University of California, Merced
Sierra Nevada Research Institute
Annual Report
July 2010 –June 2011

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Cover photo: Seeing the individual trees, yet not missing the forest: Three-dimensional model of a Southern Sierra Nevada forest based on airborne lidar data acquired in March 2010. The high-spatial-resolution (sub-meter) topographic information, together with the location of individual trees, tree height, and crown sizes, are automatically extracted from the lidar data by novel algorithms developed by the UC Merced Spatial Analysis and Remote Sensing lab, lead by SNRI faculty member Qinghua Guo. These data are then used to reconstruct the virtual scene. Not only is the resulting image a close visual representation of the landscape, but it also contains the actual physical model of the forest.
Background

The mission of the Sierra Nevada Research Institute (SNRI) at UC Merced is to discover and disseminate new knowledge that contributes to sustaining natural resources and promoting social well being in the Sierra Nevada-Central Valley region, and related regions worldwide. SNRI accomplishes its mission by:

- Fostering interdisciplinary research that focuses on the Sierra Nevada eco-region, including the Central Valley and other adjacent areas.
- Facilitating synergistic links between science, the arts, education and natural resource management.

SNRI was part of the original 1997 Academic Plan for the UC Merced campus, and UC Merced’s first partnership with resource managers, Yosemite and Sequoia-Kings Canyon National Parks, were formed that same year. The founding Director of SNRI (S. Traina) joined UC Merced in 2001; additional faculty and research scientists joined SNRI in 2003. R. Bales became SNRI Acting Director in 2007 and Director in 2008. SNRI has maintained its inaugural focus and the regional identity envisioned in its original prospectus. In 2007 SNRI became UC Merced’s first, and still only, UC Organized Research Unit (ORU). SNRI adopted bylaws in May 2008.

Membership

During academic year 2010-11, 27 UC Merced faculty were members of SNRI, and 26 research scientists affiliated with SNRI. The faculty have affiliations in the three Schools, and with seven of UC Merced’s nine graduate groups and programs. Faculty members for 2010-11 were:

- Andres Aguilar
- David Ardell
- Roger Bales
- Michael Beman
- Asmeret Asefaw Berhe
- Elliott Campbell
- Yihsu Chen
- Martha Conklin
- Michael Dawson
- Benoit Dayrat
- Henry Forman
- Caroline Frank
- Teamrat A. Ghezzehei
- Qinghua Guo
- Tom Harmon
- Stephen Hart
- Kathleens Hull
- Robert Innes
- Teenie Matlock
- Valerie Leppert
- Peggy O’Day
- Wolfgang Rogge
- Samuel Traina
- Anthony Westerling
- Roland Winston
- Jeff Wright

The SNRI advisory committee, appointed by the Executive Vice Chancellor, consisted of S. Hart (chair), A. Westerling, K. Hull, T. Harmon, H. Forman and one outside member, D. Graber (National Park Service).

Research highlights

SNRI faculty and researchers published over 70 papers in 2010-11; and nearly 60 graduate students were working with SNRI faculty. Selected highlights of work published during the 2010-11 academic year follow. Note that SNRI faculty and researchers have projects and publications focused within the Sierra Nevada and surrounding valleys and in other areas.

- Steven Hart and colleagues investigated how severe wildfire affects decadal-scale carbon fluxes in forested soils, and found much lower carbon dioxide release and methane uptake at burned versus unburned sites; overall, less carbon was available for respiration at the burned site (Biogeochemistry, Jul 2011).
- Andres Aguilar found that genetic variation in the vernal pool fairy shrimp (Branchinecta Lynchii), broadly distributed throughout California's Central Valley, indicates geographic limits to colonization and local diversification; suggesting that conservation/restoration efforts should recognize the geographic limitations to population structure for this species and focus on local endemic genetic variation (Aquatic Sciences, February 2011).
- Lara Kueppers and colleagues transplanted recently germinated seedlings from a subalpine-forest elevation and canopy gradient into the alpine zone, and found forest genetics to be important to understanding and managing species' range adjustments due to climate change (Tree Physiology, June 2011).
Roger Bales and colleagues, using spatial measurements of catchment-scale water balance in a mixed-conifer Sierra Nevada forest (Southern Sierra Critical Zone Observatory), found significantly higher rates of evapotranspiration than previously assumed; implying that seasonal water storage in deeper regolith is a very important source of water for both trees and stream baseflow (*Vadose Zone Journal*, August 2011).

Teamrat A. Ghezzehei and colleagues reported that in soils, natural root-induced compaction increases contact areas between aggregates, leading to an increase in unsaturated hydraulic conductivity of the soils adjacent to the roots; implying that contrary to intuition, water flow may therefore be locally enhanced due to root-induced compaction (*Environmental Science & Technology*, January 2011).

Qinghua Guo and colleagues found hyperspectral reflectance of the vegetation canopy in a Central Valley alkaline wetland to be a good indicator of the apparent electrical conductivity of the underlying soil, and thence plant stress and potential community structure changes (*International Journal of Remote Sensing*, 2011).

Thomas Harmon and colleagues investigated the adaptive management of soil salinity in relation to irrigation with reclaimed water, demonstrating the potential for real-time sensors coupled with an optimization model to limit salinization of soils (*Journal of Environmental Management*, October 2011).

Michael Dawson and colleagues investigated how hydrologic variability, linked to global-scale climate indicators, was manifest in isotopic signatures in lipids in marine lake sediments; and determined that global temperature and irradiance signals were quite distinct (*Quaternary Science Reviews*, April 2011).

Teenie Matlock studied the wording of political messages and its effect on voting behavior, finding that subtle differences in grammar influenced whether people thought a political candidate would be reelected (*Political Psychology*, August 2011).

Peggy O’Day and colleagues investigated arsenic contamination along a transect of groundwater monitoring wells at a site of active remediation, finding mobilization of arsenic by microbial processes, but losses immediately downgradient of the treatment site, apparently due to uptake by soils (*Applied Geochemistry*, January 2010).

Samuel Traina and colleagues studied methods for remediation of mercury-contaminated sediments, finding that the combined technique of ultrasound and alga biomass was effective (*Chemosphere*, May 2011).

Tony Westerling and colleagues analysis of how the occurrence, size, and spatial location of large fires might respond to climate projections in the Greater Yellowstone ecosystem predicted substantial increases in fire by midcentury, with fire rotation (the time to burn an area equal to the landscape area) reduced to <30 y from the historical 100-300 y; and further predicting that the new fire regime will transform the flora, fauna, and ecosystem processes in this landscape and may indicate similar changes.

Press outing at Southern Sierra Critical Zone Observatory.
− Benoit Dayrat investigated the diversity of various onchidiid marine slugs in the Eastern Pacific, finding that fewer valid, nominal species than previously reported; and finding highest rates of endemism in the Galapagos (Journal of Natural History, 2011).

− Valerie Leppert and colleagues, investigating the role of iron in silica-mediated respiratory toxicity, determined that at a low noncytotoxic dose of silica, the presence of iron significantly increased superoxide, lipid peroxidation, lipid raft disruption, and cytokine production in macrophages (Free Radical Biology and Medicine, September 2011).

− Henry Forman and colleagues studied the electrophile response element essential for regulation of many genes involved in protection against toxic agents, finding specific flanking and internal nucleotides that were more important for function than previously described (Biochimica et Biophysica Acta-Gene Regulatory Mechanisms, July 2010).

− Asmeret Asefaw Berhe and colleagues found that despite low microbial abundances and activities in permafrost soils, respiration per unit soil C was higher in permafrost compared with active layer soils, suggesting that decomposition and heterotrophic respiration may contribute to a positive feedback to warming of this eco region (Global Change Biology, 2010).

− Roland Winston and colleagues developed a comprehensive metric for evaluating the performance of nonimaging concentrators, based on the laws of thermodynamics and all known losses in efficiency (Optics Express, April 2010).

− Andrea Joyce (SNRI research scientist) and colleagues investigated genetic variation in populations of parasitoid wasps which reduce moth populations in corn crops in Kenya. Two genetically divergent populations were found using molecular markers (Entomologia Experimentalis et Applicata, 2010)

Grants

SNRI faculty and researchers continue to be very productive in obtaining grants, largely from federal and state agencies. Averaged over a four-year period, awards to SNRI faculty amounted to 41% of total campus research awards. Several of the research projects are collaborative with colleagues from other campuses and government research organizations, significantly expanding the impact of SNRI. Following is a summary of awards by year.

<table>
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<tr>
<th>Item</th>
<th>Amount per FY, dollars</th>
<th>Percent of total</th>
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<tr>
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<td>07-08</td>
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<tr>
<td>Extramural grants</td>
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<tr>
<td>Research grants</td>
<td>16.4</td>
<td>14.2</td>
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<tr>
<td>Research grants to SNRI faculty</td>
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*aDoes not include $2.25 million award to R. Winston for California Solar Technology Institute (48% of research grants with that award)

Yosemite Field Station at Wawona

The mission of the SNRI Yosemite Field Station (YFS) is to facilitate synergistic links among science, education, resource management, and the arts. YFS is dedicated to the idea that it is the interconnections among different programs and researchers that makes an “institute” more than the sum of its parts. To achieve this mission, the SNRI Yosemite Field Station provides logistical support (office space, internet access, lab and classroom space, and housing) for research, education, and collaborative workshops inside Yosemite National Park (YNP). It also provides programmatic support by acting as a
liaison between the university and the science and education divisions of Yosemite. But most importantly, the YFS manager plays an active role in connecting the dots among people and programs to create opportunities for synergies and collaborations. Housing is also consciously equipped to enable social gatherings that facilitate interaction among station users scattered in different houses. Without this engagement, we would just be a collection of individuals and programs working in isolation and too busy to talk to one another.

The SNRI Yosemite Field Station functionally opened its doors in March 2006 with the arrival of its first Station Manager. It is now a vibrant learning community with a critical mass of students (high school, undergraduate, and graduate), researchers, professors, and artists. It has also transformed the sleepy village of Wawona with an infusion of young, creative energy. In summer the station regularly houses over 40 high school, college, and recently graduated students in full-time residence.

These developments have had an important impact on the success of UC Merced. The partnership with Yosemite is critical for developing UC Merced’s unique image and standing in the entire UC system. As a new campus, UC Merced cannot ‘compete’ with other UC campuses, it must be unique. The partnership with Yosemite National Park is just that. The YFS is the first concrete, tangible manifestation of the official partnership and MOU with Yosemite. It has transformed a polite handshake (i.e., MOU) into tangible programs that impact real people and produce real products for both the campus and the park. Many students matriculating to UC Merced now express that the unique programs at YFS played an important role in their decision to choose this campus. YFS has also increased UC Merced’s visibility in the UC System as the highest profile new reserves in the UC Natural Reserve System (see NRS Transect article profiling YRS). Not only is YFS helping put UC Merced on the national map, but it has already left a profound mark on the history book of Yosemite itself. The Yosemite Conservancy has gone from skeptical giving to support UCM to now highlighting YFS programs as the flagship of their “Youth in Yosemite” project in their official magazine. NPS top administration in Washington DC is turning to YFS as a national model for University-NPS partnerships for transforming and rigorously engaging youth. In all these cases, it is the synergies among programs that are providing examples that captivate the imagination of what is possible. UC Merced and Adventure Risk Challenge high school students are now featured speakers at fund raising events from the Yosemite Conservancy to the Southeast Asian-American Professional Association.

YFS is formally the main node in the Sierra Nevada Natural Reserve, which although administered through SNRI has formal reporting to the UCM Vice Chancellor for Research. The SNRI Director continues to serve as the faculty manager for the Sierra Nevada Natural Reserve, though in the future these functions could be split.

**Staffing.** As part of being designated a part of the UC Natural Reserve System, the UCM Chancellor affirmed in writing long-term staff funding to manage and operate the SNRI Yosemite Field Station. Current positions include:
With its large deck and sweeping vistas, the Landsnaes House serves as a hub for visitors and events at the YFS.
– Joyce house – 3 bedrooms, 2 bathrooms, 9 beds, phone and internet.
– Dull house – 3 bedrooms, 2 bathrooms, 9 beds, phone and internet. No heat - Summer use only.
– River Rd. cabin – 1 bedroom, 1 bathroom, 2 beds, phone and internet. Basement converted into a maintenance workshop and storage area.
– Bruce Rd. cabin – 1 bedroom, 1 bathroom, 2 beds. No phone or internet. NEW IN 2011 – This cabin now has heat and can be used in winter.

Total housing capacity of SNRI YFS is 42, not including the Station Director’s residence. YFS frequently leverages other resources in the Wawona community:

– Boyer house – Managed by Yosemite Conservancy. 2 bedrooms, 1 bath, 4 beds. YC has generously allowed us to use this house for students participating in the Yosemite Leadership Program summer internship.
– Wawona Elementary School – The school has generously allowed us to use the entire school and to set up a tent camp behind the school to support our main high school summer program - the Adventure Risk Challenge. English literacy and leadership training for 10-12 underserved Merced County students.

– Wawona Community Center can accommodate meetings of up to about 80 people.
– Wawona Hotel Sunroom can accommodate meetings of up to about 75 people and has generously been donated by DNC for use in our annual open house.
– Wawona Hotel Restaurant has generously supported our annual open house by catering the event.
– Heidi’s Catering is a local, excellent caterer available for visiting groups to host dinners in YFS housing.

The main facilities Improvements for 2010-11 were made possible by a $20,000 grant from the UC Natural Reserve system to add heat to the Bruce Cabin, replace old and unreliable furnaces in the Livingston house, add backup power to Livingston, furnish the Livingston common room, and repair decks that were damaged in winter storms. Eric Berlow and co-PIs were awarded a $410,000 NSF grant through the Academic Research Infrastructure program to renovate the historic stable adjacent to the office building and convert it into high quality research space. Construction is anticipated to be complete before the summer 2012 field season.

Station use. Annual Station use in 2010-11 was slightly lower than the previous year, in part due to an unusually stormy winter and cold spring that resulted in Yosemite’s snowpack being up to 300% of the long-term average in some parts of the park (Figure 1). Many group trips had to be cancelled and many researchers had to postpone fieldwork into July. We also switched our system for tracking use and did not track well temporary day use (groups or individuals that used the facility but did not spend the night). Thus, after 3 years of rapid growth in response to increased housing, YFS annual use in 2010-11 leveled off at approximately 6000 user days. The station is now consistently operating at maximum capacity in summer. The main room for growth now is in the shoulder seasons and in winter. Most of this use comes from weekend field trips and workshops. But there is generally no long term use in winter.
In FY 2010-2011, SNRI YFS was used by researchers, students, and other professionals from a wide variety of organizations and institutions. The primary categories of use were research, education, and academic or lab retreats/workshops.

**Institutions and Organizations that used YFS in 2010-2011**

**Universities**
- UC Merced
- UC Berkeley
- UC Davis
- UC Santa Cruz
- UC Santa Barbara
- San Francisco State Univ.
- Stanford University
- Naval War College, Monterey CA
- York University, Toronto, Canada
- Universidad Católica, Santiago, Chile

**Organizations**
- US Geological Survey
- US Forest Service
- National Park Service
- California Department of Water Resources
- Lawrence Berkeley National Laboratory
- National Center for Ecological Analysis & Synthesis
- Microsoft Research
- Yosemite Conservancy
- Pacific Ecoinformatics & Computational Ecology Lab
- Dandelion Dance Theatre Co.
- Skoll Global Threats Fund

**Public agencies**
- Merced Union High School District

**Educational programs.** While the Yosemite Field Station was originally intended to be primarily a physical space that facilitates investigator-initiated projects or class field trips, we have capitalized on opportunities to run multiple integrated programs that have now become a flagship for UC Merced’s unique and creative contribution to Yosemite and to underserved populations of the Central Valley. Each program has an individual identity, but the key to success has been the added value of synergistic interactions among them. The broader vision for these educational programs is an integrated, intergenerational youth leadership program creates a pipeline of students at different stages from early high school to recent graduates and graduate students. These programs have been highlighted in various media outlets:
— Yosemite NP website [http://www.nps.gov/yose/naturescience/meadows.htm](http://www.nps.gov/yose/naturescience/meadows.htm)
— ARC was among the 20 success stories to be highlighted in the official [International Year of Biodiversity Countdown 2010](http://www.countdown2010.net/files/MADE_IN_C2010.pdf) publication. We were the only North American organization highlighted in the document [http://www.countdown2010.net/files/MADE_IN_C2010.pdf](http://www.countdown2010.net/files/MADE_IN_C2010.pdf)
— NPS Videos: [http://www.youtube.com/watch?v=0AEXtDNH_4M](http://www.youtube.com/watch?v=0AEXtDNH_4M)

High School programs in AY 2010-11 included:

— *Adventure, Risk, Challenge (ARC)* – ARC is a year-round educational outreach program that partners UCM and Yosemite with public high schools and underserved communities of the Central Valley to engage English language learner (ELL) high school students. A 6-week immersion summer course at the SNRI YFS integrates a rigorous curriculum of outdoor education, leadership training, English literacy, and science. ARC addresses the needs of underserved ELL students and enables them to be successful high school students, highly competitive college applicants, and ultimately our next leaders. The program continues with outreach throughout the academic year, both at the schools and also through monthly weekend workshops at YFS. Explicit program integration with the UC Merced Yosemite Leadership Program students stimulates ARC students’ interest in going to college, and UC Merced in particular. After attending ARC, 92% of the students pass the English language arts portion of the high school exit exam, compared to 40% of English language learners state-wide.

— *Robert Fore Fellowship (Merced Union High School District, MUHSD)* – This program is provides training workshops in Yosemite for 16 high school science teachers in the MUHSD. The teachers learn about ongoing research by SNRI, USGS, and Yosemite National Park researches. They discuss issues at the interface of science and conservation, and share ideas about how to incorporate new material into their lesson plans.

Undergraduate programs in AY 2010-11 included:

— *Yosemite Leadership Program (YLP) undergraduate summer internship* – This program provides UC Merced undergraduates with diverse internship opportunities in Yosemite that range from serving as bilingual interpretive rangers, to working on meadow restoration crews, to saving lives as part of the Yosemite Search and Rescue team, to creating a greenhouse gas emissions inventory for the Delaware North Companies (DNC) operations. Not only does this program provide an incredible diversity of
opportunities, but it has also been enormously successful at catalyzing stronger relationships between UC Merced, YNP, DNC, and the Yosemite Conservancy (YC). Both the ARC and YLP programs were embraced by both YNP and YC as flagship youth programs in the park. The YLP internship in Yosemite fulfills one requirement of the 2-year extracurricular environmental leadership certificate program on campus. All students participate in a 2 credit Environmental Leadership Seminar (see below) where they complete an independent project that contributes something unique to the park branch or organization in which they are working. This project then serves as a seed for the ‘capstone legacy project’ required for their environmental leadership certificate. In 2011 this program expanded to Sequoia-Kings National Parks where there were 6 UC Merced students working for the summer in these parks. Five of these students worked in various NPS positions. One student worked for the Sequoia Natural History Association.

– Research Experience for Undergraduates (REU) Program – Funded by the National Science Foundation, this program complements the YLP non-science internships by providing opportunities for undergraduates to conduct independent research projects at the interface of science and natural resource management. Most of the students are co-mentored by a UCM professor and a member of their research group; a park or USGS scientist is also involved in most projects. REU student projects are serving as a catalyst for collaborative research between UCM and the park. The grant supporting this program ended in August 2010 and it is a priority to submit a renewal proposal to continue the program in future years.

– Environmental Leadership Seminar – Both YLP and REU students enroll in this 2-credit summer seminar. This seminar includes: 1) weekly lectures by inspiring people who represent diverse leadership roles and styles, 2) weekly workshops that engage students to explore leadership issues specific to environmental issues, and 3) independent projects that lead to a final public presentation at a SNRI Student Symposium in Yosemite Valley.

Two graduate educational programs were hosted at the YFS:

– SNRI Scientific Visualization Fellowship (SciViz) – This fellowship provides 3 months of housing at YFS and a $1500 stipend to support up to three artists interested collaborating with scientists or creatively communicating scientific information. In 2011 there were four SciViz Fellows: One scientific illustrator, a professional writer, a multi-media artist, and a digital media specialist. We have been in discussion with DNC to explore options for selling SciViz Fellow art in the hotel gift shops – in addition to supporting the artists, this would provide more exposure for SNRI programs in the park.

– NRS Mathias Grant – Three UC Merced graduate students were awarded a Mathias Grant to support their dissertation research in Yosemite: 1) Kaitlin Lubetkin (Lara Kueppers lab) on conifer encroachment of meadows, 2) Chelsea Arnold (Asmeret Asefaw Behre and Teamrat A. Ghezzei labs)
While each of the programs described above is outstanding in its own right, it is the interactions and synergies among them that really stand out and have brought them to the attention of the media and donors. Some highlights are described in the following paragraphs.

Bilingual UC Merced YLP interns actively mentor ARC high school students on their writing during the summer, assist ARC instructors to tutor ARC students at their high school during the academic year, and host ARC students for visits to the UC Merced campus. In the process, going to college becomes a tangible dream for ARC students, and it motivates them to improve their language and writing skills to become highly competitive college applicants. At the same time, YLP students are thrown into true leadership roles as they give back tangibly to their community. Some YLP students have led ARC students on outdoor adventure trips as part of their ‘capstone legacy project’ – in the process YLP students are trained by ARC instructors on outdoor risk management for leading high school student groups. A number of YLP students express that their life path has been transformed by their experience mentoring ARC students, and each year, one YLP student returns as a teaching assistant for the summer ARC immersion course.

Scientific Visualization Fellows work with YLP, REU, and Ph.D. students to encourage them to communicate creatively about their work. This includes working with the students on scientific illustrations, video production, graphic design, writing, presentation slide layout, etc.

Research. Several research projects used the Yosemite Field Station as a base for part or all of their work in 2010-11, including the following:

- Sierra Nevada Adaptive Management Project (SNAMP) – a long-term collaborative project among UC Merced, UC Berkeley, UC Davis and the US Forest Service to evaluate the ecological and environmental impacts of fire control thinning practices. SNAMP researchers spent the winter at YFS tracking and photo-trapping American Fisher.
- Sierra Nevada Hydrologic Observatory – a Sierra-wide, UC Merced SNRI-led initiative to improve understanding of the hydrological dynamics that determine much of the water supply for California.
- Effects of Prescribed Fire on Spotted Owls – A USGS project to understand how management fires in Yosemite influence the food base and breeding success of the endangered California spotted owl.
- Climate Change and Amphibian Decline – A growing collaboration among UC Merced, YNP, and USGS scientists to understand the relative importance of climate and other impacts to Yosemite toads (Bufocanorus), a California species of Special Concern.
- Natural Resources Condition Assessment for Sequoia-Kings Canyon National Parks – USGS and UC Merced scientists based at YFS are contributing to this ambitious interdisciplinary effort to evaluate the state of knowledge for SEKI natural resources.
- Yosemite Invertebrate Biodiversity – This work by UCM Assistant Professor Benoit Dayrat uses DNA ‘Barcoding’ techniques to help quantify and characterize for the first time the broad scale patterns of aquatic invertebrate biodiversity in Yosemite.
Alpine Lake Microbial Ecology and Biogeochemistry – UCM Assistant Professor Mike Beman is exploring how air pollution from the Central Valley is impacting alpine lake ecosystems.

The following individual graduate student research activities were carried out in Yosemite in 2010-2011:

- Lara Kueppers – Ph.D. student Kaitlin Lubetkin is investigating conifer encroachment of subalpine meadows.
- Steve Hart – Graduate Student Steven Lee is investigating early warning signs of catastrophic shift to meadow plant communities in response to anthropogenic and environmental stress.
- Carolin Frank – Ph.D. student Alyssa Carrell is investigating endosymbiotic microbes associated with conifers that are encroaching meadows
- Asmeret Asefaw Behre and Teamrat A. Ghezzehi – Ph.D. student Chelsea Arnold is investigating the effects of drying that is expected to accompany future climate conditions in the Sierras on meadow water holding capacity.
- Benoit Dayrat – Is investigating aquatic invertebrate biodiversity as indicators of Yosemite Toad breeding pool quality
- Andres Aguilar – Recently received funding in collaboration with USGS scientists to investigate population genetics of Yosemite Toad (Bufo canorus) populations in Yosemite and Sequoia-Kings Canyon National parks.

Outreach. Multiple activities took place in the outreach area:

- UCM Admissions: The Yosemite Field Station and YLP interns are used as ‘poster children’ for UCM to illustrate the unique educational opportunities available at UCM. YFS programs and the partnership with Yosemite are commonly cited as a critical factor in why many students chose to go to UC Merced.
- UC AGEP, LEADS, and BA STAR Programs – UC Alliance for Graduate Education and the Professorate, and the Basic and Advanced Science and Technology Academics of Research programs are using the SNRI Yosemite Field Station as part of their summer program to increase the recruitment of minority students into graduate programs in science. UC Merced YLP interns lead these students on a tour, and YFS station director spoke with them about research in the park and research career options. This year we had students from both UC Merced and UC Davis programs
- UCM courses that used the SNRI Yosemite Field Station in 2010-2011: Snow Hydrology (R. Rice), Ecology (S. Hart), ESS 198 Science Fridays (E. Berlow).
- Earthdance Environmental Film Festival – SNRI Yosemite Field Station facilitated a screening in Yosemite of this “Short-Attention-Span” Environmental Film Festival, curated by the Oakland Museum of California. [http://earthdancefilms.com/](http://earthdancefilms.com/).
- YLP student projects have made significant outreach contributions

Snow pit being dug as part of high school outing, spring 2011.
to Yosemite including: 1) creating a bilingual podcast for Spanish speaking visitors, 2) creating educational videos for Half Dome trail hikers to reduce the number of annual casualties, 3) creating educational videos for park visitors to understand ecological restoration, 4) creating educational videos and fact sheets to education park visitors on Leave No Trace rules, 5) creating an incident map for the Half Dome trail that alerts hikers to hazards along the trail, 6) creating brochures to education park visitors about invasive plants and non-native fish, 7) serving as poster-kids for increasing diversity in the NPS workforce, 8) creating an interactive DVD for training future park interpretation staff on guiding tours of the Mariposa Grove, 9) creating a science journalism video explaining the frontiers of park research on the role of fire in carbon storage.

– Open House: YFS hosted the Yosemite community, Yosemite upper management, NPS top administration from Washington, UC Merced administrators (including the new chancellor), and past and potential donors for the annual SNRI YFS Open House at the Wawona Hotel. ARC and YLP students shared their experiences, and YFS station director presented an interdisciplinary science-art collaboration about research on Yosemite meadows and threatened amphibians. The event was generously catered by Delaware North Companies.

– YFS continues to support YNP staff by managing UCM Affiliate Accounts for online access to the California Digital Library.

Healthy working relationships around mutually beneficial activities are an important component that SNRI helps to nurture. Some recent activities included:

– Improved UCM-Yosemite relations by developing collaborative student projects that address immediate high-priority park needs.

– Increased awareness on campus of SNRI research and education programs by organizing and hosting SNRI retreats, increasing the visibility of YLP student interns on campus, and regularly sending news/updates about SNRI programs to the UCM media department.

– Interacting with media outlets about YFS programs

Priority needs. The rapid increase in station housing capacity and station use in the past two years has created a vibrant interactive community at YFS during the peak season. However, the available functional workspace and meeting space has not kept pace with the demand. In addition to supporting the YFS programs and researchers, there is a strong interest in also providing some work space for YNP and USGS researchers to facilitate research collaborations that are at the core of SNRI’s broader mission. To help meet this demand, we submitted and were awarded a National Science Foundation’s Academic Research Infrastructure: Recovery and Reinvestment (NSF ARI-R²) grant to fully renovate the entire detached building into a year-round Informatics and Data Visualization Center. Completing these renovations before June 2012 is our top priority for facilities improvements this year.
There are two priority needs related to house improvements and deferred maintenance. First, the Dull House has no heat and thus limits our ability to accommodate large groups in the shoulder season. An estimate for adding heat to the Dull house is ~$10-15,000. Second, the deck of the Landsneas house needs to be replaced. An estimate for this is ~$20-25,000. Given that the deck is used to host SNRI events, its current state reflects extremely poorly on the quality of UC Merced, SNRI, and YFS.

**Sequoia Field Station at Wolverton**

The SNRI presence at Wolverton, in Sequoia National Park, includes a small cabin with 3 bunks, leased from the Park, and a nearby workspace (former ski shop) that Delaware North Companies has made available for our research programs. This facility is under the same reservation system as is used for YFS, to enable managing it as another node in our field station program. Although use in 2010-11 was not tracked through this system, the calendar for the facilities shows that it was used most weeks in the summer half year, and at least twice a month in the winter half year. During 2010-11 3 faculty, 3 graduate students and one postdoctoral researcher affiliated with SNRI used it as a base for their research. Several outside collaborators also used the facility, including from UCLA and UC Berkeley.

**Environmental Analytical Laboratory**

**Mission.** SNRI is responsible for the operation and administration of the Environmental Analytical Laboratory (EAL), a campus-wide multi-user facility that serves essential analytical resources and plays a critical role in support of research and education programs in environmental, biological, Earth systems, and ecological sciences and engineering. It also serves campus users in other disciplines not closely related to SNRI. The mission of the EAL is to provide expertise in analytical applications and access to advanced instrumentation to facilitate research and education programs and foster inter- and multi-disciplinary collaboration among campus researchers. To achieve this mission, the EAL provides campus researchers with high quality, timely and affordable analytical service through its reliable, well-
maintained research-grade instrumentation, established standard operating procedures (SOPs), comprehensive user training, online reservation, technical consultation, and dual recharge billing system. The facility supports self-operation instrument use, sample drop-off service, new project and grant proposal assistance and technical consultation. The purpose of the EAL core facility is to make expensive but frequently needed instrumentation available and affordable to campus researchers by employing a sustainable operation and management model in further support of research and education activities.

**Capabilities.** The EAL is equipped with an array of state-of-the-art instrumentation and sample preparation equipment located at S&E I Room 201. The EAL advanced instrumentation offers rapid and accurate measurements of major and trace elements, organic and inorganic compounds to meet a wide range of analytical needs in support of diverse research and education programs in environmental, chemical, biological, the Earth systems, and ecological sciences and engineering. The following is a list of the major instruments and their capabilities:

1. **Agilent 7500ce ICP-MS.** The Agilent 7500ce Inductively Coupled Plasma Mass Spectrometer is a high performance quadrupole mass spectrometer that offers ultra-low detection limit in ppt range and high sample throughout for multi-element analyses in solution samples. The system can be coupled to a liquid chromatography for speciation studies.

2. **Perkin-Elmer Optima 5300 DV ICP-OES.** The Perkin-Elmer Optima 5300dv is a dual view Inductively Coupled Plasma Optical Emission Spectrometer that offers detection limit in mid-ppb range and wide elemental capabilities. Its ease-of-use software and high sample throughout makes it a powerful tool for multi-element analyses in relatively high concentration samples.

3. **Perkin-Elmer AAnalyst 600 GF-AAS.** The Perkin-Elmer AAnalyst 600 Graphic Furnace Atomic Absorption Spectrometer with AS 800 Autosampler provides general use with major and trace element analyses.

4. **Varian Saturn 2200 Ion Trap GC-MS.** The Varian Saturn 2200 Ion Trap Mass Spectrometry coupled with CP 3800 Gas Chromatography is a bench top GC-MS that offers quantification and characterization for trace levels of low molecular organic compounds in environmental and biological samples.

5. **Shimadzu TOC-Vcsh Total Organic Carbon Analyzer.** The Shimadzu TOC-Vcsh system is a PC-controlled, high-sensitivity model used to measure dissolved carbon and nitrogen (with optional TNM-1 Total Nitrogen Measuring Unit) contents in liquid samples. Carbon contents in solid samples can also be analyzed with optional SSM-5000A Solid Sample Module.

6. **LachatQuikChem 8500 Flow Injection Analyzer.** The Lachat QuikChem 8500 system uses reliable and accurate Flow Injection Analysis (FIA) technology and features high sample throughout and simple, rapid method changeover in determining ionic species from sub-ppb to percent concentrations. Our system includes 10 modules for measurement of low and high levels of ammonia, nitrate/nitrite, phosphate, silicate, and sulfate in a variety of sample matrices.
7. **Dionex ICS-2000 Ion Chromatographs (two sets, one is for anions and the other for cations).** The Dionex ICS-2000 Reagent-Free Integrated Ion Chromatography System provides analytical capabilities for major anions and cations in a variety of sample types. Applications include anion analysis of F, Cl, SO4, Br, NO3, PO4 and cation analysis of Li, Na, K, NH4, Mg, Ca.

8. **LGR DLT-100 Liquid-Water Isotope Analyzer.** The DLT-100 Liquid-Water Isotope Analyzer version 2 provides an accurate measure of hydrogen and oxygen isotope ratios in liquid water samples. The system uses tunable, off-axis integrated-cavity laser spectroscopy developed by Los Gatos Research.

Additional sample preparation and separation devices include:

9. **Anton Paar Multiwave 3000.** The Multiwave 3000 is a versatile and powerful microwave sample preparation system that meets many sample preparation needs such as Drying, Evaporation, Acid Digestion, UV-Digestion, Oxygen Combustion, and Solvent Extraction.

10. **Millpore ELIX 10 and Mill-Q A10 Water Purification System** for high quality deionized water.


12. **Other accessories** include analytical balance, oven, centrifuge, sample freezer & refrigerator, etc.

**Facility operation.** Year 2010-2011 marks the EALs second year of operation at UC Merced main campus, and also the second year on recharge. With improvements in operation, documentation, online reservation, and upgrades of lab hardware and software, the EAL this year became a fully functional core facility, with a streamlined and cost-efficient operation model. Great efforts have been taken to ensure that the facility operates to best serve our users with high quality, timely and affordable analytical service to meet their project needs and expectations. Procedures that have been employed to achieve this goal include:

- Instruments and laboratory equipment are tested and calibrated periodically
- Maintenance is conducted according to manufacturer guidelines and in accordance with the relevant standard operating procedures (SOPs) to optimize operating conditions to provide users with reliable, well-maintained instruments
- Inventories of consumables and relevant parts are updated and reordered frequently to avoid any unnecessary instrument downtime
- Software and hardware are updated when necessary.
- Laboratory method Sops, instrument operation checklists and troubleshooting tips are well documented and reviewed periodically for updates
- New instrument applications and method developments are studied and introduced to benefit users with increased productivity and reduced costs
- User requests on technical assistance and project consultation are responded timely and informatively
- EAL staff provide very fast turnaround time for drop-off service.
- Comprehensive training materials are prepared and synthesized for user training and offered to users year around with no charge
- Close attention and follow-ups are practiced routinely to ensure best instrument performance and data quality while avoid unexpected instrument damage.
Recharge rates are posted online at [http://snri.ucmerced.edu/snri/eal](http://snri.ucmerced.edu/snri/eal). Users have their choice of either a per hour or per sample rate. Drop-off services available for certain instruments offer users flexibility and convenience.

**Facility use.** The EAL user base has expanded over the past two years. More than 50 graduate, postdoctoral and undergraduate students have used the facility. A number of graduate students’ thesis work relies on EAL instrumentation. In 2010-2011 facility use was similar to the previous year, with use relying heavily on research funding and the varying stages of graduate student and postdoctoral projects. This year, five new graduate students and three new postdoctoral research scientists began their work using the EAL, and several frequent users from last year either graduated or moved on to new positions. The EAL recharge during the 2010-2011 fiscal year was about $29,000, versus $65,000 during the 2009-2010.

In addition to research use, EAL instrumentation supports undergraduate and graduate teaching. UCM courses that used EAL in 2010-2011 included ESS 170 (Soil Science Laboratory); ES 298 (Techniques in Soil Ecology); CHEM 115 (Instrumental Analysis and Bioanalytical Chemistry). A seminar course in Advanced Instrumental Analysis and an Environmental Mass Spectrometry course may be offered by EAL personnel as needed. This year, five undergraduate student research assistants participated in faculty research projects using EAL instrumentation.

Training, technical support and consultation are provided to undergraduates, graduate students and postdoctoral researchers. As the only comprehensive resources that focus on analytical instrumentation and service at UC Merced, the EAL plays an important role in user training in support of research and teaching. Operated mainly in a self-operation mode, user training and follow-ups are crucial to ensure that instruments are operated and maintained properly, and that calibrations and samples are prepared correctly. Since users come from different fields with little or no analytical chemistry background, our hands-on instrument training and our training in analytical theory, including sampling protocols, sample preparation and storage, calibration and method selection, quality-assurance/quality-control protocols, provide users with critical knowledge and practical details to help ensure the data quality.

**Research and education activities.** EAL is used in support of research by faculty, graduate students and research scientists, and in support of undergraduate education. Following are some research examples from 2010-11:

- In a study on application of ultrasound to investigate the mechanical stability of aggregates, the ICP-OES was used to determine Ca, Al, Fe, Mg, and Mn concentrations in aqueous media extracted from soil samples and TOC analyzer for measurement of dissolved organic carbon contents.
- A project using nutrient-enriched biochar for improving soil productivity and carbon sequestration was supported by three EAL instruments. Major cations and anions, organic carbon and nitrogen, as well as nitrate and ammonium concentrations were respectively measured using IC, TOC analyzer, and Flow Injection Analyzer.
A research project aimed at developing remediation technologies for Hg contamination in natural systems used a number of instruments, including the ICP-MS, ICP-OES, TOC analyzer and multiwave digestion system. The work involved studying the effectiveness of amendments by measuring Hg and other major metal concentrations, and characterizing the chemical composition of the sediments/soils. Results thus far show success in application of cement amendments for reducing bioavailability of Hg in natural sediments by co-precipitating with secondary mineral phases from cements.

A new project supported by DOE aimed at understanding molecular mechanisms and quantifying the kinetics of microbial anaerobic nitrate-dependent U(IV) and Fe(II) oxidation has begun to use a number of analytical tools, including ICP-MS located at EAL. By studying the biotic and abiotic mechanisms underlying the related processes, long-term effects of in situ reductive immobilization of uranium at a few DOE sites will be revealed.

An NSF-funded project aimed at monitoring long-term changes of ultra-low ion species in Greenland surface snow and snow pits accounts for most use of IC. The funding also allows one undergraduate student researcher to work in the EAL for assistance in sample analysis.

In addition, three researchers have benefited from a full analytical service provided by the EAL for identification and quantization of certain trace metal impurities in different complicated matrices using ICP-OES.

Facility management and development. All instruments were operated and maintained as scheduled, with no major repairs in 2010-2011. Minor hardware repairs, updates and additions included:

- The Millipore ELIX 10 Water Purification Pretreatment System was broken after 7 years’ service. Extensive part replacements resumed it to working condition
- The DLT-100 Liquid-Water Isotope Analyzer was updated to its new version with improved accuracy and throughput.
- A few more modules for Lachat applications were added to expand its use.
- The EAL website was updated periodically to reflect new changes.

Technical support. The EAL continues to work with researchers by providing technical support to facilitate research and collaboration across campus. Through in-depth knowledge and extensive skills in a broad variety of instruments, the EAL manager has been able to work effectively with diverse groups of students, postdoctoral researchers and faculty members to provide technical expertise and consultation in identification of appropriate analytical methods, preparation of method sections of a number of grant proposals, preparation of preliminary results for potential funding opportunities, and development and verification of a few new methods and applications.

Priority needs. The facility operation faces multiple challenges. As instruments become older more repairs are needed; we have no reserve for instrument repair or replacement. Meanwhile, costs of service contracts and consumables increase every year and recharge revenues fluctuate on a year-to-year basis, depending on the user base. Since recharge became effective in 2009, the

Closeup of inductively coupled plasma-mass spectrometer (ICP-MS) in EAL.
revenue generated has helped offset costs for facility operation. The EAL needs to continue to expand its user base, and transition in part to operations supported by recharge, with base support for the full-time EAL manager.

National Parks Institute

The National Parks Institute is a collaborative venture of UC Merced and the National Park Service that provides an annual international leadership seminar for Public Land managers from around the world. Focused on “Leading Strategic Change”, this management development curriculum for park and public land managers, promotes scientific research in parks, fosters stewardship, and promotes and develops environmentally sustainable resource management practices. It was introduced by Congress in 2003 under legislation (HR 1289) sponsored by California congressmen George Radanovich (R-Mariposa) and Dennis Cardoza (D-Merced). SNRI faculty provide academic leadership for development of NPI programs.

In 2010 the second NPI Executive Leadership Seminar was offered, bringing together 28 national parks leaders from around the world for an intensive 11-day program designed to improve attendees’ ability to anticipate change, innovate and manage strategically. The seminar began April 27 at the Institute of the Golden Gate in San Francisco, moved to UC Merced on May 3, and concluded with several days in Yosemite National Park. Several SNRI faculty led segments within the NPI seminar. The keynote speech was given on the UC Merced campus by Edward O. Wilson, Professor Emeritus, Harvard University. Former President Jimmy Carter was the first key note speaker for this leadership seminar.

The Executive Leadership Seminar is now an annual event, with SNRI being the academic home for this and other programs under the umbrella of the National Parks Institute.

Planning and development.

A five-year SNRI business plan was prepared in 2010-11, and will be distributed in fall 2011. It provides a vision for development activities to support SNRI programs, and provides recommendations to transition much of the SNRI budget from general university funds to other revenue sources.

A strategic plan and a business plan for an over 6000-acre Campus Reserve Site to be used for research, education and conservation activities. Faculty from UC Merced and other campuses have contributed to the strategic plan. Launching of the Campus Reserve will involve hiring a manager/director and preparing an NRS proposal within the next year.
SNRI continued development of a field station in Sequoia-Kings Canyon National Park, and through agreements with the Park and the park concessionaire (Delaware North), make use of two buildings at Wolverton. This is also a target of development activity.

SNRI continues to plan for NSF’s NEON investments in research infrastructure at the San Joaquin Experimental Range, Kings River Experimental Watersheds and other locations in the southern Sierra Nevada. Additional NSF investments are expected in the 2011-12 timeframe.

SNRI's Development Director and the SNRI Director had a number of meetings over the year with potential donors and supporters of SNRI. These meetings included scheduled meetings of the UC Merced Foundation Trustees, Chancellor’s Associates meetings, and 2-3 individual meetings per month.

The SNRI Director also worked closely with UC Merced’s government relations staff to promote SNRI research and potential infrastructure investments with elected officials at the state and federal levels. The SNRI director also participated in frequent meetings with officials in multiple state and federal agencies around research and potential infrastructure investments in the SNRI region.

SNRI also supports multi-investigator proposals for research support, and made frequent use of the grant writer in UCMs Office of Research.

Operations and budget

SNRI staffing in 2010-11 consisted of an administrative assistant, management services officer, YFS director, YFS maintenance coordinator, EAL Director, Director of Development and SNRI Director. The Yosemite Field Station maintenance manager position has been upgraded from 0.5 to 1.0 FTE for the current year by reducing the commitment of the YFS director from 1.0 to 0.75 FTE. The EAL director was 0.5 FTE on university funds and 0.5 FTE on an NSF grant for initiating the laboratory through most of 2009-10. As that grant has now ended, it is expected that for 2010-11 the 0.5 FTE for the EAL director will be covered by carryover funds from 2009-10. SNRI employs a part-time undergraduate assistant, who works in both the EAL and the SNRI office. One development director (0.75 FTE) works on opportunities and priorities for SNRI.

The SNRI budget is growing through recharge, which will cover additional costs at the field stations and analytical laboratory. Note that this revenue source just became available in early 2009, coinciding with field station and analytical laboratory resources becoming available for recharge. It is expected that recharge income will grow gradually over about a 5-year period, as demand for SNRI resources increases.

SNRI continues to be responsible for 8 vehicles, 7 of which are used on a recharge basis and one assigned to the Yosemite Field Station director. One of the recharge vehicles is assigned to the Critical Zone Observatory field hydrologist. The vehicles include:

- 2009 Subaru Forester: 100803
- 2007 Honda Element: 100621
- 2008 Nissan Xterra (CZO): 100801
- 2006 Honda Element (Wawona): 100619
- 2007 Toyota Tacoma extended cab: 100706
- 2007 Toyota Tacoma crew cab: 100709
- 2007 Nissan Frontier crew cab: 100708
- 2005 Chevrolet Silverado extended cab: 100504

Priorities for next year

Yosemite Field Station
- Complete upgrade of historic stable building and construction of laboratory space.
- Work out longer-term staffing plan, including replacement of career manager (current manager leaving in fall 2011), and addition of an educational coordinator.
- Explore options for larger meeting space, to help build up non-summer use of facility.

Sequoia Field Station at Wolverton
- Consolidate management functions and budget for existing facilities.
- Formalize agreement with DNC.
- Continue development activities to build up field station facilities and staffing.

Campus Reserve
Initiate development activities to implement strategic vision and business plan.
Hire Reserve Director and engage an SNRI faculty member to continue developing the reserve.

**Environmental Analytical Laboratory**
- Continue to grow facility capabilities, use and recharge income.
- Develop sustainable funding model involving a mix of recharge, indirect cost and state funds.

**NEON-Southern Sierra Transect**
- Continue NEON planning, in anticipation of infrastructure investments beginning in 2011-12.
- Expand development activities for research building for NEON and CZO at Dinkey Mill

**San Joaquin Valley**
- Initiate research activities aligned with the San Joaquin Restoration Project
- Continue working with partners to develop a long-term presence on valley rivers

**Tulare basin**
- Continue to work with local stakeholders on program building
- Explore development opportunities for Tulare Basin research and long-term presence including development of this site as a part of the UC Reserve system

**SNRI on campus**
- Expand development activities around graduate fellowships and research support
- Continue to explore opportunities for an SNRI building
- Develop a strategy for SNRI naming opportunity
- Continue to work with schools and graduate groups for strategic growth of UC Merced
- Strengthen collaboration among faculty, researchers, graduate students, and partners.
- Expand administrative support to better serve needs of SNRI faculty and research scientists

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