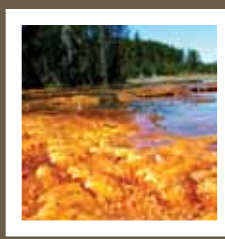
Year 3

Montana NSF EPSCoR

The Montana NSF EPSCoR Program

is a partnership between Montana's research universities (Montana State University and The University of Montana) as well as Montana Tech and Montana's seven tribal colleges. Montana EPSCoR is focusing on **increasing research competitiveness** in two targeted research areas: *Hydrogen and the Environment and Large River Ecosystems* and one support area, *Cyberinfrastructure. Hydrogen and the Environment* builds on the expertise of researchers in the Montana University System who study hydrogen-metabolizing mechanisms in nature with the mission of applying their understanding to the development of hydrogen as an alternative fuel. *Large River Ecosystems* is building partnerships in the state and region to examine the range of processes affecting large rivers and their ecosystems and restoration techniques and efforts



MONTANA NSF EPSCoR

annual report

August 1, 2009 – July 31, 2010

01/HIGHLIGHTS OF THE YEAR INCLUDE:

Twelve new faculty hires

116 publications by EPSCoR faculty including publications in *Nature*, *Science*, and *Proceedings of the National Academy of Sciences*

Reached over 50,000 children in Montana with expanded Outreach offerings

GirlTech outreach program was selected as one of ten programs in the nation to partner with Public Broadcasting's DragonFly TV SciGirls Program

Establishment of successful cyberinfrastructure at the two research universities

02/SCIENTIFIC ACHIEVEMENTS:

SELECTED PUBLICATIONS SUPPORTED IN PART BY EPSCoR DURING THE PAST YEAR

1. Banfield JF, Young M. 2009. Variety-the Splice of Life-in Microbial Communities. *Science* 326: 1198-9

2. Boyd ES, Spear JR, Peters JW. 2009. [FeFe] Hydrogenase Genetic Diversity Provides Insight into Molecular Adaptation in a Saline Microbial Mat Community. *Applied and Environmental Microbiology* 75: 4620-3

3. Davis JM, Rosemond AD, Eggert SL, Cross WF, Wallace JB. 2010. Long-term nutrient enrichment decouples predator and prey production. *Proceedings of the National Academy of Sciences of the United States of America* 107: 121-6

4. Duncan WW, Poole GC, Meyer JL. 2009. Large channel confluences influence geomorphic heterogeneity of a southeastern United States river. *Water Resources Research* 45

5. Hester ET, Doyle MW, Poole GC. 2009. The influence of in-stream structures on summer water temperatures via induced hyporheic exchange. *Limnology and Oceanography* 54: 355-67

6. Karakhanov EA, Maksimov AL, Zatolochnaya OV, Rosenberg E, Hughes M, Kailasam P. 2009. Hybrid macromolecular iron and copper complexes in the phenol hydroxylation reaction. *Petroleum Chemistry* 49: 107-13

7. Lu CF, Xin ZG, Ren ZH, Miquel M, Browse J. 2009. An enzyme regulating triacylglycerol composition is encoded by the ROD1 gene of Arabidopsis. *Proceedings of the National Academy of Sciences of the United States of America* 106: 18837-42

8. McGlynn SE, Mulder DW, Shepard EM, Broderick JB, Peters JW. 2009. Hydrogenase cluster biosynthesis: organometallic chemistry nature's way. *Dalton Transactions:* 4274-85

9. Mooney AC, Robertson HM, Wanner KW. 2009. Neonate Silkworm (Bombyx mori) Larvae Are Attracted to Mulberry (Morus alba) Leaves with Conspecific Feeding Damage. *Journal of Chemical Ecology* 35: 552-9

10. Mu QZ, Jones LA, Kimball JS, McDonald KC, Running SW. 2009. Satellite assessment of land surface evapotranspiration for the pan-Arctic domain. *Water Resources Research* 45

11. Mulder DW, Boyd ES, Sarma R, Lange RK, Endrizzi JA, et al. 2010. Stepwise [FeFe]-hydrogenase H-cluster assembly revealed in the structure of HydA(Delta EFG). *Nature* 465: 248-U143

12. Piccardo P, Amendola R, Fontana S, Chevalier S, Caboches G, Gannon P. 2009. Interconnect materials for next-generation solid oxide fuel cells. *Journal of Applied Electrochemistry* 39: 545-51

13. Smirnov VV, Roth JP. 2009. Why metabolic processes fractionate oxygen isotopes. *Geochimica Et Cosmochimica Acta* 73: A1239-A

14. Song KJ, Zhou XB, Fan Y. 2009. Multilayer soil model for improvement of soil moisture estimation using the small perturbation method. *Journal of Applied Remote Sensing 3*

15. Vorontsov AB, Vavilov MG, Chubukov AV. 2009. Interplay between magnetism and superconductivity in the iron pnictides. *Physical Review B 79*

16. Zhang K, Kimball JS, Mu QZ, Jones LA, Goetz SJ, Running SW. 2009. Satellite based analysis of northern ET trends and associated changes in the regional water balance from 1983 to 2005. *Journal of Hydrology* 379: 92-110

PROGRAMS / TWELVE NEW FACULTY HIRES:

01 Jennifer Brown (Chemical and Biological Engineering, MSU) **02** Steve Stowers (Cell Biology and Neuroscience, MSU) **03** Bern Kohler (Chemistry and Biochemistry, MSU) **04** Rob Walker (Chemistry and Biochemistry, MSU) **05** John McCutcheon (Microbial Ecology, UM) **06** Maurice Valett (Aquatic Biogeochemistry, UM) **07** Jack Brookshire (Land Resources and Environmental Sciences, MSU) **08** Tracy Sterling (Land Resources and Environmental Sciences, MSU) **09** Paul Stoy (Land Resources and Environmental Sciences, MSU) **10** Laurie Marczak (Aquatic Invertebrate Ecology, UM) **11** Marco Maneta Lopez (Watershed Hydrology, UM) **12** Stephanie Ewing (Land Resources and Environmental Sciences, MSU)

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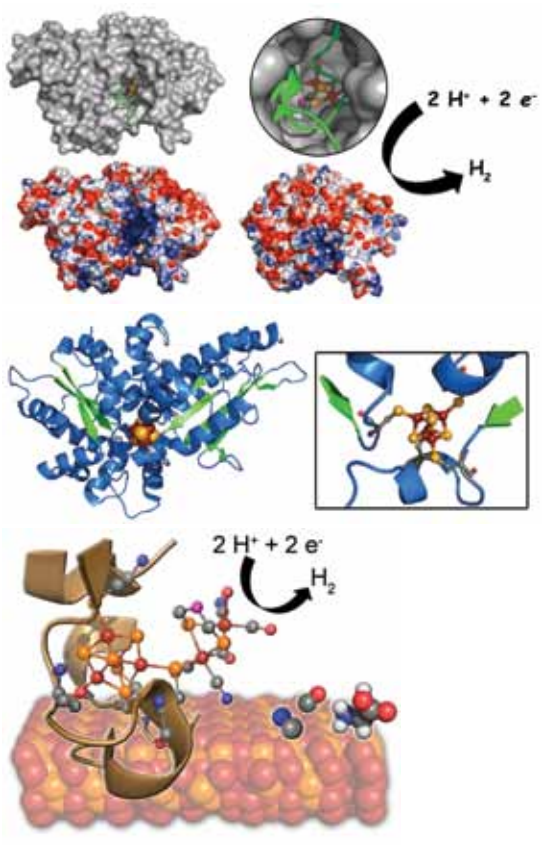
WHO'S WHO IN MONTANA NSF EPSCoR:

Project Directors: Mark Young, Ric Hauer
Project Administrators: Gay Allison, Martha Peters
Financial Managers: Susie Couch, Rhonda Stoddard
Graphic Design: Monika Chodkiewicz

2.1/ RESEARCH NOTES:



From top to bottom: 1) Graduate student, David Mulder, at work in the lab. 2) A schematic of the pathway for inserting an iron-sulfide cluster during a complex assembly. 3) The structure of a key intermediate form of hydrogenase. 4) Depiction of the hypothetical transition from mineral-based catalysts (right) to protein-based catalysts (left)
top right - Professor John Peters

HYDROGEN AND THE ENVIRONMENT RESEARCH

Montana State University chemists involved in the EPSCoR Hydrogen and the Environment research area have determined the structure of an intermediate form of a unique enzyme that participates in some of the most fundamental reactions in biology. The discovery could lead to understanding life in ancient ecosystems. It could also play a role in producing alternate fuels and fighting pollution, according to MSU researchers who published their findings in the publication *Nature*[1].

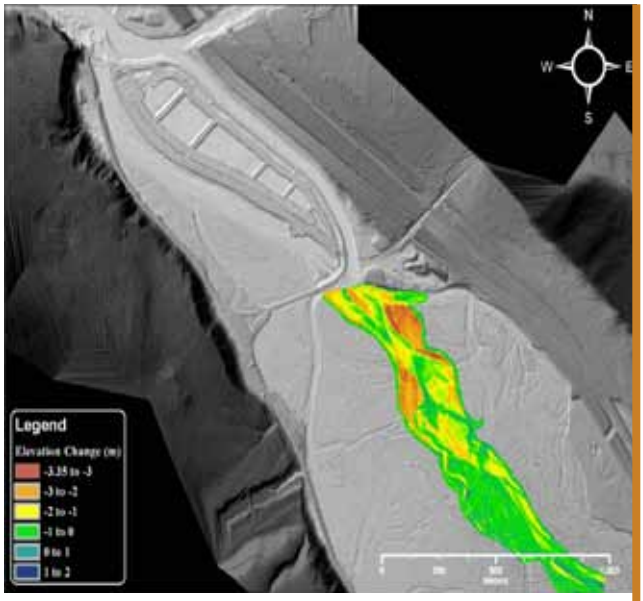
Complex enzymes that contain iron-sulfide clusters are found everywhere in nature, and they're involved in many fundamental processes such as carbon dioxide fixation, nitrogen fixation and hydrogen metabolism. The MSU researchers focused their study on one of three enzymes involved in hydrogen metabolism. They wanted to understand the structure of the enzyme and how it assembled one of the more complex clusters in biology. In the process, they saw a definite step-by-step process that may also have occurred in some manner in minerals. The discovery lends itself to discussions about evolution and environments that harbored early life that couldn't assemble complicated clusters of iron and sulfide and may have lived vicariously on transformations that occurred in minerals.

Professor John Peters said that figuring out the enzyme's structure and how it assembles clusters of iron and sulfide may help scientists produce hydrogen in the lab. If they can simulate the synthesis of the important features of the enzymes in the lab, they may use it to produce renewable fuels.

Excerpted from MSU News Service, Evelyn Boswell

[1]Mulder DW, Boyd ES, Sarma R, Lange RK, Endrizzi JA, et al. Stepwise [FeFe]-hydrogenase H-cluster assembly revealed in the structure of HydA(Delta EFG). 2010. *Nature* 465: 248-U143.

(Left) Former site of Milltown Dam, below confluence of Blackfoot and Clark Fork Rivers, in July 2008, four months after breaching of the dam. (Right) Andrew Wilcox (Assistant Professor, Geosciences) and Elena Evan (M.S. student, Geosciences) sample bed material in the Clark Fork River downstream of Milltown Dam using a McNeil sediment sampler.



(Top) Shaded-relief image of Clark Fork arm of Milltown Reservoir, where colored areas show area and varying depths of post-dam breach scour from the reservoir. (Bottom) Milltown Dam and Reservoir, from similar perspective as photo at top left of page, one day after breaching of the dam in March 2008 but prior to complete removal of the structure.

LARGE RIVER ECOSYSTEMS RESEARCH

Five students at The University of Montana supported by NSF EPSCoR conducted research on the geomorphic processes associated with dam removal of Milltown Dam on the Clark Fork River, MT. This project provided an opportunity to conduct extensive and time-sensitive field data collection and analysis, including geomorphic characterization and geochemical tracer studies, following the breach of Milltown Dam.

Under the direction of Professor Andrew Wilcox at The University of Montana, the students documented the volume, pattern, and timing of reservoir erosion following dam removal. This analysis documented not only substantial variations in reservoir erosion patterns and mechanisms (vertical incision versus channel widening) as a function of valley confinement, but also large variations in the accuracy of sediment transport modeling predictions in these two reservoir settings.

They also collected bedload transport data to measure the downstream sediment pulse moving out of Milltown reservoir and analyzed initial post-removal topographic and textural response upstream and downstream of Milltown Dam. This effort focused on two reaches: the lower 4 km of the Blackfoot River (BFR) before its confluence with the Clark Fork River, and the Clark Fork River within 4 km downstream of Milltown Dam, and entailed pre- and post-breach surveying of 36 cross sections, bed material sampling, and detailed topographic surveys of lateral and mid-channel bars that we hypothesized would be locations of active sediment deposition.

This figure from their research results showing Post-dam breach scour from Clark Fork arm of Milltown Reservoir, based on comparison of pre-removal bathymetry data and 2008 data from LIDAR and ground surveys was published in a recent National Academies report (Figure 1.4, NRC 2009).

2.2/ CYBERINFRASTRUCTURE

Bioinformatics scientist, Dr. Aurelien Mazurie joined the bioinformatics core at Montana State University bringing his knowledge of the latest bioinformatics tools and resources to PIs at MSU. Since his arrival, he has collaborated on research proposals and papers with twelve PIs across three colleges and five departments.

At The University of Montana, physical enhancement of high performance computing infrastructures has provided access to campus researchers for parallel style processing architecture, allowing the execution of larger and more structurally sophisticated compute tasks and provide a test-bed parallel environment on which to train and explore toolsets routinely used on various TeraGrid nodes.

1) Bioinformatics Scientist Dr. Aurelien Mazurie at Montana State University. (MSU photo by Kelly Gorham) 2) UM Research Analyst Joe Glassy in front of computational research nodes.

EPSCoR Track-2 Award
– *Cyberinfrastructure for a Virtual Observation and Ecological Informatics System*

The Montana-Kentucky (MTKY) cyber consortium is a partnership of the primary research universities in the two states. Through this Cyberinfrastructure project, the researchers are developing a collaborative, research-based line of inquiry and informatics framework that will function from the collection of streaming sensor data to the application of those data in simulation models and visualizations.

EPSCoR C2 Award
– *Northern Tier Networking Development Planning Grant*

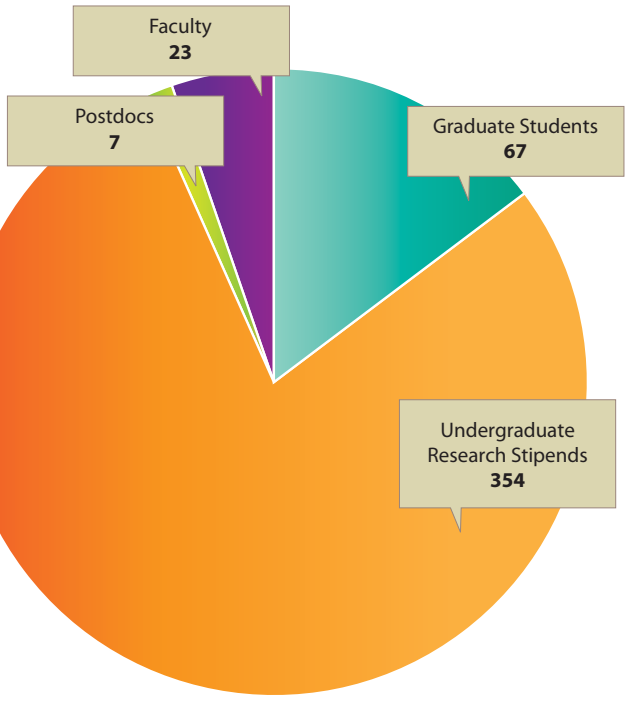
The overarching goal of this cyberinfrastructure project, is to extend the reach and capability of the Montana University System's (MUS) newly activated owned-fiber network, the Montana Northern Tier Network (MT-NTN), to a number of strategic locations and provide access for all researchers within these regions to an enterprise class computation and data storage facility being created by the State of Montana.

Improved connectivity will enhance the collection and streaming of data from environmental sensors to local data aggregation points and will enable real-time observation of ecosystem changes on a national network scale. Extending the network into rural and underserved areas will provide access to health related information and will support research to understand health conditions that affect various populations disproportionately, focusing especially on health care for Montana's rural, indigenous, and lower socioeconomic populations

The project leverages ongoing diversity activities funded through current EPSCoR programs at Montana State University (MSU) and The University of Montana (UM). In particular, this project will benefit those students and faculty at Salish Kootenai College, Dawson Community College, Flathead Valley Community College, Miles City Community College, and MSU-Billings.

03/ WORKFORCE DEVELOPMENT

The Native American Faculty Development Program was initiated this year at The University of Montana with the goal of increasing the number of doctoral prepared Native American faculty at the tribal colleges. Five tribal college faculty members are being supported for post-Masters degree work in doctoral programs at UM. Additionally, Dr. Donald Benn was the first recruit of the University of Montana Native American Faculty Development Program. Dr. Benn is a Visiting Assistant Professor with the Native American Research Lab (NARL). His research is in the area of host responses to viral challenge in eukaryotic and prokaryotic systems and biotechnological applications of microbial systems. He is very interested in traditional uses of plants in Native American culture, especially in the treatment of common viral diseases. Dr. Benn is also interested in providing advanced research opportunities for Native American students.



EPSCoR Workforce development 2007-2010

1) Dr. Don Benn at Yellowstone National Park where he conducted research with Dr. Martin Lawrence of MSU. (photo courtesy of Dr. Martin Lawrence) 2) Molecular Biosciences graduate student Joanna Gress conducted research on colony collapse disorder in one of her graduate school rotations. (MSU photo by Kelly Gorham) 3) PhD graduate student Kelly Crispin and colleague conduct research on Large River Ecosystems.

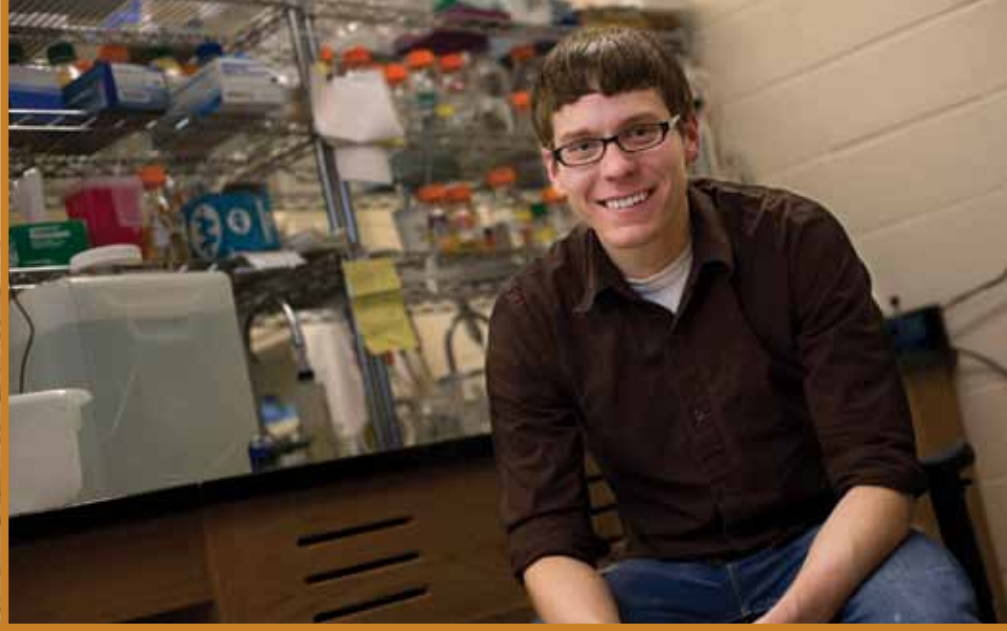
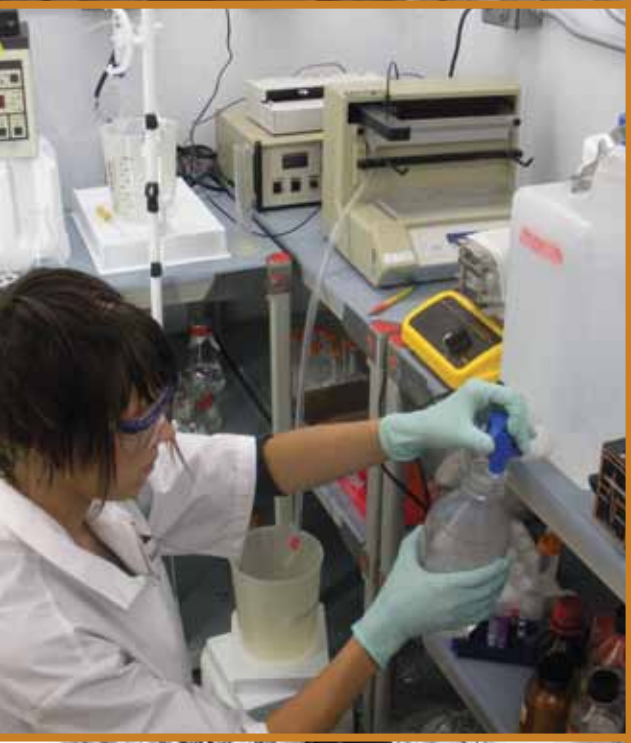
TRAINING THE NEXT GENERATION OF SCIENTISTS

EPSCoR continues to support graduate students, undergraduates and pre-college students. These students gain research experience in the labs of university faculty, conducting research and presenting at national conferences and publishing in scientific journals.

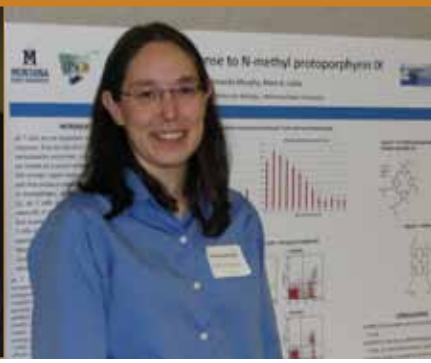
This year, a new program at Montana State University gave graduate and undergraduate students an opportunity to learn about Communicating Science to the public.

An 8-week course at MSU sponsored by Extended University trained the students in making visually compelling and informative presentations about their work. The class culminated in a final capstone project of a touch screen exhibit on their research. EPSCoR undergraduate student, Kevin Harlan's project can be seen at http://hydrogen.montana.edu/video.html

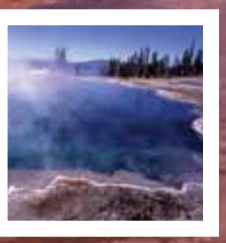
EPSCoR supports graduate and undergradute students across Montana. Clockwise from top: 1) MSU undergraduate student Danielle Bouchard is a biotechnology major studying microbes from Yellowstone National Park. 2) MSU undergraduate Kevin Harlan working in the lab of Dr. Trevor Douglas. 3) UM undergraduate Oliver Oswold looks at reservoir rocks for both carbon-dioxide and biogenic gas. 4) David Elison, UM undergraduate student, models proper lab eyewear 5) UM undergraduate student Jonathan Ebel captures salamanders in the Lochsa sub-basin in Northern Idaho.





Photos clockwise from top left : 1) UM undergraduate Jeremy Alverson wants to understand how damaged DNA in the human body repairs itself. 2) Recent MSU graduate Trevor Zuroff poses in the lab where he conducted research on biofilms. (MSU photo by Jackson Harris) 3) UM undergraduate Tia Hunter works with Dr. Art Woods and how lepidopteran larvae maintain one specific internal condition: water balance. 4) MSU graduate student Amanda Murphy at a poster session. 5) UM graduate student Glenn Pinson served as a science fair judge. 6) UM graduate student Chauncey Means is looking at remediation of Northern Cheyenne Reservation water for trace heavy metals. 7) Tara Ness in Dr. Klara Briknarova's lab at UM studying solar driven hydrogen production from acid solutions.



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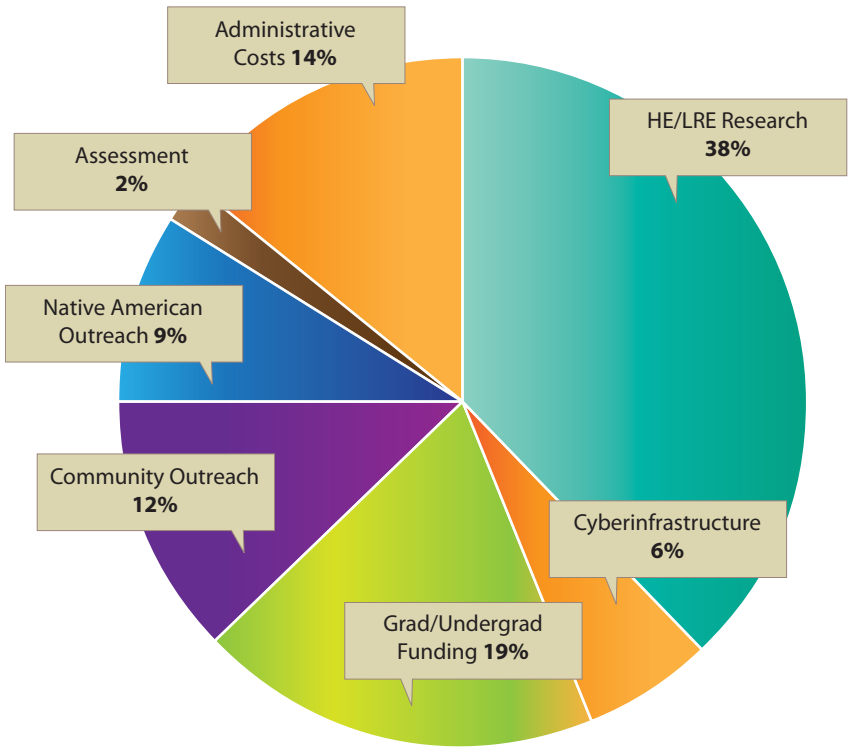
04/ OUTREACH

Montana EPSCoR has been very successful this year in developing education and outreach programs that communicate science to the public in innovative and interactive ways. EPSCoR expanded its scope of communicating with the public through print and electronic publications, specialized programs for children, girls, senior citizens, and Native American communities, and connections with teacher groups. The programs ranged from place bound and travelling exhibits, to interactive multimedia displays, to informal education opportunities. Tribal colleges in Montana also engaged in EPSCoR Large River Ecosystems research on their reservations.

Teacher Resources – partnership with RET teacher, NTEN

Lewiston Middle School teacher Suzie Flentie has taught hundreds of kids in her 30 years as a teacher. Now she is providing thousands of teachers with physics lessons through online classroom activities posted on the National Teachers Education Network (NTEN) site at http://btc.montana.edu/courses/aspx/lessons.aspx. With EPSCoR support, Flentie took the work she had done with Professor Yves Idzerda under an NSF-funded Research Experience for Teachers (RET) project during the prior summer and created self-contained modules that could be posted through Extended University's NTEN. The modules are now among the top downloads from the site and reach teachers across the country.

Middle school teacher Suzie Flentie in the lab of Professor Yves Idzerda at Montana State University. Dr. Idzerda studies the magentism of thin films, surfaces and nanoparticles. (MSU photos by Kelly Gorham)



Year 3 - Expenditure Distribution

04.1/ TRIBAL COLLEGE COLLABORATIONS

SIX MONTANA TRIBAL COLLEGES ARE CONDUCTING LARGE RIVER ECOSYSTEMS RESEARCH PROJECTS.

At **Chief Dull Knife College** located on the Northern Cheyenne Reservation in Lame Deer, MT students participate in a River Ecology, Field Sampling, and Microbial Identification class taught by Dr. Sergio Morales at UM via PolyCom – 460 miles away in Missoula. UM undergraduate student Cedric Jacobson is on-site at CDCK to help train students in microbiological research techniques for use in the field on the Tongue and Big Horn Rivers.

This year, the **Fort Belknap Community College** students and faculty involved in the LRE project presented their results to the Milk River Watershed Alliance. This group is interested in the work being conducted by Fort Belknap EPSCoR researchers on the Total Maximum Daily Loads of the Milk River and plans to follow up with their own research.

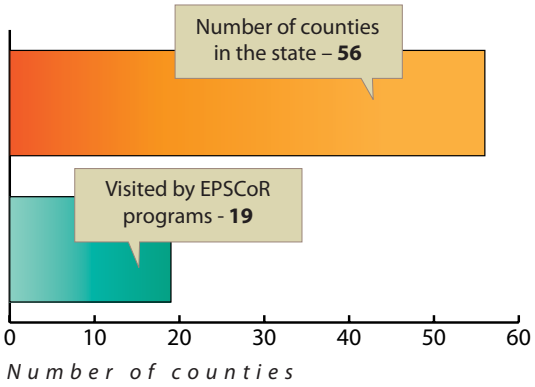
At **Salish Kootenai College** UM graduate student Shandin Pete works with students who are focused on Jocko River thermal and hydrogeological research survey results establishing permanent gauging stations.

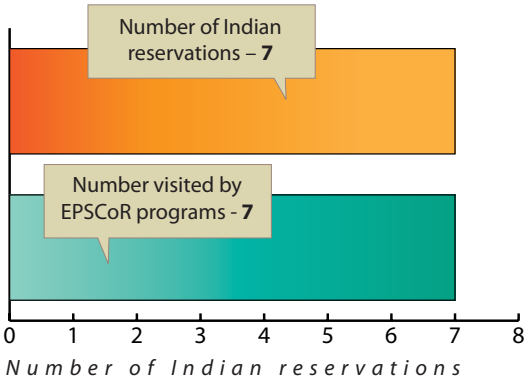
At **Fort Peck Community College** in Poplar, students have concluded that the brine plume being researched has reached the lower end of the Poplar River. They will continue to collect water samples monthly and record water flow at the 13 designated sites on the Poplar River to complete the project and analyze results.

Blackfeet Community College students continued daily monitoring during the summer of five sites along the Two Medicine River and Cutbank Creek. They collected data on water temperature, phosphate, nitrate, pH, dissolved oxygen, velocity and macro invertebrates. Data from the past two summers will be compared to the first, which provided the baseline data.

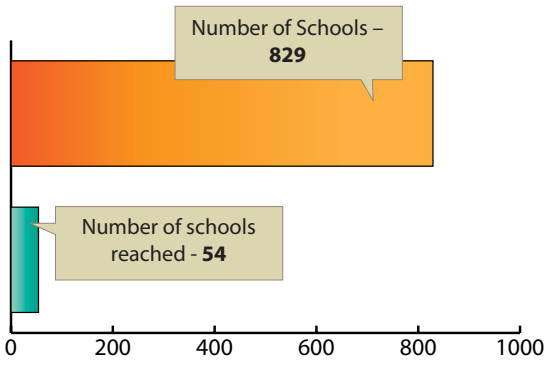
As part of the math and science curriculum, students at **Stone Child College** study the level of pollution tolerant and intolerant macroinvetebrates in the Marias River above and below the Tiber Dam.

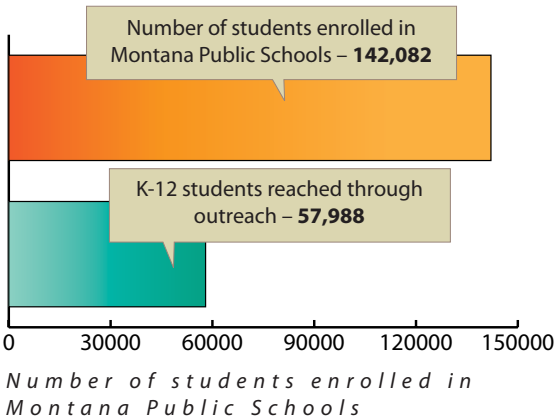
04.2/ ENHANCING **S T E M** EDUCATION AND UNDERSTANDING





EPSCoR outreach and education programs reached across the state of Montana.





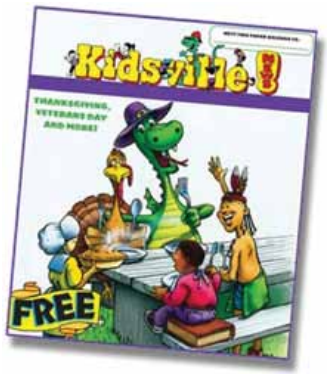
1) Tiara McGee, a high school senior from Highwood, MT, compares notes with Montana State University professor Mark Skidmore during a geology class as part of the Montana Apprenticeship Program. (MSU Photo by Kelly Gorham) 2) Kids enjoy science activities with The University of Montana mascot, Monte, at a science fair in Missoula sponsored by spectrUM.

MT EPSCoR outreach initiatives grew in scope this year, touching more Montanans and reaching educators all over the country. Through a partnership with MSU's Extended University, EPSCoR science was distributed through Kidsville News, a monthly publication distributed to over 50,000 school age Montana children. The SciZone articles featured hands-on, do-it-yourself science lessons based on research being done at Montana's universities and specifically the science lessons presented at MSU's Science Saturdays, another EPSCoR sponsored project.

The University of Montana's spectrUM Discovery Area shared hands-on science with 39,000 Montanans this past year through on-site and outreach programs. Last year, spectrUM provided on-site field trips to 4,000 K-12 students of whom 14.5% were Native American, 39% low income and 50% from rural settings. Additionally, spectrUM's traveling science exhibit, MosSE, visited six of Montana's Native American reservations, serving over 6,000 students.

MOLLI: Grandparents and Grandkids "Connecting the Circle" Science Day Camp: A two-day science camp for grandparents and their grandchildren allowed for multiple generations to interact in scientific exploration. Under the guidance of current UM faculty, experts in the community and spectrUM support educators, participants engaged in scientific exploration in the areas of Puppets and Robots, the Buzz about Bees, To Be a Paleontologist, and Fun with Stars.

GIRLTECH – a program through spectrUM supports collaborative, tactile learning and was selected as one of ten science museums in the country to partner with Public Broadcastings DragonFly TV SciGirls program.



(Left) EPSCoR sponsored a regular science activity feature in "Kidsville News" (Below) Screenshots of the "Hydrogen and the Environment" website which was publicized to science teachers through the National Science Teachers Association (NSTA).

Montana EPSCoR's new *"Hydrogen and the Environment: The Quest for Alternative Fuels"* multimedia website is online at http://hydrogen.montana.edu. At the Hydrogen and the Environment website, visitors can discover how Yellowstone extremophiles are playing a role in the search for alternative energy; learn the pros and cons of different forms of alternative energy; see the most common forms of hydrogen production; view a world map of extreme environments; navigate a map of Yellowstone extremophiles; see interactive 360-degree Yellowstone panoramic photos; meet many of the researchers and students involved; and download interactive videos and maps.

Clockwise from top: 1) Students from across Montana participate in the Lego Robotics tournament in Bozeman. 2) Participants in the Girl Tech Camp at The University of Montana. 3) Children enjoy the bubble table at spectrUM Discovery Area. 4) Visitors to the spectrUM Discovery Area learn about the fish native to Montana Rivers in the Wonders of Water exhibit.

Montana NSF EPSCoR

http://www.mtnsfepscor.org

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