aspects of the lesson in these plans. Consider explicitly developing strategies to help teachers move from guided to open-ended inquiry activities, to enable both teachers and Fellows to better make these distinctions and be more deliberate about their goals for student learning.