

Summary of Education and Outreach Initiatives Plum Island Sound Long Term Ecological Research

Education

Connections to Local Schools, K-12

Governor Dummer Academy

- Marine Science class transects
- Summer interns (1-5) – assistants, annual GDA surveys (mussel/snail transects), independent projects

Massachusetts Audubon Society– Salt Marsh Science Education Project

- Teacher training programs
- Middle and High School student field trips to the Marsh
- Monitoring: salt marsh vegetation, invasive species, salinity and salt marsh fish
- Involves 12-13 schools, 10 teachers, over 600 students on the Massachusetts North Shore.

Undergraduates and REU's

Research Experience for Undergraduates (REU's)

- 2-6 students per year (LTER and other funds)
- Independent projects closely supervised by PIs and RA's
- Students also participate in joint research efforts
- Products include posters, presentations, and manuscripts published in Biological Bulletin

MBL Semester in Environmental Science

- Independent research projects (4 in 4 years)

Graduate Students, Post-docs and RA Fellowships

- Graduate students at University of New Hampshire, University of South Carolina and Clark University working on various components of the project
- Post-docs at MBL, MIT, USC
- RA fellowships – 2-year fellowships to superior recent college graduates planning to pursue graduate training in environmental sciences or policy

Science writers

-MBL-sponsored summer program

-Two groups participated in 2-day intensive field and lecture experience at PIE

- Investigated effects of anthropogenic activities in watersheds on estuarine systems

PILTER Outreach to Government Agencies, the Public, and the Media

Assistance to Town and State Agencies

- Town of Ipswich (sewage outfall assessment)
- Town of Ipswich et al. "Ipswatch" program (EPA EMPACT)
- Ipswich taskforce
- Communities Connected by Water
- Participation in state-sponsored Ipswich and Parker River Basin Teams
- Advisors to Mass EOE and DEP

Federal Agencies

- EPA region 1 (Ipswatch)
- USGS – HSFP modeling of Ipswich hydrology
- USFWS – Advice on salt marsh restoration and data management

Non Profit Environmental Organizations

Ipswich River Watershed Association - collaborating since 1993.

- Volunteer river sampling and nutrient analysis
- Assessing the "low-flow" problem in Ipswich

Massachusetts Audubon Society – collaborating since 1991

- Participated in regional conservation initiatives
- Volunteers have assisted in sampling fish and water

Presentations

- Scientific meetings
- National and international colleges and universities
- Falmouth in the Fall symposium for Cape citizens
- Future plans for North Shore outreach

Publications

- Estuarine Synthesis book edited by Hobbie – SCOPE, NSF and NOAA support
- Many research publications in refereed literature

Web Site

<http://ecosystems.mbl.edu/PIE>

MCM-LTER Outreach

SLTER

The Schoolyard Long-Term Ecological Research program associated with the McMurdo Dry Valleys (MCM) LTER focuses on stream ecology and long-term monitoring by high school students and teachers at three schools in the United States. Due to the remoteness of the site, teachers and students are not able to visit the research area for observation or direct participation. Therefore, each school performs the same measurements at the same time of year so that cross-site comparisons can be made among these school locations and the Antarctic streams (pristine environment). As proposed in the National Science Education Standards by the National Academy of Sciences, the goal of this project is to make the scientific process more real for students by exposing them to hands-on methods and real environmental data collected by them, other students like them and professional scientists. Dr. W. Berry Lyons and members of his research team have been actively involved with the three MCM Schoolyard LTER schools and their teacher representatives (Barb Schulz, Lakeside School, Seattle, WA; Kim Ouderkirk, Tuscaloosa Academy, Tuscaloosa, AL; Carol Landis, Linworth Alternative School, Columbus, OH). The Lyons group have given presentations at the schools demonstrating proper techniques and participated in sampling with the students. They have sponsored annual meetings for the teachers to discuss goals, issues, etc. about the project. The teachers have also visited each other's classrooms in order to coordinate sampling protocols so that data could be compared among the three schools, as well as to Taylor Valley stream data, and to provide information to the students about their "sister" Schoolyard sites in the U.S.

TEA

Over the history of the MCM_LTER, members have hosted five participants in the Teachers Experiencing Antarctica program. The teachers conduct their own experiments as well as assist scientists in the field and lab. Two teachers, one a past participant with the LTER, returned to the ice under a new grant, TEA for TWO, that is supervised by MCM-LTER.

Other Outreach

Many of the PI's with the MCM-LTER and members of their teams frequently give presentations at schools, organizations and public institutions, have been involved in mentoring and advising programs, and host open houses and tours of their facilities. In addition several of the PI's have been the speaker at the science lectures which are provided for the support and science community at McMurdo Station during the field season.

Press

MCM-LTER PI's research and experiences have been the focus of several radio, television and newspaper stories, specials and interviews.

Educational Outreach at the Kellogg Biological Station (KBS) and the KBS-LTER Site

KBS has a rich history of involvement in educational outreach. The activities directly associated with the KBS LTER are documented in the following statements.

LTER-Schoolyard Project: Our schoolyard project began in 1999 through LTER supplemental funding. We began working with twenty-two middle school teachers from four local school districts. The program was teacher driven in that teachers informed us about topics in ecology and ecosystem science that they would like to have workshops structured around. We also engaged faculty from the MSU College of Education who worked with teachers on pedagogy and incorporating workshop material into their classroom activities. In 2000-2001 we also funded a quarter-time position for a graduate student who visited teachers at their schools to assist them and provide feedback to the project about the schools. A "teacher coordinator", (one of the participating teachers) was also funded to serve as the voice of the teacher to the project. We conducted five full-day workshops in 2000-2001.

The program was well received and was awarded an Education Excellence Award by the Michigan School Board Directors in 2001. One of the school districts indicated that their scores on state standardized tests in 8th grade science rose by 155% over a three-year period, partly because of the impact of this program.

This pilot program served as a model for a proposal to NSF-EHR to expand the current project. The three-year project was funded in June of 2001. The proposal is a partnership between KBS and LTER scientists, MSU College of Education faculty and 60 teachers from 13 local school districts. The program follows that of the pilot, i.e., school year workshops, graduate students visiting schools, and two one-week science institutes which will be initiated during the summer of 2002.

LTER faculty are also working with area schools to develop long term measurements in schoolyards, and fostering the exchange of data between local schools. "Mini" grants are also being awarded to schools to assist teachers to initiate these studies. These activities are funded from LTER supplement support.

Our LTER site is also used by visiting undergraduates during field trips, e.g., Honors Biology. It is also used as a field site for undergraduate classes taught at KBS, i.e., Biogeochemistry and General Ecology.

Schoolyard LTER Program
Cedar Creek Long-Term Ecological Research (LTER) Program

Feb 2002

The U. of Minnesota's Cedar Creek LTER Project conducts a Schoolyard LTER (SLTER) program working with public schools in east central Minnesota. The purpose of the program is to help students and teachers become better educated about ecology and biology in general by direct hands-on involvement in long-term learning/research programs focusing on biological processes in the local and regional environs of each school. Secondly, there is an opportunity for the Cedar Creek LTER program and site to better serve as a resource for public education. The program is currently focusing on work at one elementary school and one middle school in the greater Minneapolis-St. Paul metropolitan area. Schoolyard prairie grasslands have been established at both schools (immediately adjacent to the classrooms), with different designs and goals. In the year 2001, approximately 700 students were directly involved in research and/or educational activities using these schoolyard prairie resources. Teachers (approximately 12 in total) at both schools have been and remain in consultation with the SLTER staff about developing curriculum, and planning and conducting activities.

The elementary prairie is used in a variety of ways to teach biology, math, history, art and culture to students in all grades in a 250 student K-5 school. Each fall, at the start of school, all new kindergarten students plant a prairie plant into the prairie. These plants were grown from seed by 1st-graders the previous spring (see below). All kindergarten students "adopt" an individual plant in the prairie and watch it through the seasons. Each kindergarten class frequently goes outside into the prairie in fall and spring and does "journaling" in which they write or draw about their plant and more generally what they see. All first grade classes participate in seed germination studies. Children collect seeds in fall in the prairie (one species per each team of two children). In spring the children plant the seeds in trays that are grown under grow lights. Seeds of a variety of prairie species (typically about 16) are sprouted. Every student (working in pairs) then measures, records and graphs the height growth rates over time (for several months) of the plants they have planted. All second and third-graders take measurements in fall of plant height for three different grass species in the outdoor prairie, and compare these to each other and to results from prior years.

The middle school prairie is a replicated biodiversity experiment, which was established in summer 2000, with varying numbers of species and functional groups among treatments (four replicates of four levels of diversity). Every sixth grade science class (includes a total of approx. 400 children) works in the grassland experiment in fall and spring, measuring phenology, plant height and survival. In addition, SLTER educators have developed a plant identification key for the 18 species used in the experiment, and the 6th graders use this key in learning field identification of the species. In fall, two of the 8th grade classes are trained in percent cover estimates, which they then make on all plots. Data are maintained by the SLTER educators and the teaching staff. As these data accumulate and are entered into spreadsheets, they will be used in future educational activities.

At both schools curriculum development is an ongoing activity. The Cedar Creek Natural History area is periodically used for workshops or field course for teachers. To date, given limited funding limitations, SLTER staff and teachers have decided that working on-site at the schools was a more cost-effective way of involving a larger number of students than developing programs for students at Cedar Creek, although this would also be highly desirable if funding allowed this. In addition to the limitations of SLTER work on a small budget, vandalism has been the largest difficulty with this program. Plants, fences, and markers have required maintenance following several such events.

**SUMMARY OF EDUCATION OUTREACH ACTIVITIES OF THE SANTA BARBARA CHANNEL LTER
8 MARCH 20002**

Education Outreach of the SBC-LTER has two main foci, community and scientific outreach. Our community outreach is designed to inform the public about our research objects and findings through partnerships with established environmental education programs, and exhibits at museums and other venues. We also seek to address public concerns about environmental issues related to land-ocean margin ecosystems. Our scientific research program is designed to educate students, teachers, faculty, and managers working in coastal ecosystems about SBC-LTER research activities. Our general objectives are to (1) facilitate communication and collaborations that will advance public understanding of land-margin ecosystem processes, (2) enhance and refine the quality and scope of our research, and (3) advance the field of interdisciplinary ecosystem research. Here is a brief description of the specific activities related to our educational outreach.

Community Outreach

Growing concern over frequent beach closures due to high bacterial pollution continues to focus public attention on the declining water quality of Santa Barbara's creeks and beaches. SBC-LTER has partnered with the Community Environmental Council to develop sets of educational tools and resources housed at the South Coast Watershed Resource Center (SCWRC) to inform the public about: (1) the importance of our watershed resources, (2) the connections between watersheds and coastal ocean ecosystems, (3) how these resources are impacted by human activities, (4) the role watershed restoration plays in improving water quality, and, (5) ways that the community can actively protect our creeks, wetlands, and ocean. SCWRC opened its doors in August 2001 and has since provided education programs for numerous elementary schools, organized public workshops on a variety of environmental issues, and hosted numerous meetings and tours for a wide variety of non-profit environmental awareness groups. SBC researchers worked with SCWRC staff to develop displays depicting ongoing research in the watersheds and nearshore waters in the Santa Barbara area. Schoolyard funds supplied by NSF were used to purchase start-up equipment for the school programs at the SCWRC as well as the production of student journals that were used by all the students who participated in the programs.

Several SBC investigators routinely give lectures in local K-12 schools on LTER related topics (e.g. kelp forest ecology, watershed processes, ocean circulation, etc.). Additional outreach activities conducted by SBC investigators include: a segment on live TV for Project Oceanography (<http://www.marine.usf.edu/pjocean/>) on SBC research in the Santa Barbara Channel, assisting the Channel Islands Marine Sanctuary in developing curriculum on associations between terrestrial runoff and phytoplankton blooms, and giving several public presentations on LTER related research to non-scientist groups. Two pre-college teachers and several non-scientists from the local community routinely participate in our ongoing stream sampling program and gain considerable knowledge on the constituents of runoff and of the processes that influence their abundance. SBC investigators have also worked closely with the Santa Barbara Maritime Museum in developing curricula and exhibits that expose non-scientist members of the public to SBC research activities.

The SBC-LTER outreach program also played host to Eagle Scout Tim Brox, selected by NSF's Polar Programs to visit US research stations in Antarctica. A 'cross-site' LTER outreach effort (in conjunction with the Palmer Station LTER) introduced Tim to ongoing studies at the SBC-LTER and emphasized the value of long-term research efforts. In addition, SBC-LTER research will be featured on an upcoming 2002-2003 JASON PROJECT™ interdisciplinary, multimedia curriculum (Jason XIV: From Shore to Sea). Several of our researchers, lead by Tim Robinson, participated in a video shoot that described our LTER's research in the Santa Barbara Channel and Channel Islands. Live broadcasts via multimedia will be made January-February 2003 (see <http://www.jason.org/>).

Scientific Outreach

SBC enhanced the education of undergraduate and graduate students by providing support to the Western Society of Naturalists, which is one of only a handful of societies that provide a forum for young marine ecologists and naturalists to present their work. PI Reed was invited to organize a symposium on human effects on ecosystems at the land/ocean margin for the annual meetings of WSN. The result was a symposium that featured speakers from all over the continental US and Hawaii speaking on a wide variety of topics related to linkages between land and ocean ecosystems. SBC research was featured in two of the talks. The society received many compliments on the symposium and was very appreciative of NSF's support. Finally, SBC's web site contributes to information resources by providing the scientific community (and the general public) access to unique datasets that are of interest to a diverse array of people. Some examples of such datasets include: historical data on giant kelp abundance in the northeast Pacific, SST imagery from NOAA-AVHRR polar orbiters of the Santa Barbara Channel, high frequency radar data of surface currents in the Santa Barbara Channel, and soil mapping and land-use coverage of the Santa Ynez Mountains.

CAP LTER
Ecology Explorers Summary
Monica Elser and Charlene Saltz

Ecology Explorers is a K-12 education program that gives teachers and students the opportunity to participate in an Arizona State University research project. Through this program, students collect animal population data in their schoolyards or backyards that parallels the research protocols being carried out by CAP LTER scientists across the Metropolitan Phoenix Area. Data collected includes: bird surveys, ground arthropod surveys, bruchid beetle surveys and plant surveys. All of the protocols and purpose of each project are clearly outlined on the Ecology Explorer Web site at <http://caplter.asu.edu/explorers>.

Teachers benefit from Ecology Explorers through:

- paid internships with ASU scientists and CAP LTER education liaisons
- workshops on topics such as mapping, insects in the classroom, data analysis and social science
- sustained visits to the classroom by scientists and CAP LTER education liaisons
- presentations to teachers and parents
- curriculum resources
- biannual teacher meetings
- lesson plans linked to Arizona Education Standards
- online database (entry and retrieval)
- protocols for collecting data

By participating in the Ecology Explorers program, students

- learn more about where they live
- learn to identify and survey birds, ground arthropods, and/or vegetation in their local area
- share their data with other schools and ASU scientists via the Ecology Explorers Web site
- develop and test hypotheses about the impact of urbanization
- interact with local scientists

By participating in the Ecology Explorers program CAP LTER and ASU scientists benefit by:

- strengthening partnerships between the community and ASU
- creating public awareness of the CAP LTER project
- working with diverse student and teacher populations
- gaining a better understanding of the K-12 education system
- getting data from additional sites around the Valley

What the participants are saying:

"This research is exactly what I've been looking for. It will provide relevance to the curriculum. Thank you".—Ecology Explorers Teacher

"After this project I will remember to view nature and Arizona's birds more often."—Ecology Explorers Student

"The most valuable aspect, for me, was the approach to scientific inquiries and data analysis." – Ecology Explorer Teacher

" I felt that this was a great experience. Due to my busy life, I usually don't stop and observe nature." -Ecology Explorer Student

Jornada LTER Education Programs

Scientists associated with the Jornada LTER have been working on science education from the K-12 to graduate level for many years. As word of our high quality, inquiry-based programs spread, there was rapidly a demand for student/scientist interactions that far outstripped availability, especially at the K-12 level. In order to partially ameliorate the situation, Jornada LTER scientists formed a collaboration with a local nonprofit organization, the Chihuahuan Desert Nature Park. As this collaboration grows, LTER scientists continue to (1) provide the scientific basis for curriculum, (2) guide students on field trips, (3) assist students with data collection, and (4) participate in teacher workshops. Chihuahuan Desert Nature Park staff (1) handle scheduling and administrative tasks, (2) ensure that all curriculum materials are age-appropriate, and (3) work with students in all educational programs. We cannot overemphasize the benefits of this collaborative relationship. The joint efforts of the Jornada LTER and the Chihuahuan Desert Nature Park served over 8,000 K-12 students and 300 teachers in 2001.

The Jornada Schoolyard LTER (SLTER) program focuses on setting up long-term plots on land adjacent to schools. Students use these plots to conduct studies that parallel Jornada LTER research. Current studies include vegetation monitoring, weather monitoring, a disturbance experiment, and a restoration experiment. SLTER teachers and students also attend field trips to the Jornada Experimental Range and take advantage of Nature Park classroom programs on various aspects of desert ecology. Finally, we hold an annual, two-week summer workshop for fifteen 3rd - 9th grade teachers.

While all of these programs are successful, one problem we encounter is finding a way to work with schools that do not have native vegetation in or around their schoolyards. We are therefore planning the creation of five new long-term ecological research modules that can be used in all schoolyards, especially those *without* native desert vegetation. Each module will contain background materials, pre-measurement activities, and at least three data collection protocols focusing on a common theme. Like all existing protocols, focus will be placed on (a) student research that parallels local LTER projects and (b) establishing projects that will continue over many years.

Undergraduate and graduate training at the Jornada LTER includes ongoing as well as new, innovative programs. Between two and three REU's and many graduate students each year have worked on LTER projects. Most of the REU students come from the diverse population at New Mexico State University where over 45% of students belong to an ethnic minority. In 2001, LTER investigators Dr. Laura Huenneke and Dr. Curtis Monger taught a new, interdisciplinary graduate student seminar for twelve students from many departments on campus. They focused on the history of research at the Jornada LTER to illustrate key ecological principles in arid ecosystems.

Andrews Experimental Forest -- Schoolyard LTER, March 2002

The Schoolyard LTER Program of the Andrews Forest is changing this year. During the previous 4 years, our program had three separate areas of activity:

1. SMILE (Science and Math Investigative Learning Experiences), a partnership among 11 school districts and Oregon State University to provide science and math enrichment for minority and low-income students in grades 4-12, <<http://osu.orst.edu/precollege/TheSMILE/>>;
2. The WELL Program (Water and Energy Learning Lab) of the Eugene and Springfield, OR school districts. WELL addresses the hydrologic cycle, water yield and quality, energy generation and consumption, and greenhouse gases in an ecosystem context; and
3. The secondary education program of the Northwest Center for Sustainable Resources (NCSR), an NSF-supported Advanced Technology Center located at Chemeketa Community College, Salem, OR. NCSR <<http://www.ncsr.org/>> organizes field exercises throughout the school year and conducts summer workshops for science teachers, grades 7-12.

In the future, we will emphasize our interaction with OSU's SMILE, a program that currently provides science & math enrichment to over 740 minority, rural and/or low-income students (mostly Native American and Hispanic) starting with grade 4. SMILE has a year-round schedule of educational activities with weekly after-school SMILE Club meetings that include science activities and field trips. Students are strongly encouraged to stay with the program year after year, and SMILE Family Math-and-Science Nights often bring three generations together to reinforce the benefits of the program. SMILE functions as a long-term pipeline to higher education by providing academic enrichment and encouragement, including several field trips and workshops for high school students on the main OSU campus with the intent of easing the transition to college.

SMILE also provides professional development workshops that are linked to national standards for all SMILE teachers, currently 70-plus. Many of these workshops are held at the Andrews Forest. The teachers are presented with recent research findings from scientists and try out inquiry-based activities/labs that are incorporated into their classes, and the teachers provide feedback on how activities can be refined to meet their needs. They also are instructed in cooperative learning and culturally appropriate teaching techniques. As an example, last May at the Andrews Forest, several LTER scientists shared their expertise with teachers and led them in trying out activities/labs for their classrooms. In addition, educational opportunities at field stations were discussed, as were ideas for workable models for Schoolyard LTERs, and possibilities for future collaboration. There was clear enthusiasm about the concept of a statewide network of schoolyard activities (observing and sampling plants, insects, birds, etc. in permanent plots in schoolyards or nearby parks) that interacts via an interactive web-based system of data management and analysis.

The future direction of Andrews Schoolyard LTER clearly includes working with SMILE to develop 1) the network of schoolyard activities and 2) the interactive web-based data management and analysis system. Additional funding is necessary to accomplish these goals, however.

The Virginia Coast Reserve Schoolyard LTER Program

The VCR/LTER SLTER Program was introduced to Northampton County Public Schools in 1998 when, as part of a networking supplement the VCR/LTER provided networking equipment to improve the Internet access of Northampton High School (NHS), so that LTER WWW resources would be accessible. In the Fall 1999 and Spring 2000 semesters we began with classroom activities in the high school including introductions to Global Positioning Systems (GPS) and Geographical Information Systems (GIS), Water Chemistry and Plant Taxonomy, where we interfaced with 125+ students.

We introduced the SLTER program to teachers at the Northampton Middle School (NMS) in Fall 2001 and conducted a SLTER workshop for NHS and NMS on January 25, 2002. In January 2002 we began classroom activities at the Middle School: GPS and Pond Water Chemistry. We will be interfacing with 300+ students at the Middle School level this semester.

During the SLTER workshop in January 2002, we developed a vision of how the SLTER Program would interact with students from Grade 6-12. We hope to introduce students at the Grade 6-8 levels with research tools and build on that process to the point where they will be doing investigative science at the High School level. Many of the current activities at the high school (GPS and Water Chemistry) provide data sets that are very beneficial to the VCR/LTER Program. We hope to develop more programs that provide a dual role: education to students *and* provide useful data sets to VCR/LTER.

During the summer of 2001, the SLTER Program supported two NHS juniors to conduct a water chemistry project sampling fresh water drainage basins. These students return to the high school the following year and act as interns to their peers. They recently presented their data sets at the annual VCR/LTER All Scientists meeting in January 2001.

The VCR/LTER PI Bruce Hayden also taught a graduate level course (ENVSCI 796) for high school teachers during the 2001 summer in which we used the same tools and methods (at an advanced level) used in teaching the SLTER high school students. This 10-module course covered GPS/GIS, data management in Excel, Watershed Crop Biogeography, Field and Drainage Water Chemistry, Thermal climates, Populations (Sociology of Friends and Fiddler Crabs).

At the high school level, we now have a dedicated SLTER class that is called ENVSCI II. The VCR/LTER staff teaches all aspects of this class in which all of our SLTER research tools are utilized. Water chemistry coupled with GPS locations provides training for students but also provides excellent data sets for use by VCR/LTER. Low-cost digital "HOBO" air temperature loggers are deployed at various locations in the county, which again provides training to students but also provides VCR/LTER with data sets useful in determining variability in air temperatures throughout the County. We encourage our students to take the equipment home with them and record data. The students are also assisting in VCR/LTER's annual Biomass sampling where they are refining their Plant Taxonomy skills. These students will be making presentations on their data and results at various levels in the school system, public forums and VCR/LTER meetings.

Number of SLTER students involved: 425+

Equipment purchases: One of our approaches has been to provide field and computation equipment needed to support field exercises. To this end we have purchased for use by SLTER students 48 Magellan 310 GPS units (24 for the high school and 24 for the middle school); Ten Dell Dimension PC's with Internet Explorer, Netmeeting and GIS software, Win2000 upgrades; PC Cameras for Netmeeting and research photos; Water Chemistry equipment and training at high school; Pond sampling kits; 72 plant tax resource books and herbarium equipment (presses, mounting supplies); Other resource books: Life on the Chesapeake (24 copies).

'Hands On' Training Programs: Excel spreadsheets and data management, GPS, ArcView 3.2 (GIS), water chemistry equipment, Hobo air temperature recorders and PC interface, and making good scientific presentations.

We are currently working on a Wireless Networking System within the VCR/LTER Program, which will enable SLTER interactive classrooms via the Internet whereas we will broadcast live on the web interactions between researchers/SLTER students as well as SLTER field trips and research activities.

Web Page: <http://www.vcrlter.virginia.edu/slter>

Progress Report: 2/22/02. C.R. Carlson.

Educational Activities at Harvard Forest

During the past three years Harvard Forest has averaged 13 REU students per year (1999=13; 2000=13.5; 2001=12.5) in our summer internship program. An average of 7 non-REU students a year (1999=11; 2000=7; 2001=2.5), supported by Mellon Foundation and Harvard Forest funds have also participated in this program.

During the past three years Harvard Forest has employed 1-2 local high school students a year (5 total) through the schoolyard LTER program to provide research experience and experience working in our soils/nutrient analysis laboratory.

Through the schoolyard program Harvard Forest has developed programs with Shutesbury Elementary School (1999-2001) and Amherst Middle and High Schools (2001) including: vernal pool identification and monitoring workshops for Shutesbury teachers and students; field trips to Harvard Forest for Shutesbury and Amherst classes; LTER workshops at Harvard Forest for Shutesbury teachers; natural history trail development on Shutesbury school grounds; phenology and hemlock woolly adelgid observation and monitoring programs on school grounds and other town sites, coordinated with similar, ongoing programs at Harvard Forest; the purchase of research and educational materials to support these activities.

Harvard Forest has been certified by the Massachusetts Department of Education as a Professional Development Points (PDP) provider to teachers for professional development activities in ecology and, in collaboration with other institutions in the area, identifies, offers and facilitates teacher participation in these development activities.

Through the Fisher Museum, Harvard Forest maintains several miles of interpreted trails used by several thousand visitors annually, and has recently updated this interpretation to place greater emphasis on LTER activities. During the past year the Museum provided educational programs to 90 groups, including 24 elementary and secondary school classes, 43 college and university classes, and 23 community and professional groups, and hosted the 12th annual Harvard Forest Symposium attended by more than 100 researchers, natural resource managers, educators, and interested members of the public.

Also, over the past year Harvard Forest has had 4 master's students, 4 doctoral students, and numerous post-docs working on site, with diverse sources of funding, including LTER.

Education Activities at the GCE LTER

1. In July, 2001, ten educators, 2 facilitators and several LTER scientists worked together to pilot a model for the GCE-LTER Schoolyard Program. Dubbing themselves S.A.P.E.L.O. – Scientists and Professional Educators Learning Outdoors – the team represented educators from both classroom and outdoor programs. The model teamed educators and scientists for a week of research in the salt marshes and waters in and around Sapelo Island and the adjacent mainland – focus site of the LTER. Teachers and researchers together gathered data in the field, installed critical equipment, and analyzed and expounded upon lab results. Using the distance learning network in Georgia (GSAMS), the well designed web support of the GCE-LTER and with corroborating conference calls to the scientists, the ability of the educators to use the research as critically needed local examples of math/science application was seen by them to be immeasurable. Application has been made for funds to repeat the workshop with revisions. An Eisenhower grant has been awarded to run a second workshop with an emphasis on curriculum and pedagogical content knowledge.
2. On October 4-7, 2001, Dr. Carolyn Ruppel led students in her environmental field methods class at Georgia Tech to Sapelo Island for hands-on training in environmental field methods. This year the class installed 2 new marsh monitoring wells and 3 multilevel samplers during the trip. The new marsh monitoring wells extend the transect begun by the Fall 2000 EAS 4420 class. Thanks to the Fall 2001 students, the GCE focus site now has 2 marsh-based wells in the *Spartina* and *Juncus* marsh on the south side of the hammock. The course is now an annual component of the education and outreach program for GCE-LTER.
3. This year, graduate students enrolled in the Georgia Tech Hydrogeology Certificate, will be taking EAS8804CDR to fulfill part of their requirements. The class will be involved in an extended trip to the GCE-LTER to study field techniques and application.
4. Bryan Henry, an EAS senior and Weather Channel employee, is looking at long term climate in this part of coastal Georgia by culling through existing databases and doing a preliminary dendrochronologic study.
5. Six to eight undergraduate and graduate research internship positions are opened each year, on a competitive basis, through the University of Georgia. These students conduct a variety of research under the direction of the PI's for the LTER. Research projects on the graduate level often lead to masters theses and doctoral dissertations.
6. The GCE-LTER has been a research/study area since the early 1950's. It was begun by Dr. Eugene Odum at the University of Georgia. As a result, over fifty years of data is available to researchers and students.

Bosque Ecosystem Monitoring Program/Sevilleta LTER Schoolyard Program:

The Bosque Ecosystem Monitoring Program/Sevilleta LTER Schoolyard Program, commonly referred to as BEMP, completed its fifth year of monitoring in 2001. Supported by congressionally appropriated Bosque Initiative funds, Sevilleta LTER Schoolyard funds, and a spectrum of assistance from Bosque School in Albuquerque, BEMP is on target with its two central objectives. The first objective is to involve citizen volunteers (mainly K-12 students) and site representatives (mainly their teachers) in monitoring key variables that reflect ecosystem structure, functioning, and biodiversity at currently seven similarly organized Middle Rio Grande riparian forest (bosque) sites with different flooding histories. These BEMP sites are located, north to south, at the Pueblo of Santa Ana, Alameda, Bosque School (or Savannah), the Rio Grande Nature Center, Los Lunas, and Lemitar. BEMP's second objective is to track environmental trends at these sites and make this information available to appropriate resource agencies and the public.

Monitoring by students who are mentored by their teachers and University of New Mexico (UNM) student interns takes place every third Tuesday of every month. More specialized monitoring is performed by the interns and experienced biologists. A complete description of the entire program is recorded in the *Bosque Ecosystem Monitoring Program (BEMP): First Report: 1997-2000*, published locally in August and available with additional information about the program on our web page (www.bosqueschool.org/BEMP/bemp.htm). A modified version of the report is available on CD, which also contains student-collected data in manageable datasets and tips on creating graphs. The CD is available on request. Comparisons between student- and scientist-collected and processed data show the same trends, emphasizing the importance and validity of the students' work. Students learn about science, their community, and some of the issues that are important to the environment they study.

BEMP's *Bosque Internship* course is taught year around by director Cliff Crawford, coordinators Mary Dwyer, Mary Stuever, and Dan Shaw, together with data manager Kim Eichhorst through UNM's Biology Department. Up to now the course has been taught under a Special Topics number: Biology 402/502. Beginning with spring semester of 2002, it has its own number: Biology 408/508.

BEMP presentations included the following (organized by date):

- 30 January – Teacher training for Hubert Humphrey Middle School 5th grade teachers (Stuever).
- February 14 – BEMP was featured in the New Mexico Museum of Natural History's syndicated Television series "Way Out West: The Electronic Bridge" (New Mexico distribution with nationwide distribution sometime in 2002.)
- 10-11 February – Presentation on BEMP and monitoring techniques, Cottonwoods and Cranes Natural History Weekend, Sevilleta LTER Field Station (Stuever).
- 20 March – Hosted Hubert Humphrey Middle School 5th grade class at Alameda site (Dwyer and Shaw).
- 21 March – Hosted Hubert Humphrey 5th grade class at Savannah site (Dwyer and Shaw)
- 28 March – Conducted leaf litter lab for several Hubert Humphrey teachers at Bosque School (Dwyer).
- 20 April – *BEMP Annual Student Congress* at Bosque School.
- 3 May – Hosted Hubert Humphrey 5th grade class at Alameda site (Shaw).
- 4 May – Hosted Hubert Humphrey 5th grade class at Savannah site (Shaw).
- 11 May – Participated in New Mexico Watershed Watch Congress, NM Dept. of Game and Fish (Stuever).
- 18 June – Presentation on "Ecological Monitoring and BEMP" at the Teachers Science Academy, UNM College of Education (Stuever).
- 20 June - Tour of BEMP Lemitar site with Pueblo of Santa Ana YCC crew (Stuever).
- 8 August – Poster "Long Term Ecological Research Network K-12 Education Partnership: Students and Teachers Experiencing LTER" by Sprott, Baker, Krasny, Elser, Rohanan, & Eichhorst, Ecological Society of America meeting, Madison, WI (Eichhorst)
- 8 September – 4th Annual BEMP Teachers Workshop at Bosque School.
- 22 September -BEMP Presentation at Arizona Association of Environmental Education Annual Conference, Flagstaff, AZ (Dwyer)
- 3 October – Set up and ran BEMP booth at NM Museum of Natural History Teachers Open House (Dwyer).
- 30 October – Presentation on "The Bosque Ecosystem Monitoring Program (BEMP)" at the annual meeting of the Institute of Wetland Science and Public Policy of the Association of Wetland Managers, Albuquerque (Eichhorst, Stuever, Shaw, Crawford).
- 12 November – Presentation on "The Bosque Ecosystem Monitoring Program on the Middle Rio Grande" at the annual meeting of the American Water Resources Association (Eichhorst, Stuever, Shaw, Crawford, Dwyer).

BEMP has been asked by a number of sources to establish additional monitoring sites. An eighth site has recently been set up at the Hispanic Cultural Center. New sites are also being discussed for the Pueblo of San Juan, Harrison Middle School, and three sites surrounding the proposed dam site for the City of Albuquerque. The City and Bosque School would be involved in site establishment, and there appear to be other schools that would contribute to the monitoring. Thus the prospects for BEMP to contribute to both the public's and resource agencies' conceptions of Middle Rio Grande bosque ecosystem dynamics appear strong.

NORTH TEMPERATE LAKES LTER EDUCATION PROGRAM

The SchoolYard LTER (SYLTER) project has steadily developed from the pilot we began with elementary school teachers at two schools in 1998. Initially staff worked with a small group of interested teachers (6) at one elementary school in northern WI (Arbor Vitae-Woodruff) and one in southern WI (Country View Elementary, in Verona, WI). Staff and teachers developed strategies, materials, and protocols to help students begin ecological measurements of lakes or ponds near their schools. We expanded the project in 1999 to include middle school teachers and students in both professional development and enrichment activities. Activities include research at or near their school and winter limnology field experiences at the Trout Lake Station in northern WI and at the Center for Limnology and Lake Mendota in southern WI.

In 1998, UW-Madison's Center for Limnology (CFL), North Temperate Lakes LTER (NTL-LTER), and Center for Biology Education (CBE) faculty, staff, and students provided science enrichment opportunities for 60+ students in Arbor Vitae-Woodruff, near the Trout Lake Station, and 40+ students from Country View in Verona, WI, near the Center for Limnology. In subsequent years, we have continued to provide enrichment opportunities such as these for students and have expanded our outreach activities to include professional development opportunities for teachers.

We have expanded activities in northern Wisconsin to include middle school students and teachers while continuing to provide enrichment for elementary school students. Activities in 1999 and 2000 involved approximately 100 students and 9 teachers (grades 3-7). Middle school students participated in hands-on activities as part of the NTL-LTER Limnology Explorers. This program included field experiences at the Trout Lake station combined with small group and independent student research investigation mentored by NTL-LTER scientists.

In 1999, CBE staff and NTL-LTER staff developed a Saturday Enrichment Program for students in grades 5-8 in partnership with the UW-Madison School of Education (SOE) Outreach. Activities used winter limnology research techniques and protocols in a series of science enrichment experiences for students from Dane Co., WI. CBE staff, NTL-LTER staff and UW-Madison undergraduate science majors led activities. This program was offered in 2000, 2001, and 2002. Additionally, the program was expanded in northern WI, to include middle school students and teachers from 5 schools. Activities include winter limnology field experiences as well as science clubs at each of the schools.

We have leveraged previous NSF supplement funds in two successful **Dwight D. Eisenhower Professional Development Program** grants, closely allied with our SYLTER, awarded to Dr. Robert Bohanan at the Center for Biology Education. The first, **SchoolYard Science: Inquiry-Based Workshops and Research Experiences for Middle School Teachers (SYS) 2000-2002** has provided summer research experiences, curriculum development, and pedagogy workshops for teams (1 learning coordinator, 2 science/math teachers, and an education major) from 5 middle schools in the Madison Metropolitan School District. SYS was recently renewed and will work with teams from 5 new middle schools in 2001. Approximately 150 students, 14 teachers, 5 learning coordinators, and 5 education students participated in SYLTER from the Madison-area in 2000. As part of the SYS professional development activities, we have created a web resource, **School Yard Science**, for teachers and students to share their ideas and have assembled several educational links and resources.

The second recently funded project, **Teacher Leadership Professional Development Project: Creating School-Based Leadership Cadres to Adapt Exemplary Science Curriculum to Foster Student Inquiry (TLDP) 2002-2004**, builds upon the professional development model and long-term ecological student inquiry pedagogy and engages middle school science teachers, administrators, university faculty, staff, and students in a 2 year project to create cases for student investigation based upon local and regional LTER data.

SYLTER began a partnership with a UW Madison GK-12 project, K-Through-Infinity (KTI) in 2000. Five graduate students participated in professional development activities during 2000-2002. They participated in SYLTER activities at 10 middle school classrooms.

COWEETA LTER EDUCATION PROGRAM

During the 2001-2002 school year we continued Coweeta Schoolyard LTER activities initiated in August 1998. We involved teachers and students at three grade levels: sixth grade at Macon County Middle School (Franklin, NC), high school at Rabun Gap Nacoochee College Preparatory School (Rabun Gap, GA), and college at Southwestern Community College (Sylva, NC). We selected this range of grade levels to conduct projects and investigate the potential success across a wide range of teachers, students, and facilities.

Our experiences have continued to be positive. All five teachers involved (3 at sixth grade, 1 at high school, and 1 at community college) gave positive reviews of the activities and had overwhelmingly positive responses from the students involved. A summary of the people involved included 5 teachers, 8 researchers, and 47 students. A variety of material is available online at the following URL address that lists the people involved, a summary of project experiences, online data sets, photos of some of the field days, and evaluations from students and teachers.

<http://coweeta.ecology.uga.edu> (See Education Section)

The projects, ranging from stream water and fish sampling, to riparian plant quantification, to tree respiration measurement, gave teachers and students experience with a wide range of field techniques, equipment operation, and experimental design. Teachers have used these experiences to take what they have learned to initiate other projects on their school properties including an extensive vegetation regrowth study in a riparian restoration project at Rabun Gap Nacoochee Preparatory School and a stream health monitoring program at Macon Middle School.

Two representatives from the Coweeta Schoolyard LTER program (Brian Kloeppel and Susan Steiner) are also planning to attend the LTER Network Education Workshop to be held March 2002 at the Sevilleta LTER site.

Palmer LTER Outreach and Education Overview (Karen Baker, 08 March 02)

The Palmer LTER (PAL) education and outreach activities are diverse. A critical element in creating a sustainable program is our national and local education partnerships. In addition, the allure of the Antarctic ensures that the majority Palmer LTER (PAL) personnel participate in public outreach regularly whether through interface with classroom teachers and reporters or in cooperation with the NSF sponsored Artist and Writer Antarctic projects often focused on video and book production. PAL interfaces with university education through undergraduate and graduate seminars as well as with NSF/Research Experience for Undergraduate projects. Outreach products include publication of a Palmer LTER site brochure, a site CD, an education forum proceedings (Baker et al, 1999) in addition to digital and outreach material collections. Diversification with respect to products into multimedia and journaling is underway. Presentations are made regularly at community events such as ESA, NSTA, NPACI All-Hands, and the local universities.

Attendance at the LTER Education Committee first workshop at the Biosphere (Oct98) in Arizona and the second workshop at Kellogg Biological Station in Michigan (Oct99) set the stage for the Palmer LTER Education Outreach Forum in conjunction with the National Center for Ecosystem Analysis and Synthesis brought together national and local representatives (scientists, educators, teachers and information manager/technologists) to explore options for a long-term educational program and to develop two prototypes: "Education Outreach Goals" and "Guidelines on Creating a Long-Term Perspective in Classroom Science".

The Palmer LTER interfaces with the LTER Schoolyard Education (SLTER) program, collaboration with the Digital Library for Earth System Education, and with the San Diego Supercomputer Center (SDSC). Since 1998 Palmer sponsors a teacher annually in partnership with the national Teacher's Experiencing the Arctic and Antarctica (TEA) program (NSF/OPP/HER). This program creates a multi-year learning framework focusing on inquiry based learning and Antarctic science. Participating teachers intern at a scientist's home institution and in the field as part of the research team. LTER support extends TEA internships when projects benefit from continued researcher-teacher interface. Internship at UCSD/SIO provides a focus on data and multimedia productions as well as interface with the Stephen Birch Aquarium. The Palmer LTER Education and Outreach liaison, Karen Baker, is a TEA Advisory Board Member (1999-ongoing).

Collaboration with University of California Outreach Programs is ongoing with participation planned this summer in the Academic Connections program. This program's goal is to expose high school students to the research experience through participation in university life. Students live on campus and take courses taught by graduate students from departments across the university. Palmer LTER's experience with marine science, information management and network contributes to program development in cooperation with the teams of SIO graduate student instructors. Another partnership bridges the local and national arena. Collaboration is building with the San Diego county Girl Scout organization and the national Boy Scout program through events such as this year's internship and Antarctic field work of an Eagle Scout (www.scoutonice.org) and sponsorship of a SIO event "New Age Knowledge in the Digital World" for Girl Scouts to learn about women in science.

Bonanza LTER Education Outreach Program Summary

Outreach by the Bonanza program has contributed substantively to education and diversity at many levels. Equipment, educational materials and fast internet connections have been provided to Alaska schools. Outreach to K-12 students through the Schoolyard LTER partnered with other K-12 programs such as the Global Learning and Observations to Benefit the Environment (GLOBE) and the Global Change Education Using Western Science and Native Observations, has brought hands-on research experience to children learning science through teacher training courses/workshops, classroom involvement by LTER scientists, engaging all students in a classroom in on-going research or by mentoring some students in investigations that they have independently developed and conducted.

Other educational outreach activities Bonanza LTER scientists have been involved in are coordinating a local school Science Fair and serving as judges at local and district Science Fairs, and also at the Statewide Science and Engineering Science Fair and High School Science Symposium. A couple of LTER scientists who partnered with an education specialist, have developed educational curricula on scientific measurements and learning activities to support student understanding of science concepts imbedded in plant phenology research.

Other research experience opportunities have been provided by Bonanza LTER by providing funding and mentoring for undergraduate students in the Research for Undergraduate Program, and for students in graduate studies, which have trained them as professional ecologists. Some have become scientists in universities and agencies. High school students of SLTER teachers have also been hired as research student assistants. Female, male, urban, rural, Alaska Native and non-Native students have participated in these research experience opportunities.