MONTANA NSF EPSCoR

Fall 2014

Montana University System STEM research and education news

Duck photo by Karen Nelson, US Fish and Wildlife Service in Helena; other photos by Amaya Garcia Costas

Microbiologist studies human impacts, remediation at Hailstone NWR

Few Montanans have heard of—let alone visited— **Hailstone National Wildlife Refuge**, a nearly 3,000-acre site located off a dirt road northeast of the town of **Rapelje**. The natural wetland is home to many species of birds and game, but the site has changed significantly since an earthen dam was installed by the Works Project Administration in 1938. Intended to increase habitat for migratory fowl, the dam, instead, channeled runoff from saline seeps in nearby hills into the new reservoir, which also became a repository for naturally occurring selenium deposits.

Meanwhile, developments in nearby dryland agriculture practices meant more highly saline water was flowing horizontally across the area, generating dangerously high concentrations of salts and selenium. The result was an ecological disaster. According to a report by the **U.S Fish, Wildlife & Parks**, in July 2002, "the Reservoir reached high enough selenium concentrations to cause salt encrustation on ducks landing on the reservoir, making them flightless, and eventually causing them to succumb to sodium toxicosis." The report led Defenders of Wildlife to label Hailstone as one of America's 10 Most Endangered National Wildlife Refuges in 2007.

The federal government took action in 2011, removing the earthen dam and beginning remediation work. **Jim Bauder,** a member of the MSU Land Resources and Environmental Sciences faculty (now retired), began working with **Robert Dunn** and **Laura Smith** of Bozeman-based **Westscape Nursery** to conduct a study on the soils and plants around the Hailstone Reservoir. **Russell Smith**, a restoration practitioner, also joined the research team while earning an MSU master's degree. LRES Professor **Cathy Zabinski** later joined the research team, and, along with Bauder was co-advisor for Smith, who has now graduated from MSU and remains working on the site through Westscape.

"One gram of soil has ***millions of organisms****"*

–EPSCoR researcher Amaya Garcia Costas

In 2013, an EPSCoR-sponsored MSU researcher is studying a different angle of the Hailstone situation: its microorganisms. **Amaya Garcia Costas**, an environmental microbiologist and post-doctoral researcher in the **John Peters** lab (see sidebar at right), is documenting the impacts of human activity and helping inform remediation efforts by using microbiology to determine what role the area's tiniest residents might play.

Garcia Costas's approach is two-pronged: she analyzes soil samples *in situ*—on site— to measure microbial diversity and paint an accurate picture of the current landscape. And, she takes soil samples from Hailstone back to MSU, where she isolates the micro-organisms. She hopes her research might one day assist land managers at Hailstone and other high-saline sites in choosing plants and soil treatments for reclamation, as well as introducing micro-organisms that can naturally precipitate out selenium and other minerals that are toxic.

continued on back page

Peters Lab launches DoE Center

John Peters, an IoE affiliate and head of the MSU lab where **Amaya Garcia Costas** (see story at left) is a researcher, received a $10 million, four-year grant from the **U.S. Department of Energy** to establish the BETCy Energy Frontiers Research Center. BETCy stands for Biological Electron Transfer Catalysis, and the research will involve harnessing the metabolic systems of microorganisms to meet the global demand for abundant, clean and economical energy. MSU's center is one of 32 EFRCs funded by the DOE. Partners include **the National Renewable Energy Lab, Arizona State University, Utah State University,** and the **Universities of Georgia, Kentucky and Washington**. Visit *http://eu.montana.edu/*

Montana NSF EPSCoR

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a National Science Foundation program to advance science and engineering capabilities for discovery, innovation and overall knowledge-based prosperity. EPSCoR catalyzes key research themes, activates effective collaborations, broadens STEM participation, and drives programmatic experiments that motivate positive change and progression. Montana EPSCoR's flagship research program is the Institute on Ecosystems (IoE), a statewide, university system-led effort dedicated to understanding the effects of climate change on sustaining healthy ecosystems and economic growth.
http://www.nsf.gov/od/iia/programs/epscor/

UPCOMING **EVENTS**

Wednesdays, September–December 10, 2014: Rough Cut Science. Join us Wednesdays at noon as faculty from the Institute on Ecosystems and partner organizations present their research in open seminar talks. Talks are hosted at MSU-Bozeman and Webcast at **http://montana.adobeconnect.com/roughcutscience** See schedule at **http://montanaioe.org/outreach/ioe-rough-cut-science-series**

Oct. 6, Mammoth Hot Springs, YNP. 12th Biennial Science Conference on the Greater Yellowstone Ecosystem. Crossing Boundaries -- Science, Management & Conservation in the Greater Yellowstone. This conference series has become the foremost scientific venue for researchers and management partners with a shared interest in understanding the geological, cultural, and biological resources of the region.

Nov. 3 and 5, Bozeman / Missoula. Distinguished Visiting Lecturer Series: Paul Robbins. Dr. Paul Robbins of the Nelson Institute, University of Wisconsin presents "Producing Wildlife in Montana, India and Beyond: Conservation in the Anthropocene." Robbins will speak at MSU on Monday, Nov. 3 and UM on Wednesday, Nov. 5. The talks are free and open to the public.

Nov. 7, Helena. The Montana Girls STEM Collaborative, an EPSCoR outreach program, presents its fall Collaboration Conference focused on professional development, networking and partnerships for STEM educators and professionals.

Montana NSF EPSCoR
PO Box 173142
Bozeman, MT 59717-3142
406-994-7658
mus-epscor@montana.edu

facebook.com/MontanaEPSCoR
Twitter: @MontanaEPSCoR and @MtIoE
Youtube.com/MontanaEPSCoR

EPSCoR webpage: mtnsfepscor.org

IoE webpage: montanaioe.org

This material is based on work supported by the National Science Foundation under Grant EPS-1101342. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PEOPLE IN THE IOE

EPSCoR director, IoE researchers named World's Most Influential Minds

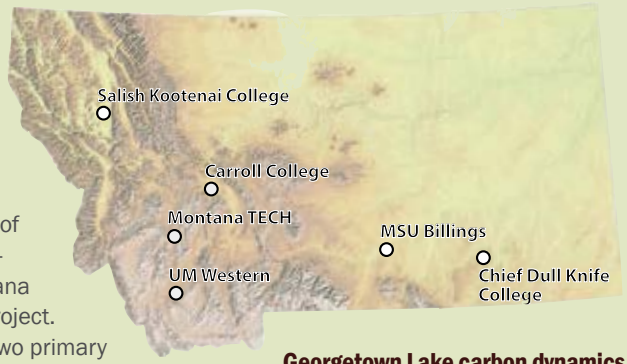
Montana EPSCoR Director **Ray Callaway** and University of Montana researchers and IoE affiliates **Steve Running** and **Gordon Luikart** are included in a recent list of 3,200 scientists and social scientists named "The World's Most Influential Scientific Minds." The publication, created by Thomas Reuters, Inc. analyzes researchers whose work has been cited most often by their peers. The report looks at high-impact work from 2002-2013, identifying academic papers that rank in the top 1% by citations for their field and year of publication. Callaway is a biology professor and Luikart is an Associate Professor of Conservation Ecology; both are listed in the Environment/Ecology Section of the publication. Running is a UM Regents Professor of Ecology listed in the Geosciences section.

IoE director receives E.O. Wilson biodiversity award

Cathy Whitlock, co-director of the Montana Institute on Ecosystems, was selected to receive the E.O. Wilson Biodiversity Technology Pioneer Award, which was presented by Wilson himself at an October awards ceremony at Montana State University. Whitlock was selected for her nationally and internationally recognized scholarly contributions and leadership activities in the field of past climatic and environmental change. Whitlock is a fellow of the American Association for the Advancement of Science, and her current research sites extend from Yellowstone and the western U.S. to New Zealand, Tasmania and Patagonia. The award was established by George Keremedjiev, founder and director of the American Computer and Robotics Museum in Bozeman.

IoE extends research projects across Montana

The Institute on Ecosystems announces seven new research project awards: competitively selected projects that extend the statewide research integration and impact of the IoE and in its implementation of the Montana NSF ESPCoR Track-1 project. Extending beyond the two primary research campuses, these projects address important topics related to microbiology, ecosystem processes and change, natural resource management, and ecological restoration. The following projects will be supported over the next year:



The Yellowstone Basin Advisory Council (BAC) and the science of vulnerability PI: Susan Gilberts, Montana State University–Billings

Upper Tongue River stream study PI: Mary Noel, Chief Dull Knife College

Chemical inhibition of bark beetle fungal symbionts PI: Kurt Toenjes, Montana State University–Billings

Georgetown Lake carbon dynamics in the water column and sediments PI: Steve Parker, Montana Tech

Understanding human and landscape responses to regional climate and environmental changes in central Montana Co-PIs: Lauri Travis and Patricia Heiser, Carroll College

Informing *Camas* restoration on the Flathead Indian Reservation: Adapting to climate change and invasive species PI: Robert Kenning, Salish Kootenai College

Wetland ecosystems and climate variability across two Montana National Wildlife Refuges PI: Michelle L. Anderson, University of Montana–Western

ICN Graduate student researches microscopic pioneers of ecosystem succession

by Sarah Castle, University of Montana

When glaciers recede, previously buried land surfaces are exposed that may have been uninhabited by life for thousands of years or more. Substrates closest to the glacial terminus are the youngest while substrates furthest from the terminus are older. In some cases, continually melting glacial ice creates an annually resolved age-gradient. Soil organisms quickly colonize these barren substrates and begin the long process of soil formation that ultimately leads to the development of mature ecosystems.

Bacteria, fungi, and soil animals are responsible for decomposing organic matter, mineralizing nutrients, weathering primary minerals, and, in some ecosystems, are responsible for a majority of primary production. Despite their importance, we know very little about how communities of soil organisms change with time during succession or whether the process happens differently in various parts of the world. That is to say, do all early successional microbial communities start out with the same community members conducting the same functions? Further, do early developing communities follow the same successional trajectories throughout ecosystem development?

Measuring how soil biota and the soil environment develop with time in these relatively simple deglaciated landscapes may help us to unravel the relationships between community structure and ecosystem function that may be otherwise obscured in more complex soil systems.

In order to understand the generality of microbial community succession, we have examined microbial community structure and function along glacial chronosequences in both North and South American continents. Each site is unique in climatic and soil edaphic characteristics that are known to have a strong influence on soil communities. We show that immediately following retreat, soil communities vary dramatically between the geographically distant sites. However, despite very different starting conditions, microbial communities become more alike through time and converge both in terms of which types of microbes are present and how they function. We suspect that this convergence is driven mostly by changes in soil chemistry, specifically changes in soil organic carbon chemistry, which are the result of increasing plant-derived carbon inputs as plants colonize these newly deglaciated lands.

Puca Glacier Chronosequence, Peru. Photo by Joey Knelman

Glacial retreat is one specialized type of ecosystem disturbance, but there are many other natural and human caused disturbances that influence microbial communities and their functions. The study of natural gradients may offer us some insight into how to maintain and restore degraded systems.

Sarah Castle is a PhD student in Cory Cleveland's lab (Soil Biogeochemistry) at the University of Montana. As part of the ICN, the Interdisciplinary Collaborative Network, she works with other graduate student researchers to address the need for transformative research by connecting Montana researchers from varying professional levels, universities, and disciplines. Visit interdisciplinarycollaborativenetwork.org

UM UNDERGRAD STUDIES WILDFIRE IMPACTS ON POLLINATORS

Wildfire is a common and prominent force that is constantly reshaping ecosystems in the Northern Rockies. The response of various species to wildfire has been heavily studied and is relatively well-understood. However, interactions among species after fire is a somewhat overlooked area of research.

Over the summer 2014, **Greta Hoffman**, a junior studying biology at UM, investigated the interactions of plants and pollinators (bees) in the **Coal Creek State Forest** area near **Glacier National Park**. She also incorporated data collected by other field crews in Paradise Valley and Helena National Forest. Her advisors are **Laura Burkle** (Ecology, MSU) and **Travis Belote** (The Wilderness Society).

According to Hoffman, specialist bee species such as *Anthopora porterae, Ashmeadiella bucconis*, and *Megachile brevis* tend to focus their foraging efforts on a few specific plant species. *Anthophora ursina*, *Ashmeadiella cactorum*, and *Megachile policaris* are generalist pollinators and commonly pollinate whatever flowers are available. When bees pollinate a flower, many pollen grains usually remain on their bodies. In the lab, Hoffman stained and analyzed the pollen grains using a microscope, allowing her to identify the plant species that each individual pollinator species had visited and therefore estimate the average fidelity of each species. By comparing these values across wildfire gradients, she could identify plant-pollinator interaction patterns that arise in response to fire in terms of foraging habits and species abundance.

UM student Greta Hoffman studied bee pollination patterns in fire-affected areas.

Hoffman said Nature has always fascinated her so she couldn't be more excited to spend her summer outside in the beautiful Montana wilderness. In her free time she likes to hike, read, backpack, and camp.

IoE faculty practice SciComms with Concerned Scientists & OneMontana

A Montana non-profit that seeks "what unites us rather than what divides us" worked with Montana Institute on Ecosystems faculty this summer to help the researchers better communicate their work to the public.

OneMontana, a statewide organization that bridges the rural-urban divide, worked with the **Union of Concerned Scientists** to offer the training. Faculty from both Montana State University and the University of Montana participated, discussing the backgrounds and values of various populations and practicing ways to describe their research using personal narratives and a focus on each audience member's perspective.

A young hydrologist takes water samples during an outreach workshop led in June by Water Center assistant director Stephanie McGinnis.

Montana Water Center joins IoE

The Montana University System Water Center, a statewide organization that advances water research, information, education and problem-solving partnerships, is now part of the Montana Institute on Ecosystems. The Center is one of 54 in the U.S. collectively known as the Water Resources Research Institutes. MWC's director is **Wyatt Cross**. Visit **watercenter.montana.edu**

EPSCoR-supported VISTA member serves Blackfeet community

An **AmeriCorps VISTA** member supported by Montana EPSCoR is serving the community surrounding **Blackfeet Community College**, fulfilling the VISTA mission of helping to end poverty with education, and building pathways to higher education for first generation and low-income Montanans.

Melissa Bremner, a graduate of BCC in Browning, has served since January, building the capacity of the college's Native Science Field Center by recruiting and supporting a cohort of student fellows, and helping establish partnerships and learning opportunities, including organizing a Water Summit at BCC. With Center director **Helen Augare**'s support, Bremner has worked with BCC's High School Fellows Institute, which engages native high schoolers in hands-on, immersive science learning in a college setting. Bremner supported student fellows in studying hydrology and traveling from Browning to the Hungry Horse and Kerr Dams, as well a wild bird sanctuary.

AmeriCorps VISTA is known as the domestic analog to the Peace Corps. "VISTAs" (as they are known) take an oath of service, and sign on for a year supporting a local community's work to end poverty. Montana EPSCOR and the Institute on Ecosystems partner with **Montana Campus Compact** (MTCC) to support the placement of AmeriCorps VISTAs with Montana tribal colleges. MTCC is a higher education network that includes Blackfeet Community College, **Salish Kootenai College** and 15 other public, private and tribal Montana institutions all committed to educating students for civic and social responsibility.

Melissa Bremner (left)

"Marissa has been a dedicated and hardworking VISTA," said MTCC Director Josh Vanek. "Her passion for connecting students with hands-on science learning opportunities is an inspiration!"

Microbiology research benefits Hailstone NWR (cont. from p. 1)

"The Hailstone site is like a black box," Garcia Costas said. "We know the inputs--nitrogen runoff, selenate and a lot of sulfate—and we know the outputs: what's coming out. But we don't know what's going on inside the box. We want to understand that and be able to manipulate that." Already she has discovered a diverse community of sulfate-reducing microorganisms and is cultivating several bacteria in the lab that can utilize selenate.

Garcia Costas collaborates with **Eric Boyd** in MSU's Microbiology Department and says the project has the potential to involve many more interdisciplinary scientists—from plant ecologists who could study the symbiosis between salt-tolerant plants and the microbes that live in their roots, to biological engineers who could cultivate the micro-organisms she has gathered and exploit their abilities to remediate the soil.

Tony Hartshorn included Hailstone on a northern Rockies soils tour as part of his MSU graduate class called Land Rehabilitation Field Problems (LRES 562), and **Stephanie Ewing** has investigated salinity effects in two areas: agricultural lands in the **Judith Basin** and another site at the **American Prairie Reserve** north of **Fort Peck Reservoir**. Both Hartshorn and Ewing are IoE affiliates in MSU's Land Resources & Environmental Sciences Department.

"Salinity is a problem in eastern Montana and Wyoming," said Garcia Costas. Other areas of the West—like California's San Jose Valley—face similar contamination issues as chemicals from agricultural runoff pool in low-lying basins and require reclamation strategies.

Garcia Costas said that, in addition to the excitement of researching such a microbiologically unique site, her involvement also has a personal connection. A native of Spain, Garcia Costas came to the U.S. as a high school exchange student, placed in the tiny town of **Reed Point**, less than an hour away from Hailstone NWR.

"At the time, I didn't understand the landscape and geography," she said. "Now that I'm a scientist, I can go back and hopefully help."