MONTANA EPSCoR

IN REVIEW

January 2003, Issue 2

Dear Colleagues:

Welcome to the second edition of the Montana NSF EPSCoR newsletter. We are approaching the end of Year 2 of the three-year award, and the good news is that it will be difficult in this introduction to cover the number of successes that we can report on from the three participating campuses, Montana State University (MSU), Montana Tech and The University of Montana (UM). These successes translate into programmatic goals and milestones that have either been achieved or exceeded. In addition to "staying the course" in the program, we have been very pleased with the development of novel program initiatives in diversity and outreach that were initiated in this grant period. We are also delighted to have aided the science and technology learning and career development for a large number of Montana students at every educational level.

As many of you are aware, the goal of the Montana NSF EPSCoR is to enhance science, engineering and technology infrastructure in the state. The strategy chosen to achieve this goal centered on recruiting over twenty internationally competitive, science faculty at MSU and UM. The recruiting and hiring process is nearly complete and the impact of our new colleagues is already resonating nationwide. Much of the positive impact stems from the fact that these new faculty were hired into three core research areas, namely, nanotechnology, integrative analysis of complex biological systems and biomolecular structure and function. Because their research interests were targeted and focused, new collaborations and project overlaps became possible. As a result, more faculty, students and technical staff are working together driving a more productive research engine. These collaborations have resulted in more program projects being submitted to federal agencies and, more importantly, a greater number are being funded, for example, the Integrative Graduate Education and Research Training (IGERT) award at MSU and the Center of Biomedical Research Excellence (COBRE) at UM.

Through years of planned investment in people, (faculty, students and staff), equipment, resources and programs, the Montana NSF EPSCoR program, in collaboration with the State of Montana, is now harvesting the results and witnessing its important contributions to our institutional and statewide success. One representative indicator of this success is the increased number and amount of extramural grants awarded to MSU and UM. In 1998, MSU had $52M and UM had $20M in research and development (R&D) expenditures. By July 2002, (halfway through the current EPSCoR award), MSU had over $66M and UM had over $30M in R&D expenditures, an overall increase of $24M (33%) and projections from the MSU and UM grants and contracts offices indicate this successful trend is still increasing!

Intangibles - intangibles - intangibles. As a scientist, I cannot leave this introductory column without an 'observation,' the mainstay of discovery. IN REVIEW reports on our progress, updates program information and brings the people involved in our program to your desktop. What IN REVIEW cannot easily report in these pages are the favorable comments and personal reviews we receive from visitors of prestigious organizations and universities. Some select comments on research in Montana from these folks include: "state-of-the-art," "impressive and a complete surprise," "rising star," and "place to be." And, all of us already here agree.

We encourage you to visit the two Montana NSF EPSCoR websites at:
http://www.epscor.montana.edu
http://www.umt.edu/epscor/

Sincerely,

Chuck Thompson
Project Co-director

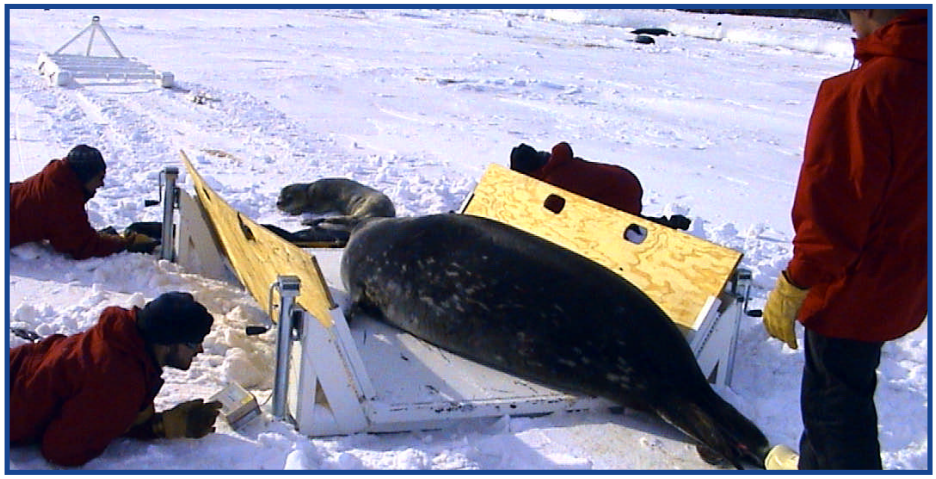
Patterns and Process: Dynamics of the Erebus Bay Weddell Seal Project

ROBERT A. GARROTT and JAY ROTELLA
Ecology Department
Montana State University

The Weddell seal inhabits sea-ice regions of Antarctica and is the southernmost mammal in the world. Field investigations of the species have been conducted annually for the past 34 years in McMurdo Sound, where the southernmost population of Weddell seals live. The study represents one of the

A newborn Weddell Seal in Erebus Bay during tagging operations.

longest intensive field investigations of a long-lived mammal in existence and offers the opportunity to gain unique insights into animal ecology and life in extreme environments. In the next few years, Dr. Donald Siniff, the person who has been the primary leader of this research program since 1968, plans to retire. Given our strong interest in this project, we worked in concert with Dr. Siniff to transition the Weddell seal research program to Montana State University. As a key step in this transition, we sought support from the Montana EPSCoR State Competitive Grant Program to aid us in preparing a competitive NSF proposal that would provide the essential funding for maintaining the long-term project and to incorporate several new research innovations. Support from the Montana EPSCoR State Competitive Grant Program was essential for



Researchers weighing a female Weddell Seal to obtain reference data for evaluating the utility of digital imagery for future studies of body-mass dynamics.

development of a strong NSF proposal. The resources requested were used to support summer salary and travel among potential collaborators required to perform preliminary analysis of the long-term databases, refine research questions, and prepare the full NSF proposal. The support also allowed us to develop prototype hardware and supporting software for digitally quantifying body mass of seals, which is a major emphasis of additional work on the seals. With EPSCoR support, we submitted and received funding (~$625,000) for a 5-year proposal to NSF's Office of Polar Programs (Biology and Medicine Area - Polly Penhale Program Manager). Having deployed to the Antarctic sea ice in October 2002, our research team, which included 4 students, has just successfully completed the 2002 field season. We tagged over 400 pups and recorded the presence of more than 500 returning animals. We are now mining the long-term database as part of comprehensive analysis and integration of the long-term demographic database using both traditional and recently developed analytical approaches. We are pleased that the transition has been so successful and feel privileged to be involved with research on such a fascinating animal in one of the world's most spectacular natural areas. To learn more, please visit our project website at: http://www.montana.edu/ecology/staff/garrott/antarctica/index.htm.

Researchers work their way through a crevassed area while surveying and tagging Weddell Seals in Erebus Bay.

Cross-Discipline Collaborations on the Rise

Today, as the world seems to be shrinking and the academic ponderings ever increasing, one finds inspirational examples of cross-disciplinary collaboration. A fine and well-publicized example is Dr. Robert Nash, the Princeton mathematician who was awarded, jointly, with John Harsanyi and Reinhard Selten, the 1994 Nobel Prize in Economic Science for his work on game theory. It is important to note that Nash has only taken one economics class in his life, yet created a mathematical equilibrium that is used by economists and other social scientists to make predictions about human interactions (i.e. candidates' election strategies, the cause of war or people's reactions to events). Wisely, the Nobel Prize committee recognized the cross-disciplinary contribution Nash made to economics, as well as to mathematics, academia and humanity.

As the world goes, so does The University of Montana. UM's NSF EPSCoR program has its eyes set on cross-disciplinary collaborations--the bringing together of UM science programs and other campus disciplines. As UM's NSF EPSCoR assistant to the director, Gay Allison, puts it, "We want to assist in the marriage [cross-disciplinary] of the liberal arts and the science disciplines. There is a real need to support all programs across campus. And, as long as they tie into one of our two grant directives: environmental science and biomolecular structure and function, we can help support them." Two years ago, NSF EPSCoR began working collaboratively with the Environmental Studies Department (EVST) to bring world-class speakers to the UM campus.

In 2001, EVST and NSF EPSCOR brought the widely known environmental justice activist, Lois Gibbs, to Missoula. In 1978, Ms. Gibbs, a housewife discovered that her child was attending an elementary school built on top of a toxic-chemical dump in Love Canal, New York. She founded the Love Canal Homeowner's Association, and struggled for more than two years for relocation of her community. The experience not only changed her life, but also led to the passage of the nation's Superfund Law and launched the environmental justice movement. Gibbs went on to found the Center for Health, Environment and Justice in 1981, an organization that has assisted over 8,000 grass roots groups with organizing, technical and general information nationwide.

While in Missoula, Ms. Gibbs met with an undergraduate EVST class, as well as led a training workshop for EVST graduate students. The highlight of her visit was a major public lecture delivered in the evening to an overflow crowd of more than 250 people-from across campus and around the wider Missoula community. Ms. Gibbs's visit garnered significant media coverage-with stories in all three of Missoula's newspapers, three radio stations and several local television networks.

Dr. Neva Hassanein, lecture organizer and EVST professor felt that, "This award had a tremendous impact on my teaching, as well as that of other faculty who also incorporated the training and lecture into their courses. The NSF EPSCoR funds were key to making these activities possible."

Once again, in 2002, EVST and NSF EPSCoR teamed up to bring two national experts in sustainability, Dr. David Orr and Dr. Matthis Wackernagel, to the UM campus.

Dr. Wackernagel, the sustainability Program Director of Redefining Progress, a national non-profit organization based in Berkeley, California, spoke to a full and excited audience on a cool night this past October, on his concept of "Ecological Footprints". He explained how his concept has introduced a new environmental and resource accounting tool, which clearly illustrates the connection between consumption and impacts on natural resources. Also, he hauntingly shared with the audience that his research seems to conclude that humanity's use of natural

Lois Gibbs

resources since the 1980s has now exceeded the regenerative capacity of the Earth. In closing, Wackernagel cited some everyday ways in which we humans can better care for our planet and for our future generations.

Then in November, Dr. David Orr, professor and chair of the Environmental Studies Program at Oberlin College, Oberlin, Ohio, spoke to an audience of 300 people about his recent work in ecological design. He shared with them about his efforts to design and build a $7.4 million Environmental Studies Center at Oberlin College, a building described by the New York Times as "the most remarkable" of a new generation of college buildings. The center is constructed from recycled resources, salvaged and certified sustainable managed wood. It's design includes: a reconstructed wetland, a greenhouse that houses the "Living Machine" that treats all wastewater from the buildings toilets and sinks, thermal wells that help in the heating and cooling, as well as high-tech solar panels. In the past, Orr has wondered if, "Is it possible to design buildings so well and so carefully that they do not cast a long ecological shadow over the future that our students will inherit?" But from the Environmental Science Center, "We now know that such things are possible--that buildings can be designed to give more than they take.", said Orr's.

NSF EPSCoR feels confident that this is only the beginning of an illustrious friendship with EVST, and hopes it can take part in other collaborations like this one. We, in the UM NSF EPSCoR program, feel certain that these relationships will spark further dialogue and innovative thinking. Which, who knows, may be the catalyst for another cross-discipline Nobel Prize!

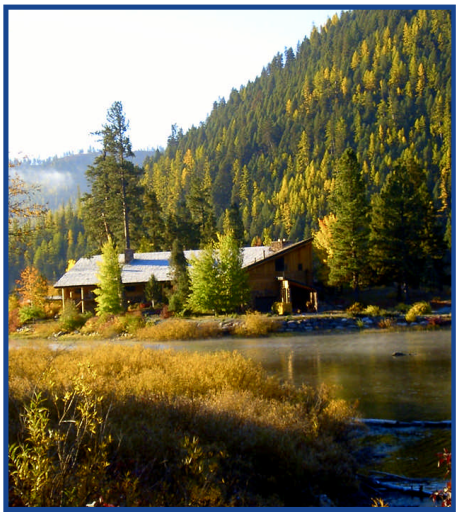
State Conference held in the Swan Valley

In Montana's Swan Valley lies a small lake that is surrounded on three sides by mountains painted with Larch and Ponderosa. Known as Salmon Lake, though no salmon grace its waters, it is home to an island, which houses The University of Montana's elegant conference facility Center at Salmon Lake. Where, this past October, the Montana National Science Foundation EPSCoR program hosted its 8th Annual Conference.

Morning slowly came to Salmon Lake, but by 9:00 am Saturday, October 12, 2002, many NSF EPSCoR State Competitive Grant Program participants (SCGP) had arrived by boat. They spent the first part of the morning sipping coffee and chatting about research with peers from The University of Montana and Montana State University campuses. NSF EPSCoR administrators, meanwhile, held a private meeting to discuss outreach to the local communities, science education, innovative research programs and numerous plans for the 2004 grant submission.

With the late morning approaching, SCGP scientists presented posters that detailed their current research topics. Small groups huddled around a

MSU's Dr. Mark Taper (left) at the poster session, collaborating with U of M's Dr. Marc Hendrix (right).



The U of M Conference Center at Salmon Lake.

poster while one researcher enthusiastically spoke, always pausing to explain complex details to scientists from other disciplines. As the poster session came to a close NSF EPSCoR new faculty hires began to arrive for lunch and the afternoon session. At lunch, a group of more than 30 people sat down and enjoyed the fine fare at the center laced, as always, with science conversation.

Following lunch, Dr. Mark Young, NSF EPSCoR Director (MSU) presented, to an audience of 35 people, on the Montana State University NSF EPSCoR funded Thermal Institute and its successes. Next, Dr. Chuck Thompson, NSF EPSCoR Co-Director (UM) gave a talk entitled, "Parting the Red Sea and Onto the Promised Land--An Example of a NSF EPSCoR Success Story". In his presentation, he highlighted NSF EPSCoR's critical role in the development of the newly created Center for Environmental Health Sciences (CEHS). He fully entertained the room with his multimedia presentation, which included footage of Charlton Heston's Moses, while at times wearing a rather biblical beard, and a clip from Star Wars). Needless to say, he had the room's full attention while touting the $18M CEHS grant awards that have sprung from the $1M UM NSF EPSCoR seed funding.

After a question and answer period, those attending turned their attention to the new faculty hires' posters, which were as equally enlightening as the earlier SCGP presentations. As the afternoon came to a close, some headed home, others sat and chatted with old friends and new acquaintances, and others boarded the conference center's boat for a tour of Salmon Lake.

Back on shore, Chuck Thompson reflected on the conference saying, "From start to finish, the state NSF EPSCoR conference showed in miniature size what has been happening at the state level; a collaborative environment dedicated to improving the science, technology and learning in Montana."

Personal Interest Story MSU Bozeman

Personal Interest Story
Dr. Yves Idzerda

NSF ESPCoR new faculty hires are making a difference at Montana State University. Building a core of cutting edge researchers is imperative for collaborations on highly competitive grants. Offering competitive wages is no small challenge to Montana State University, however the NSF EPSCoR state program has been able to assist in this regard.

One of our recent hires is Dr. Yves Idzerda, working as a Professor in the Department of Physics. Dr. Idzerda came to Montana State University after serving as the Head of the Artificially Structured Materials and Non-linear Physics Section of the Materials Physics Branch of the Naval Research Laboratory in Washington, D.C.

Yves was thrilled at the opportunity to bring his wife and three daughters to live in Montana. An opening coincided at the Medical Associates family practice, where his wife Sheila works as a pediatrician. Dr Idzerda said, "New faculty hires have made it possible to form a core group of people working together. This type of synthesis brings in a lot more than individuals. Funding group efforts has proven to be more effective and more productive than just supporting individual investigators." Dr. Idzerda enjoys the multidisciplinary side of working with other departments on campus. "This allows for a variety of research directions and prevents the possibility of investing too much time or money in a field that is perhaps dying. Collaborating with a variety of departments offers the opportunity to bring graduate students together, insuring that repetitive research isn't being done, or looking for new ways of approaching a research project".

An excellent example of this multidisciplinary group funding is the NSF sponsored Nanoscale Interdisciplinary Research Team (NSF-NIRT) that he heads here at MSU. This is a coordinated research program examining the application of protein and viral cages as templates for the synthesis of magnetic nanoclusters as new materials for ultra-high density memory and logic. It synergistically combines aspects (and researchers) of biology, chemistry, physics and virology.

Dr. Idzerda's other interests are in ultra-thin film and interface magnetism of itinerant electron magnetic systems, and in novel characterization techniques that have strong magnetic contrast. Part of his research includes exploiting polarized X-rays to obtain unique knowledge of the behavior of magnetic thin films and surfaces. Some of this research is performed at the MSU/NRL X-ray Magnetic Materials Characterization Facility located at beamline U4B of the National Synchrotron Light Source (NSLS) where he has been its spokesperson for this effort since its inception. For additional information, contact Dr. Idzerda at: Idzerda@physics. montana.edu

Prof. Idzerda transfers a substrate for magnetic thin film growth under ultrahigh vacuum conditions.

Personal Interest Story The U of M

Dr. Lisa Eby - New Faculty Hire in Wildlife Biology

2002 NSF EPSCoR new faculty hire, Dr. Lisa Eby, is a self-proclaimed lover of Montana's landscape, but this is not why she has relocated to Montana. Lisa came for the science and academics. As she explains, "The Wildlife Biology program at The University of Montana is a great program. It is unique in that it is a cross-campus program between the School of Forestry and the Division of Biological Sciences. Therefore, the program includes a mix of theoretical and applied aspects of ecology and conservation biology. In addition, The University of Montana has attracted a creative and collaborative group of great scientists."

Dr. Daniel Pletscher, chair of The University of Montana Wildlife Biology Department, when asked about hiring Lisa Eby stated, "We feel very fortuate to have attracted Lisa to our faculty position in the Wildlife Biology Program this year. Dr. Eby was the clear choice of the search committee in a field of formidable candidates. She brings a strong background in aquatic vertebrate ecology and experimental design to UM from her graduate work at Duke University and post-doc at Arizona State. EPSCoR, through assistance with her start-up package, was a key element in our ability to attract Dr. Eby to UM."

Before arriving at The University of Montana, Lisa worked on two projects with Dr. Bill Fagan, Department of Biology, for 9 months in a postdoctoral research position at Arizona State University. Lisa describes, "The first project involved examining long term monitoring data of a desert stream fish community in Aravaipa Creek, AZ. Native fish in the Southwest are declining due to destruction and alteration of aquatic habitats and the effects of introduced species. Until recently, Aravaipa Creek remained relatively free of non-native species and had a natural hydrograph. I was investigating how best to characterize directional change of the fish community in an intrinsically variable system, as well as examining potential driving factors on community composition, such as stream flow and exotic species."

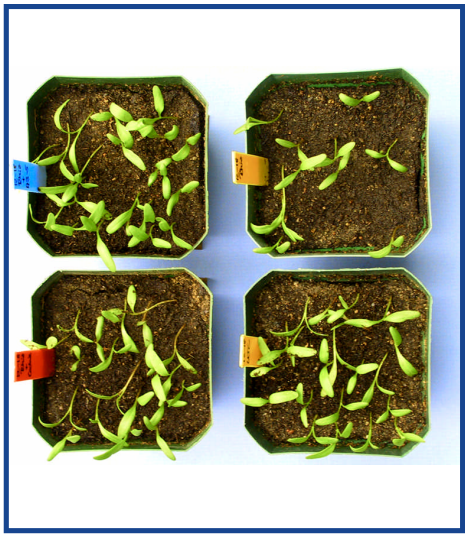
Even though Eby is now at The University of Montana, she continues to be involved in a second project with Arizona State University's Dr. Craig Aumann and Dr. Bill Fagan. Together, they are examining, "how alteration of the dynamics of habitat patches (size, structure, placement, edge, and duration) may alter species interactions and population dynamics. Human activities are rescaling habitat characteristics (e.g., temperature plumes, dissolved oxygen zones, and sea grass beds) in aquatic systems without much understanding of the

consequences. We plan to examine two aspects of this system, first whether predictions developed from ecological theory associated with patch dynamics typically developed in sessile and/or terrestrial communities hold for these systems, and second, how the fishery interacts with these spatial environmental dynamics."

Today, Lisa's general research interests include investigating how alterations to characteristics of watersheds influence aquatic vertebrate populations and communities and conversely how community change may alter the functioning of ecological systems. According to Lisa, "I try to combine observational, experimental and modeling approaches to understand these interactions in an effort to better inform conservation practices and fisheries management. There are a couple general areas that encompass my current projects: the role of dynamic aquatic landscapes on species interactions and populations and consideration alternative reproductive strategies in fisheries management."

Lisa has begun to settle into Missoula. She notes, "The things that I like most about Missoula are that it has a great farmers market, an active artistic community, lots of people on bikes, and great local breweries." As winter arrives in the mountains of Montana, Lisa has high aspirations to learn to ski. So, when you're on the slopes keep your eyes open for NSF EPSCoR's new faculty hire, Dr. Lisa Eby.

Endophytic fungi making volatile antibiotics



A new endophytic fungus: Muscodor albus placed in soil, protects plants from attack by soil pathogenic fungi. (controls are shown on the left)

Dr. Gary Strobel on tree walk near Denmark, SW Australia.

A conservative estimate of the number of fungi on our planet is 1.5 million. However, the number of species described is only in the range of 70,000 to 100,000. One of the major niches to be explored for novel fungi and their products is the diminishing rainforests of the world. Besides expanding the world's mycological collections and learning more about microbial biodiversity, an alternative compelling rationale to seek out these unique microbes is the prospect that they may offer promising new biological systems for solving major problems in medicine, agriculture and commerce. Several new fungi that are all related to each other and each producing volatile bioactive substances have been discovered in Strobel's lab at MSU. These organisms belong to the newly created genus Muscodor and at least three new species fit into this genus.

The story begins with a consultancy trip to Honduras in 1997. On a weekend I asked the officials sponsoring my trip if we could visit a local rainforest and pick a few tree samples that I may eventually examine for microbial endophytes. Ultimately, from the limbs of a Cinnamomum zeylanicum (cinnamon tree) we discovered a novel endophytic fungus (Muscodor albus). This fungus makes no spores and produces a stringy ropy mycelium. The most curious thing about this organism is that it produces, in culture, volatile compounds. These substances are both inhibitory and, for the most part lethal, to a broad range of pathogenic fungi and bacteria. While some fungal species are known to emit low concentrations of gaseous substances, especially ones that have distinctive obnoxious odors, and this has prompted a complete chemical analysis of the fungal volatiles of M. albus.. Thus, in spite of some attention being given to the volatile compounds of fungal cultures over the years, to our knowledge, no lethal mixture of volatile antimicrobials produced by fungi have ever been reported.

Ultimately, a system was found by Joe Sears (Chemistry -MSU) that effectively trapped the M. albus gases allowing for effective analysis by gas chromatography/mass spectrometry. Then, an artificial mixture of most of the putatively identified compounds was produced by both chemical synthesis and from chemical supply houses. A mixture of these compounds provided final evidence for the identification of the volatiles produced by this organism. Most importantly, however, this artificial mixture mimicked the antibiotic effects of the volatile compounds produced by the fungus. Each of the five classes of volatile compounds produced by the fungus had some inhibitory effect against the test fungi and bacteria, but none was lethal. However, collectively they acted synergistically to cause death in a broad range of plant and human pathogenic fungi and bacteria. The most effective class of inhibitory compounds was the esters, of which 1-butanol, 3 methyl, acetate was the most biologically active. A report published in a recent issue of "Microbiology" describes the ecological implications and potential practical benefits of the "mycofumigation" effects of M. albus.

M. albus has been used to find other relatives of this fungus including the newly described M. roseus, and M. vitigenus. These fungi make other volatiles that have biological activity. M. roseus, for instance, makes a mixture of biological antibiotics while M. vitigenus produces almost exclusively -naphthalene- an insect repellent.

The practical implications of these discoveries have been immediately realized by the Strobel lab. It appears that M. albus may have use as a methyl bromide replacement as a means to fumigate soils for the removal plant pathogens. Patents have been filed and licensing has been done by a California company-Agraquest and a Belgrade company, Phillips Environmental Products Inc. In the meantime, Drs. Nina Zidack and Barry Jacobsen are investigating the prospects of how to formulate and apply M. albus and make it useful to agricultural crops in Montana and California.

Thermal Biology Institute

The Thermal Biology Institute (TBI) at Montana State University-Bozeman was established in 1999 with some financial support from the Montana NSF EPSCoR Program. The mission of TBI is to carry out basic research to elucidate the unique physical and biological interactions that define life at high temperatures. TBI's close proximity to Yellowstone National Park provides TBI faculty, staff and students a unique opportunity for in-depth analysis of life at high temperature. TBI has created a multi-disciplinary and interactive research environment that combines the talents and expertise of physical and life scientists. TBI supports 11 major research projects that span from the discovery and cultivation of new high temperature organisms and viruses, to examination of unique plant-microbe interactions, to understanding the interplay between the geochemical environment and the diversity of life that exists at high temperatures. Recent NSF EPSCoR hires Drs. Trevor Douglas and John Peters have joined TBI, expanding TBI's interest in the chemical and structural basis of life at high temperatures. The results of TBI research have resulted in 26 publications in the past year in leading scientific journals and invited presentations at national and international meetings. All TBI faculty have nationally recognized and competitive research programs that are supported by grants from NASA, NSF, NIH, ONR, EPA and the USDA that exceed $9.4M (excluding TBI base support from NASA).

Thermal Biology Institute students investigating one of Yellowstone's 10,000 thermal features

The education and training of the next generation of scientists is a high priority for TBI. At all levels, from primary education to postdoctoral training, TBI is involved with education and training. Over the past year TBI research has engaged and supported twelve graduate students, seven undergraduates, seven postdoctoral fellows and three technicians in these research projects. These individuals are actively engaged in research and are the main driving force behind TBI's research success. TBI is striving to become nationally recognized as a top institute for education and training in thermal biology.

In the past year, TBI has greatly expanded its outreach efforts. This includes forming a partnership with the MSU Big Sky Institute to include thermal biology in its efforts to nationally expand K-12 math science education and to expand an understanding of science to the general public. Every year, TBI faculty, students and staff lead numerous Yellowstone field courses in thermal biology for the K-12 students and the general public. TBI faculties are activity engaged in working with the National Park Service to upgrade their interpretative materials addressing thermal biology for the approximately 3.0 million visitors to Yellowstone National Park each year. TBI is supporting TBI faculty efforts to write books for the general public about life at high temperatures. In the past year TBI faculty and research have been highlighted in articles in U.S. News & World Report, Science News, Astrobiology News, and stories/interviews aired by PBS, BBC, NPR and Belgium Public Radio.

TBI is an expanding institute. We look forward to even greater success in the future. Our objective for the upcoming year is to expand our portfolio of research projects, education and training programs and outreach efforts. Our goal is to become one of the premier national centers for study of life at high temperatures. The Montana NSF EPSCoR program has significantly contributed to the success of TBI.

TBI students and postdocs sampling in Yellowstone.

EPSCoR
Montana NSF-EPSCoR Office
315 Ag BioSciences Bldg
Montana State University
Bozeman, MT 59717