

ABSTRACT: The Ecologists, Educators and Schools (ECOS) GK-12 Program creates partnerships between K-12 educators and University of Montana graduate and undergraduate fellows to provide authentic research experiences for students in their own schoolyards and nearby open areas. ECOS fellows model what ecologists do by immersing themselves and their student and teacher collaborators in ecological investigations in schoolyard and classroom laboratories. Through ECOS, teams have built outdoor classrooms in schoolyard habitats such as a cottonwood grove, grassland, and dryland forest; some even have new seating and work stations. At one school, fellows developed learning centers to address behavioral ecology, Native American medicinal plants, and the interaction of the physical sciences with ecology. Participating teachers and students learn about local ecology through specially developed curricula that link directly to their schoolyards while fellows learn how to communicate with non-scientist audiences. ECOS has enlisted the assistance of government agency partners to develop insectaries on schoolyard weed patches where students can extend baseline research on biological control agents, and collaborated with local merchants to provide materials for building outdoor learning labs. An extensive *Guide to the Ecology of the Northern Rockies* (www.bioed.org/ecos) features natural history information on the plants, animals and geologic features of the region, and supplements schoolyard investigations. The ECOS partnership model has proven highly successful, engaging dozens of teachers and hundreds of K-12 students in western Montana in its first two years. One fellow reported that, "I believe that [ECOS] experiences, beyond just changing the ways I can work, have changed the ways I want to work." By getting involved in the education of K-12 students, ECOS fellows and K-12 teachers are fostering learning that provides students a strong sense of place and connection to local environments, and a deeper understanding of ecological processes and relationships in these environments and beyond.



Students collecting data on knapweed abundance.



Building an insectory.

Developing Partnerships

Partnerships are important to developing sustainable schoolyard ecology projects. They encourage continued investment and use beyond the lifetime of the ECOS grant. As a result, ECOS teams enthusiastically seek partnerships to sustain the life of the ECOS philosophy - no child left indoors. **Target Range Elementary**, for example, formed a partnership with the Missoula County Weed District to build insectories and monitor the effectiveness of the knapweed root-boring weevil, *Cyphocleonus achates*, as a biological control agent. The idea was to have students collect baseline data on spotted knapweed (*Centaurea maculosa*) abundance and density before and after the introduction of the weevils. In the spirit of sustainable partnerships, Americorps volunteers helped construct four insectories (two for rearing the root-boring weevil and two designed to exclude weevils). Weevils were introduced in Fall 2005 after extensive data collection guided by the Missoula County Weed District staff. The 4th grade class collected the first of at least five years of post-introduction data in Spring 2006.

In addition, the Missoula County Weed District is facilitating comparisons to other insectaries across the region, including the Hellgate Elementary insectory built in 2006. The insectories also may enable cross-school partnerships; students at schools without insectories can work with students at schools that do. Ultimately, the insectories will act as a source of individuals for future biological control sites, potentially providing income to the school. Indeed, partnerships between teachers and the Missoula County Weed District will last beyond ECOS.

Schoolyard Habitats

Two of the outdoor classrooms, the Lyceum Outdoor Classroom at Florence Carlton and the Outdoor Discovery Corps at Lewis and Clark School, are designated *Schoolyard Habitats* by the National Wildlife Federation. Only six other schools in Montana have received such a designation.

Florence Carlton School
Lyceum Outdoor Classroom

The wheelchair-accessible path through the Lyceum Outdoor Classroom at Florence Carlton



Elements of Sustainability

The ECOS model has identified at least five elements that support sustainability of scientist-educator partnerships, so that no child is left indoors:

- **Long-term partnerships** between schools and organizations and agencies
- **Sustainable infrastructure** that provides a lasting schoolyard laboratory for ecological investigations
- **Engaging the community** in both investment in their local schools and participation in ecological activities such as citizen science projects
- Developing **sustainable resources** for teachers that are straightforward and tailored to their own backyards.
- **Engaging educators** by providing knowledge of local ecology and hands on curriculum ideas

www.bioed.org/ecos

Target Range School

Outdoor Classroom and Native Gardens

Learning Centers

Hellgate Elementary School

Planting seeds in the Medicinal Plant Garden Learning Center



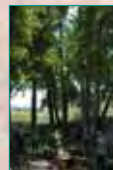
Sussex School

Butterfly Garden

The Burning Question

Big Sky High School

Students from UM College of Technology grading the terraces at the Target Range Outdoor Classroom



Outdoor Classroom at Target Range Elementary

Outdoor Discovery Corps at Lewis & Clark Elementary



Learning Centers: Native American Medicinal Plant Garden at Hellgate Elementary

No Child Left Indoors

Engaging the Community

Engaging the community is an integral part of the ECOS mission to enhance understanding of environmental sciences in the northern Rockies. Building sustainability requires a vested interest not just from teachers and schools, but also from parents, local businesses, and other community members. ECOS teams actively work to connect the schoolyard to the local community. At **Hellgate Elementary School**, for example, the ECOS team developed learning centers, each with large signs designed to encourage student-parent participation in guided inquiries. The Native American Medicinal Plant Garden lays out an experiment for students and parents that explores plant adaptations in xeric habitats, and the Rock Walk provides a timeline where students and parents can investigate the scale of geologic time with rocks from local sites.

Community support was integral in the development of the demonstration projects throughout ECOS.

Community members contributed significant amounts of time, money, and materials to the construction of the Lyceum Outdoor Classroom at Florence Carlton School. At Target Range School, students from the University of Montana College of Technology honed their heavy equipment skills building the terraces and grading the slope surrounding the cottonwood grove. Parents and teachers also volunteered time and effort to enhancing the outdoor classroom. The Big Sky High School demonstration project included a controlled burn, which could not have come to fruition without the Montana Department of Natural Resources.

The OC - Outdoor Classroom

The strength of ECOS lies in the idea that the schoolyard and adjacent open areas in western Montana can be outdoor laboratories for learning about the environment. Consequently, each ECOS team is charged with developing and enhancing schoolyard demonstration projects to serve as classrooms. These projects are designed specifically as long-term study sites for student research. The projects also serve as models for schoolyard-based ecological research and science education that can be readily transported to other sites and schools, both within and beyond the region. ECOS demonstration projects range from enhancing access to nearby natural areas to creating new ways to explore schoolyards. For example, **Florence Carlton School** is fortunate to have a large outdoor area of relatively intact native woodland, called the Lyceum, immediately adjacent to the school. However, the area was essentially undeveloped, making access difficult for teachers and students. For two years, ECOS teams enlisted the assistance of the Florence Carlton school district and community members to develop a wheelchair accessible nature trail, amphitheater seating and workstations, and an entrance kiosk with maps to inquiry-based nature stations along the trail. The community was instrumental in the development of the Lyceum, donating expertise, time, and money.

Partnerships: Montana ECOS

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A Sustainable Resource: The Natural History Guide

The Natural History Guide, a collaborative project of the ECOS fellows and project staff, is an innovative and interactive tool for students and teachers to identify and learn more about the ecology and natural history of plants and animals in western Montana. Oftentimes, it is difficult to use guidebooks and keys for groups of organisms such as plants or insects because the terminology is difficult or the local organisms are not covered in its pages. This presents a frustrating barrier for people to easily discover what they are looking at, and to fully appreciate the beauty and diversity of their local environment. The Natural History Guide minimizes these problems by providing a dynamic on-line database that includes local photographs (frequently covering many life stages), drawings and descriptions of the most common species, information on how to use these species for schoolyard ecology investigations, and references for further information. The Natural History guide is a sustainable, user-friendly guide for all K-12 schools in the region.

Some inquiries ECOS fellows have developed using the Natural History Guide include:

- ❖ *Testing Hypotheses about Plant Diversity* – students are introduced to the concept of random sampling, build observation skills, practice averaging, and introduce the On-Line Plant Guide (grade 4)
- ❖ *Plant and Pollinator Adaptations* – Why do plants produce flowers? Why are flowers attractive? (grades 7-8)

<http://www.bioed.org/nhguideweb/>



Other demonstration projects from 2005-06 include:

Hellgate Elementary Learning Centers: learning centers focused on separate aspects of western Montana ecology including a Native American Medicinal Plant Garden, a Behavior Ecology Center, an Insectory, and a Rock Walk representing geologic time. These learning centers offer specific settings for inquiry for diverse subjects, ranging from microbial studies on soils to plant form and function to rodent behavior to the geologic effect on macro-ecosystems.

Lewis and Clark Elementary Outdoor Discovery Core: identifying and labeling plants in Lewis and Clark's outdoor classroom with permanent, highly visible signs. The signs are supported by a color, laminated nature guide for students identifying the most common plants and a full-length nature guide for teachers with all the plants in the Outdoor Discovery Core.

Target Range Outdoor Classroom: restoring and enhancing a cottonwood grove adjacent to the native garden developed by the previous year's ECOS team. The grove will be a wonderfully shaded gathering place with amphitheater seating and tables for nature journaling, bird watching, and ecological investigations.



The University of Montana



A soil microbes inquiry at Lewis & Clark Elementary

Engaging Educators

ECOS is designed to develop scientific ways of thinking and understanding in K-12 students through authentic research experiences in their schoolyards and adjacent habitats. An additional goal is to promote teaching practices focused on "learning by doing" and inquiry instruction. Accordingly, teams work to develop curriculum materials that are well matched to the habitats in and around the schoolyard, and that meet the recommendations of the National Science Standards for science education.

For example, the Outdoor Discovery Corps at **Lewis and Clark Elementary School** was a beautiful outdoor garden, but few teachers used it for ecological inquiry. The ECOS team designed identification plaques for plants throughout the garden and developed a color identification guide for the most common plants in the Outdoor Discovery Corps. The guide was designed specifically for easy use by young students. The team also produced a complete nature guide for teachers and worked to develop curriculum pieces to promote ecological learning in the garden that was aligned with the Montana Science Standards.

Lewis & Clark Elementary



Increasing the Use of the Outdoor Discovery Corps

Some of the exciting, innovative curriculum pieces for science education ECOS fellows have developed include:

- ❖ *Tracking Mysteries* – How do animals make different track patterns? (grades 1-5)
- ❖ *Pipe Cleaner Animal Camouflage* – How is color important for animal camouflage? (grade 4)
- ❖ *Ecosystems are Everywhere!* – What is an ecosystem? What things make up an ecosystem? (grades 1-5)
- ❖ *Mineral Scavenger Hunt* – What daily objects do you use every day that come from minerals? (grades 5-12)
- ❖ *Plant Identification at the Lewis & Clark Outdoor Discovery Core* – How are plants identified and classified? (grades 1-5)
- ❖ *Phases of Matter: Understanding the Chemistry Behind Water Quality* – How are solutions made? What is dissolved in our water? What does water quality really mean? (grades 1-5)
- ❖ *Classroom Mark-Recapture with Crickets* – How do we estimate the size of animal populations in the wild (grades 9-12)
- ❖ *Composting 101: It's the Microbes* – What is composting and what causes decomposition (grades 1-4)
- ❖ *What Is This Beak For?* – How does form define function? How are beak differences adaptive for exploiting different food sources (grades 1-5)
- ❖ *Effect of Acid Rain on the Ability of Soil Microbes to Decompose Organic Matter* – How do changing environmental factors influence decomposition (grades 9-12)

To download these and other curriculum pieces, go to:

www.bioed.org/ecos/inquiries.aspx