National Park Service
U.S. Department of the Interior

Sequoia and Kings Canyon National Parks

Science Symposium: Sequoia & Kings Canyon National Parks

November 9-10, 2016

ON THIS PAGE
Photograph of symposium participants listening to a talk at Saint Anthony Retreat, Three Rivers, California.

ON THE COVER
Photographs from top left to bottom right: Bullfrog Lake from Kearsarge Pass, Kings Canyon NP (Joan Dudney); Crescent Meadow, Sequoia NP (Evan Wolf); burned forest in Yosemite National Park's Illilouette Creek Basin (Scott Stephens); Sierra Bighorn Sheep ewe being released (California Department of Fish and Wildlife); and mountain yellow-legged frogs (Roland Knapp).

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National Park Service
Sequoia and Kings Canyon National Parks
47050 Generals Highway
Three Rivers, California 93271

This report is available in digital format from:
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National Park Service. 2017. Science Symposium: Sequoia and Kings Canyon National Parks. November 9-10, 2016. Three Rivers, California.

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Acknowledgments

This symposium was supported by funding from Sequoia and Kings Canyon National Parks and the Sierra Nevada Conservancy with in-kind assistance from Sequoia Parks Conservancy. We appreciate the participation and contributions of all who attended the symposium.

Acronyms

ACI	Acoustic Complexity Index
ALS	Airborne Laser Scanning
Bd	*Batrachochytrium dendrobatidis*
CZO	Critical Zone Observatory
FRID	Fire Return Interval Departure
GLO	General Land Office
LiDAR	Light Detection and Ranging
NAPAP	National Acid Deposition Assessment Program
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NEPA	National Environmental Policy Act
NPS	National Park Service
ROVs	Remotely Operated Vehicles
SEKI	Sequoia and Kings Canyon National Parks
SIEN	Sierra Nevada Network (Inventory & Monitoring Program)
SNBS	Sierra Nevada Bighorn Sheep
USGS	U.S. Geological Survey
VA	Voronoi Area
WNS	White Nose Syndrome (bat disease)
YOSE	Yosemite National Park

Introduction

Purpose for Symposium

The National Park Service Centennial was an opportune time to host this science symposium, to celebrate the history of science, learn more about current work, and look toward the future of research in the parks. The Sequoia and Kings Canyon National Parks Science Symposium organizers aimed to:

CELEBRATE the strong relationships between land managers, scientists, and research community;
COMMUNICATE recent research results and current resource issues in the parks;
CONSIDER the next 100 years of park research.

The park staff seeks to expand scientific collaborations and partnerships to address challenges posed by climate change and other resource threats, and to encourage and support more research within these parks to further scientific knowledge and inform management decisions.

Overview

The symposium took place November 9-10, 2016 at Saint Anthony Retreat in Three Rivers, California, about four miles outside of Sequoia National Park. At total of 126 people registered for the symposium, and 114 attended. Of the attendees, approximately 43 percent were affiliated with the National Park Service, 31 percent with universities or colleges, and just over 10 percent with other federal or state agencies. The remaining 15 percent included non-profits, educational organizations, and unaffiliated individuals (Figure 1). In addition to scientists and park resource managers, the attendees included numerous park staff, partners, and others who interpret science and park resources to public audiences and who engage youth in science and the outdoors (e.g., park interpreters, Sequoia Parks Conservancy staff, county outdoor educators, and institutes that provide science support to parks and internships to young people).

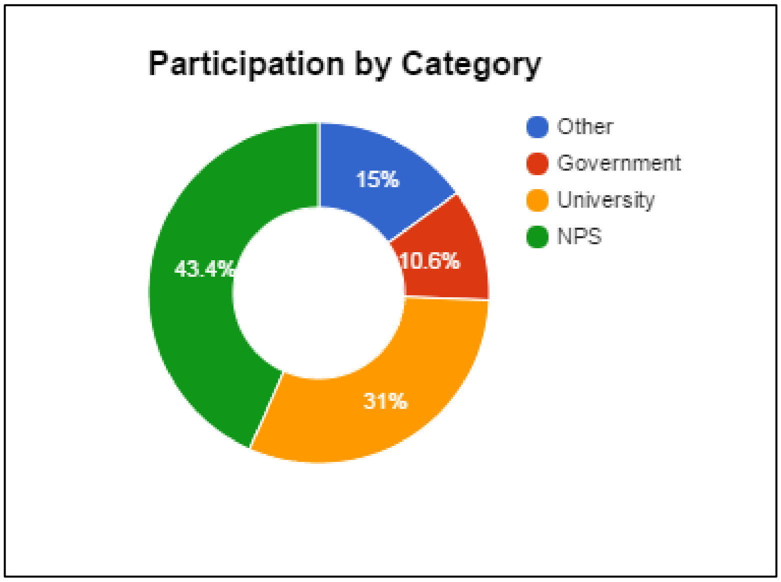


Figure 1. Percent of participants from NPS, universities or colleges, other government agencies, or a variety of other organizations/unaffiliated.

The symposium schedule was organized into eight sessions based on the subject matter or type of presentations:

- Keynote Addresses
- Lightning Rounds (local NPS staff presentations)
- High Elevation Plant Communities and Values
- Poster Session
- Current Stressors to Forest Systems
- Aquatic Ecosystems
- Wildlife
- Fire Ecology

See Appendix I for the detailed symposium schedule.

A small group of park staff planned and coordinated this symposium: Christy Brigham, Chief of Resources Management and Science; Koren Nydick, Science Coordinator; Ginger Bradshaw, Ecologist; and Theresa Fiorino, Special Events Coordinator. Additional staff from Sequoia & Kings Canyon National Parks, the Sequoia Parks Conservancy, the Sierra Nevada Conservancy, the Sierra Nevada Network, and the US Geological Survey provided input on meeting goals, invitees, and content.

What We Learned

In a post-conference email, Koren Nydick highlighted four take-home messages from the symposium:

- These national parks have a rich legacy of long-term data sets and collaborative research that have informed how we steward park resources and will continue to provide valuable insights into the future.

- Research on response to drought, climate change, the fire suppression legacy, and other stressors is yielding results that we can build upon to inform management decisions now and into the future.

- Collaborative Science is the wave of the future. Land managers need scientists and scientists need input from managers to produce results with relevance to stewardship issues.

- Science communication is not optional! We need to reach kids and adults from all walks of life in ways that help them see the value of parks as well as open space in their own neighborhoods. We'll be looking for more opportunities to connect science communicators with scientists in the field.

Purpose of this Report

This symposium met with enthusiastic participation and follow-up reviews, and there is strong interest in continuing to have similar symposia in future years. This report documents the symposium to: provide written information highlighting the presentations and posters, facilitate continued contacts and collaboration, and provide a framework for organizing future symposia.

Attentive conference participants.

Keynote Addresses

In her introductory comments, Christy Brigham highlighted the five major stressors (also locally known as the five horsemen of the apocalypse) that inform the direction and emphasis of resource stewardship in these parks:

- Climate change
- Altered fire regimes
- Air pollution
- Non-native species
- Habitat fragmentation and loss

The keynote speakers are both scientists who have worked for decades in these parks and the larger region, and their long-term experience provided important perspective for the attendees, who included people from a variety of disciplines and backgrounds, some of whom are relatively new to working in the Sierra Nevada.

The purpose of the keynotes was to provide historic context for the symposium. The first key note summarized the development of scientific programs beginning in the 1930s in the NPS and then in SEKI. The second presentation then profiled a watershed research program that began in SEKI in the early 1980s and continues to provide valuable information to managers today.

David Graber

David Graber retired from the NPS Pacific West Region Chief Scientist position in 2014. He worked more than 32 years for the National Park Service and three years for National Biological Survey/USGS. His graduate studies started in the 1970s with bear research in Yosemite and Sequoia & Kings Canyon, and by 1980 he had started working as a park Research Scientist stationed in Sequoia National Park. His long-term role in these parks and in the region makes him especially suited to highlight the parks' history of science.

Brief summary of the history of science at Sequoia & Kings Canyon National Parks

At the national level, there was a small cadre of scientists as early as the 1930s dealing with specific questions, primarily related to wildlife. Adolf Murie and Joseph Dixon were two notable examples of these scientists, who published a Fauna of the National Parks in the United States series on wildlife surveys, research, and management issues. They were passionate conservationists at a time when parks were managed strictly for tourists. They spoke out for wildlife and resources from the beginning, but it's not clear that management listened.

In the 1960s, there was an overpopulation of elk in Yellowstone. Starker Leopold was appointed Secretary of Interior Stewart Udall to head a Special Advisory Board on Wildlife Management to determine what to do about the elk problem. The team focused on broader issues, such as how should the NPS manage natural resources. The result was the Leopold Report ("Wildlife Management in National Parks") in 1963 that shook up the National Park Service. Read it!

Starker Leopold ended up being Chief Scientist for the National Park Service for about four years. During this time, he dispatched colleagues and students to do work in the parks. One of these students was Bruce Kilgore, a student of Harold Biswell at UC Berkeley, an early fire ecology pioneer who championed prescribed burning in the Sierra Nevada. Kilgore came to Sequoia and Kings Canyon National Parks (SEKI) in the mid to late 1960s as a research scientist. He oversaw the first prescribed burns, documented the results, and recommended that the parks get serious about using fire as a management tool, primarily due to research showing the importance of fire to giant sequoia reproduction.

Fire has been an important topic ever since in these parks. By the early 1990s, a solid foundation of fire history research and records of fire occurrence led to the development of Fire Return Interval Departure (FRID) GIS analyses and publications (for example, Caprio and Graber 2000). These spatial data show how in- or out-of-synch different areas are from their historic fire regimes and enable park staff to better prioritize areas for prescribed burning.

In the 1970s, SEKI saw a need to hire more scientists. David Parsons was hired in the early 70s to manage the science program. He got involved in giant sequoia research, and in addition to fire ecology research, he addressed questions such as "Why are monarch sequoias falling down near meadows?" He also worked with numerous scientists, including Jan van Wagtendonk in Yosemite, to study long-term impacts of backpacking (fire rings, trampling, etc.). Limits on backcountry use (trailhead quotas) resulted from this research, an example of science closely connected to management outcomes.

I came to SEKI in 1980 (and Yosemite in 1974) to study the bear problem as part of my dissertation research – bears getting food and visitor/bear conflicts. I recommended bear-proof food storage containers, which are still used today. I was offered a position in SEKI in 1980 to continue my bear research, which I took and continued the research for additional years.

Under President Carter, the National Acid Precipitation Assessment Program (NAPAP) was established in response to acid rain in the eastern United States. Sequoia National Park was selected as a pilot park to study the effects of sulfur, nitrogen, and acid rain in this ecosystem. Prior science focused mostly on single species. NAPAP focused on ecosystems, and we hadn't done this before. We relied on cooperators from universities as well as other NPS programs to do the interdisciplinary work. We had a large budget and spent a lot of time managing projects. In the 1990s, these watershed study areas across an elevation gradient became part of a network of forest plots managed through a global climate change research program.

In the 1980s, Nate Stephenson, who is currently a Research Ecologist with the USGS Sequoia and Kings Canyon Field Station, conducted his dissertation research in the parks on the climatic control of vegetation distribution (Stephenson 1990, 1998). His work was a foundation for the climate change research that followed in the 1990s. The initial climate change research involved collaborations with Tom Swetnam and Lisa Graumlich at the University of Arizona Laboratory of Tree-Ring Research, who used tree-ring records to reconstruct past climate and fire regimes. These studies informed fire management and our understanding of the relationships among fire, climate, and forest dynamics.

In the late 1980s, a visiting South African bird researcher complained that he could find almost no data about most species of plants and animals in national parks across the country – there was no systematic documentation of flora, fauna, and other natural resources in most parks. I was able to convince the regional office to let me start a plot-based survey for vascular plants and vertebrates at SEKI. We used map grid intersections as locations for documenting what is there. What we found didn't match well with the stories we were telling, and it provided a foundation for later inventory, monitoring, and research studies.

Also in the late 1980s, a biochemist who had documented DDT levels in the Sierra in the 1960s by using fat bodies in mountain yellow-legged frogs—Dr. Lawrence Cory—tried to do a re-survey and couldn't find frogs in most of his study sites in the northern Sierra Nevada. He called to ask whether the frogs had persisted in SEKI, which led to our first investigations here. He was right that mountain yellow-legged frogs were becoming rare. These observations led to many studies documenting the effects of introduced, nonnative trout and chytrid fungus on mountain yellow-legged frog populations across the Sierra, and later, restoration efforts to save some of the remaining populations.

In 1993, the Department of Interior under Secretary of Interior Bruce Babbitt created a new agency for scientists in the department (which included US Fish and Wildlife Service, National Park Service, and the Bureau of Land Management). It was initially the National Biological Survey, and later was moved into US Geological Survey. It wiped out the NPS research budget. Dave Parsons lasted one year, then left for a job with the Forest Service in Montana. I lasted a few years but was not happy and got back into the NPS as a Science Adviser, nurturing graduate students and overseeing research.

In 2000, the Natural Resource Challenge was established, which called for increasing the role of science in decision-making, expanding natural resource programs, gathering baseline data on resource conditions, establishing monitoring, and sharing knowledge more broadly within the scientific community and with the public. It brought an influx of money that created the national Inventory & Monitoring Program as well as other park programs and resulted in a mass influx of scientists into the NPS.

A program I am really proud of got its start in the early 2000s with a pilot study in SEKI done by Bernie Kraus and Stuart Gage (through Michigan State University). Their project was "Testing biophony as an indicator of habitat fitness in Sequoia & Kings Canyon National Parks". Now the NPS has a whole Division that focuses on Dark Night Sky and Soundscapes.

In recent years, I was part of a team of people who worked on the "Reinventing Leopold" project, drafting recommendations that fed into (NPS) Director's Order #100 – Resource Stewardship for the 21st Century. DO #100 provides policies that form a new framework for stewardship decision-making within the NPS. It takes into account climate change, biodiversity loss, pollution, land use changes, and other pressures that impact parks and other resources we manage. It also addresses sustaining a scientific cadre in the NPS – paying people to do peer-reviewed papers and attend scientific meetings, among other things. We had to fight to keep this in the final document. It requires scientific literacy for superintendents and investing in resource stewardship training servicewide.

In the question and answer session that followed Dave's talk, one question was: What should we be doing that we're not? Dave's response was "Don't just identify information gaps. Ask the questions you need answered and determine whether the science is already out there or needs new research. We are usually reactionary – we see something awful, then do something. It's important to be proactive."

Jim Sickman

Jim Sickman is Professor of Hydrology and Chair of the Environmental Sciences Department at the University of California, Riverside. His specialties are biogeochemistry of rivers, lakes, and watersheds; limnology of high-elevation lakes; and environmental isotopes. Jim has been studying lakes and watersheds in Sequoia and Kings Canyon National Parks since 1980.

Following are Jim's abstract and then a summary of his talk:

Watershed research in Sequoia and Kings Canyon National Parks: A window into the effects of global change on the Sierra Nevada

Watersheds have long attracted study by scientists, and insights derived from their investigation have led to important advances in the field of environmental science. Because watersheds integrate physical, chemical and biological processes across a wide range of scale, they have been used extensively in the fields of hydrology, forestry and ecology and to study major environmental problems such as acid rain and global warming. Mountain watersheds and lakes, in particular, are recognized as sentinals of regional environmental conditions and their long-term study is necessary to separate anthropogenic drivers of change from natural variability. Sequoia and Kings Canyon National Parks have a rich history of watershed research that began in the early 1980s and which continues to the present day. Emerald Lake and the Tokopah Valley have been the focus of sustained limnological and watershed research since 1983 and are among the best studied small watersheds in the world. Knowledge gained through this research has transformed our understanding of how aquatic ecosystems in Sierra Nevada are responding to global change and is represented by more than 200 peer-reviewed publications, technical reports and graduate theses and dissertations. In this presentation we will present a retrospective on SEKI watershed research from the earliest investigations on the impact of acid deposition on aquatic ecosystems (1983-1989), to integrative investigations of hydrologic and biogeochemical processes in lakes and watersheds (1990-2001), through current research on the responses of lakes and watersheds to climate change and altered atmospheric deposition (2002-present). The presentation will also address the broader impacts of SEKI watershed research on air quality regulation in California, Federal management of wilderness areas in the Sierra Nevada and student education spanning K-12, undergraduate and graduate levels.

Introduction

Global change is producing multiple, interacting stressors on high elevation ecosystems. This talk addresses:

Question 1: What is watershed science?
Question 2: What are some highlights from 35 years of watershed research in SEKI?
Question 3: What is the value of this research?

Primary Drivers of Change

There are thousands of small lakes and ponds in the Sierra Nevada that are vulnerable to external stressors, the primary ones being:

- Nutrient deposition – nitrogen, phosphorous (resulting in acidification)
- Altered snowpack dynamics – magnitude, timing
- Changed growing season and summer temperatures
- Invasive species (introduction of brook trout)

The neighboring Central Valley has numerous pollution sources, from agriculture to automobiles and industry.

Watersheds an Appropriate Scale to Study Global Change

Efficient integration of atmospheric, terrestrial, hydrologic, ecological, and temporal processes

The Emerald Lake Watershed Study has focused on:

- Sensitivity of Sierra Nevada lakes to acid deposition (1982-1989)
- Remote sensing of snowmelt and regional lake studies (1990-2001)
- Drivers of long-term change in aquatic ecosystems (2002-present)
- Paleolimnology (13,200 BP to 2013)

Scientists gaze into the Emerald Lake basin in the upper Marble Fork Kaweah watershed. Photo by: Jim Sickman.

Acid Neutralizing Capacity, Snowpack, and the Clean Air Act

Jim used a graph of Acid Neutralizing Capacity (ANC) trends (ANC is similar to alkalinity but measured differently) (Figure 2) to emphasize the importance of short-term vs. long-term studies and what can be determined. If you only had data from 1983 to 1989, you wouldn't know if you had a positive, long-term trend, or if this was part of a cyclical pattern. As you gather more years of data, a cyclical pattern emerges.

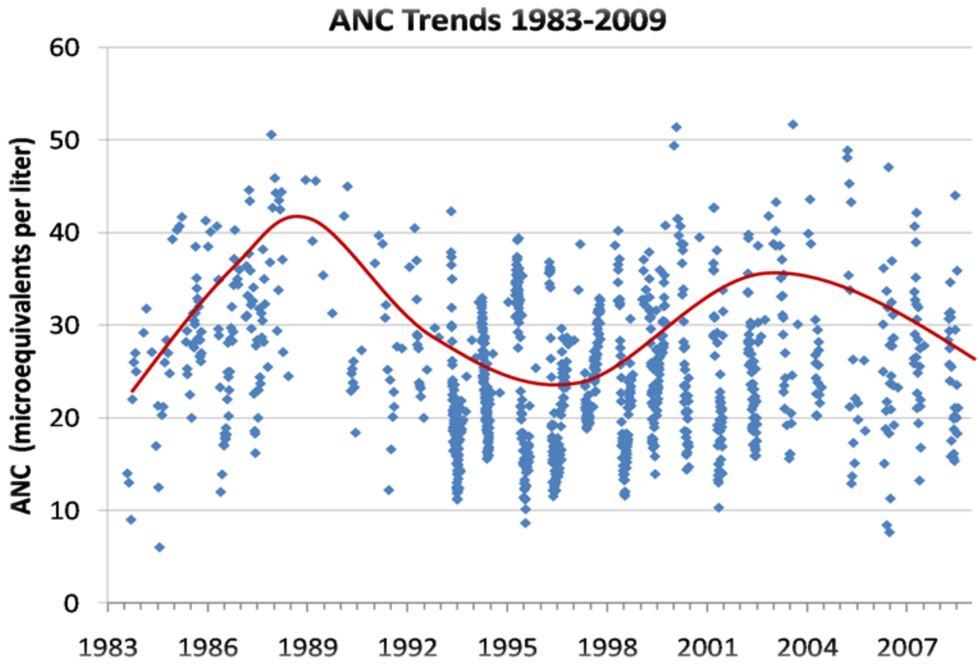


Figure 2. Emerald Lake alkalinity.

Jim found that the ANC pattern was mostly explained by the amount of snowpack (snow water equivalent, SWE). ANC tended to be low when snowpack was high, and vice-versa. Once the influence of snowpack was removed from the dataset, Jim also found that ANC was increasing in Emerald Lake from 1980-2010. Why was it increasing?

To answer this question, longer-term patterns in ANC were investigated - but to do so Jim and his team had to use paleolimnology to go back in time. This involved collecting sediment cores from the lake bottom because the remains of diatoms (a type of algae) can be used to reconstruct past environmental conditions of the lake. A 1600-year record of diatom data from Moat Lake was used to reconstruct ANC. Most conspicuous was that ANC decreased rapidly between 1920 and 1970, then started increasing rapidly by the 1980s. Based on correlations with sulfur dioxide emissions and combustion particles, Jim's team concluded that the increase in alkalinity in the 1980s was related to the beneficial effects of the Clean Air Act on improving air quality and reducing atmospheric deposition to Sierra Nevada lakes. Acid rain is not completely over, however, and some lakes still show indicators of acid deposition. Now the research is turning toward understanding the effect of drought and climate change on lake processes (see Steve Sadro's talk).

Conclusions

Because of watershed research, SEKI has among the best:

- High quality climate records including detailed snow surveys
- Records of montane lake and stream chemistry in the U.S. (temporally and spatially)
- Instrumented catchment studies in the world

SEKI watershed research has made a large impact, resulting in hundreds of publications, thousands of citations, and millions of dollars in funding; provided graduate and undergraduate training; been utilized for national and state resource condition assessments and incorporated into inventory & monitoring projects; and contributed information to NPS and USFS wilderness management.

Questions

After his talk, Jim was asked about how his research had informed policy. Since he studies drivers that the NPS cannot control, has he been able to interact with the state or other agencies?

He said he and his students have talked with hundreds to thousands of people at Emerald Lake, helping inform the public about the research, and they have worked closely with NPS staff in collaborative research and monitoring to better understand the watershed.

He also mentioned a research topic that could be of interest to the state. There is likely a snow albedo effect from dust (transported from the valley) – its dark color on the snow surface could be increasing the rate of snowmelt, as has been documented in other areas, particularly the Rocky Mountains in Colorado. Local air quality districts could have some control over this. Powerful arguments can be made regarding the local environment to initiate effective change.

An interpreter asked how Jim could communicate the value of this research to members of the public who won't be able to hike to Emerald Lake.

Jim replied he had tried to get the research on the positive impact of the Clean Air Act to the media, but no California newspapers took an interest in this story despite it being a positive "good news" story. He does use the story in his own teaching at the university where hundreds of students hear about it.

Lightning Talks

National Park Service staff from Sequoia and Kings Canyon National Parks and the Sierra Nevada Network gave a series of 16 lightning talks. These provided brief (5-minute) overviews of resources management, science, and communication/outreach work going on in the parks while ensuring most of the symposium time was devoted to highlighting on-going, past, and future research efforts. Following are highlights from the lightning presentations, which were presented in a variety of formats (including humor) to spark interest:

Dark night sky image from Mount Whitney, Sequoia National Park. NPS photo by Dan Duriscoe.

Annie Esperanza: Air Quality

Air Quality Specialist/Physical Sciences Branch Chief, Resources Management & Science, SEKI

- SEKI routinely experiences the worst air quality of any national park unit and is known as one of the worst ozone polluted parks in the NPS.
- Starting in the early 1980s with the acid rain research program, SEKI started a stream of air-related research that has added a wealth of knowledge of air pollutants and their effects. These efforts wouldn't have been possible without working with other federal and state agencies, universities, and private research groups.
- In our history of air related research we've either conducted or hosted investigations into acid rain, ozone, nitrogen deposition, soundscapes, night skies, fine particulates, contaminants, and atmospheric transport.
- Our knowledge has greatly evolved over the years and with each study, new direct and indirect impacts to the parks' ecosystems are revealed, but then, more questions develop.
- It is our hope to continue to work collaboratively with interested researchers in expanding efforts to better understand air pollutant threats and how they affect park resources.

Erik Meyer: Prioritizing Pesticide Monitoring

Ecologist, Physical Sciences Branch, Resources Management & Science, SEKI

- Nearly 900 pesticides are applied to California agricultural lands in close proximity to Sequoia and Kings Canyon National Parks.

- The large number of pesticides applied has made it difficult for regional land managers to understand what pesticides to monitor and where to look for them.
- Therefore, SEKI has teamed up with the California Department of Pesticide Regulation to create a user friendly web-based map that will prioritize pesticide monitoring in California national parks based on pesticide use and toxicity.

Danny Boiano: Mountain Yellow-legged Frog Management

Aquatic Ecologist, Resources Management & Science, SEKI

Electrofishing in a lake outlet. Photo by: Isaac Chellman.

The top ten reasons for managing mountain yellow-legged (MYL) frogs:

10. Cute, Handsome, and Entertaining critters

- People love seeing frogs while in the parks' backcountry.
- Staff often get reports of visitors delighted to see these frogs hopping along the shore and tadpoles scattering in bursts of frenzy.

9. Endangered Species Act

- MYL frogs are federally listed as endangered.
- NPS Mgt Policies guide parks to recover threatened and endangered species when feasible.

8. Non-native Trout are a significant threat to MYL frog populations

- All MYL frog habitat in the parks was historically fishless.
- From 1870 to 1988 trout were stocked in hundreds of park lakes and ponds.
- Today ~550 waters have self-sustaining trout populations.
- Trout eliminate or drastically reduce frog breeding, and also fragment frog populations that occur in fishless habitat.

7. *Batrachochytrium dendrobatidis* (amphibian chytrid fungus)

- A recently established pathogen that infects MYL frogs with chytridiomycosis.
- Many frog populations already reduced by trout declined to zero after die-offs caused by chytrid infection.

6. Climate Change

- MYL frogs are often restricted to small shallow ponds in lake basins filled with trout.
- Climate change may reduce these habitats through drying and/or make them less suitable through water temperature increases.

5. **Habitat Restoration**
   - NPS Management Policies guide us to remove non-native species when feasible.
   - Trout removal in selected areas restores key habitat and allows MYL frog populations to expand.

4. **Frog Restoration**
   - Because frogs have declined to zero in many lake basins and are struggling to adapt to living with chytridiomycosis, frog restoration actions are also needed.
   - Direct movements of disease-resistant adults can re-establish populations.
   - Rearing tadpoles and small frogs to adult size in zoos and immunizing them before they are reintroduced may help more frogs survive in the wild.

3. **Genetic Diversity**
   - The parks contain both species of MYL frogs (*Rana muscosa* and *Rana sierrae*) that include at least three distinct genetic groups.
   - Protecting MYL frog populations across the parks will conserve diversity important for long-term adaptation and evolution.

2. **Food Webs**
   - MYL frogs cycle lots of nutrients as tadpoles, prey on invertebrates and small vertebrates as frogs, and are consumed by a large number of native predators.
   - They are integral to maintaining productive high elevation food webs.

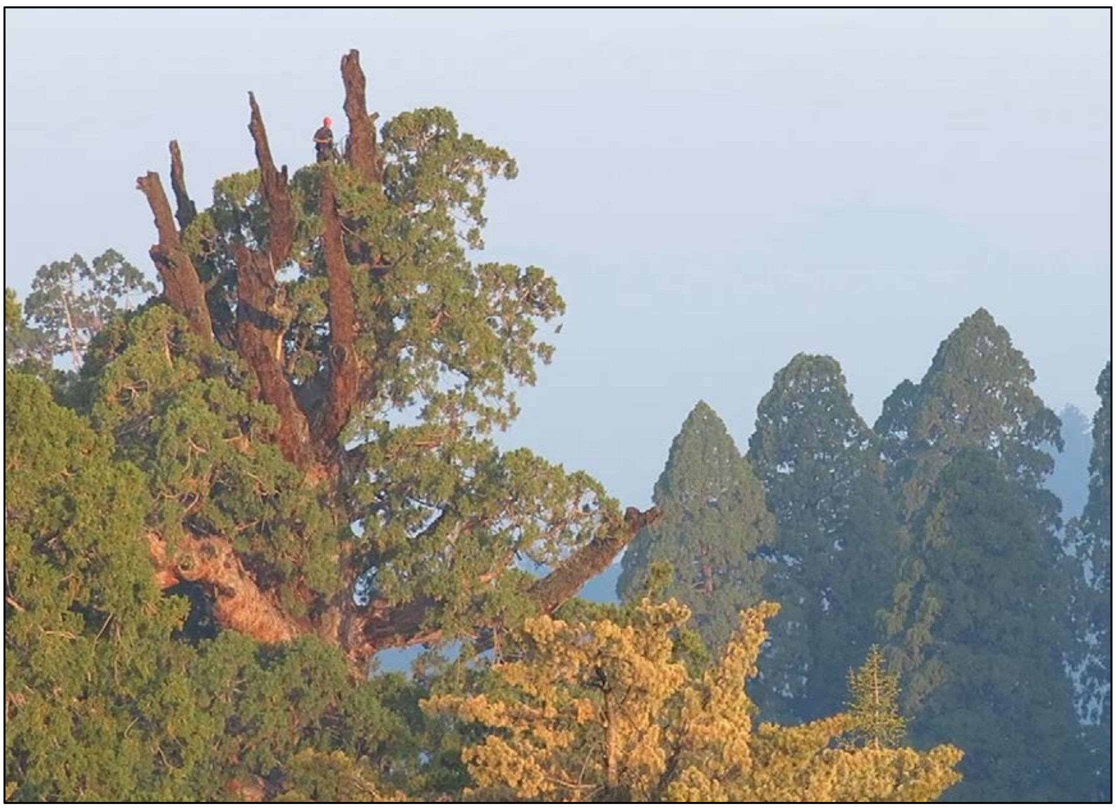
1. **Ecosystem Resilience**
   - Removing trout from critical frog habitat and restoring MYL frog populations actually restores high elevation aquatic ecosystems.
   - Restored ecosystems are more diverse and abundant, and more resilient to environmental conditions over time.

Koren Nydick: Climate Change and Adaptation

Science Coordinator, Resources Management & Science, SEKI

- Climate change is happening and will continue, but thanks to science we know some of the changes going on (warming temperatures, hotter drought, more rain relative to snow, melting glaciers, earlier snowmelt, more trees dying, longer fire season, animals moving…)
- SEKI is not alone. Many parks across the nation are dealing with extreme warm temperatures (Monahan and Fisichelli 2014).
- Climate change adaptation seeks to limit the negative effects or take advantage of opportunities brought on by a changing climate. Adaptation also is equated by the park service as building resiliency—finding ways to help ecosystems and resources withstand and recover from climate change.
- Sometimes we don't know if a particular change is negative or not. It might be different but provide ecosystem services. It will take both science and values to figure this out.

- Adaptation strategies vary along a gradient from managing for persistence to directing transformation to a new state. There's also less direct strategies like removing other stressors and letting the system respond as it will….or taking no action…and learning from what we do or don't do.
- But how do we decide what to do and where? What do we need to know to make these decisions?
- The Leaf to Landscape project is an example where we use remote sensing to map indicators of forest drought vulnerability and apply ground-based measurements to calibrate and validate the results. This kind of information can help manager triage where to best apply forest treatments.
- At SEKI we've been asking these questions – what do we need to do and what do we need to know to do it – as part of the Resource Stewardship Strategy. The RSS focuses on 12 priority resources and analyzes their current condition, vulnerability and potential impacts - to identify climate-smart goals, management objectives, and a portfolio of prioritized activities. It's in draft, almost finished, and we hope you'll look at it to identify projects you might want to do.



Measuring giant sequoia response to drought. Photo by: Wendy Baxter, UC Berkeley, California.

Athena Demetry: Meadow Restoration

Restoration Ecologist, Resources Management & Science, SEKI

Athena used slides and narration to tell a story about the restoration of Halstead Meadow. She has moved on to Yosemite National Park since the symposium, where she is working as Program Manager of the Branch of Vegetation Management. In her honor, we include her whole story below.

- Once upon a time, a century and a half ago, a plague of hoofed locusts descended upon the wetlands and caused deep, vast gullies where there had been none.
- And lo, came the Soil and Moisture Conservation Crew, who fenced off the livestock and brought forth check dams.
- And for a while it was good, and the sediments did accumulate, and the grasses did grow.
- But then came great floods, and the check dams were washed out, and replaced, and washed out, and replaced, and no further sediments were captured. And the people despaired and gave up.
- The century changed, and the people from Colorado State University and NPS Water Resources Division came unto the deeply-gullied and dewatered Halstead Meadow wetlands.
- They saw that reference meadows had sheet-flow hydrology, few channels, and a dense mat of rhizomatous wetland vegetation to hold soils in place.
- They had a vision of restoring pre-disturbance topography, hydrology, and vegetation by filling the gully and bringing forth wetland plants.
- And it was made so. In the 2007 pilot project, the trucks came forth with 8000 cubic yards of fill, the dozers did make it level, and the waters were spread out.
- The plants were planted, and grew forth.
- But lo, the floods came again in 2009 and the people did despair.
- But the people persisted, and fixed the storm damage, and re-assessed the logs, erosion blanket, soil compaction, and plant growth. And learned from their mistakes.
- The Coloradans experimented with wood chip amendment. And collected and analyzed data, and the people did further learn and change.
- In 2012, the people moved the water aside, the trucks came forth with 16,000 cubic yards of fill and a great bridge was built across the abyss, and thus was phase 2 restoration implemented.
- The people had learned, and placed wood chips in the fill to decrease compaction, and buried the logs and used woven erosion blanket and a multitude of wattles, and established plant cover early to protect from floods. And it was good.
- Dr. Holmquist brought forth the nets and sampled the invertebrates. He found that the people’s phase 2 learning restored the invertebrate community 4 years earlier than the pilot. And it was published.
- The people turned their gaze to wetlands not reachable by road.
- They saw that Cahoon Meadow had lost 5 acres of wetland to its great gully, and 14 acres were threatened by an advancing headcut.
- They proposed that the wetlands be restored by calling forth great air machines to carry the land machines at great expense, and in wilderness. The people paused, and thought.
- The people thought about the future, and the legacy of the hooved locusts, and the waters drained away in the smaller gullies and ditches throughout these great park wilderness wetlands.

- They called upon American Rivers to enumerate these gullied wetlands, and to assess them, and to prioritize them.
- They saw a future where these gullies were blocked by wilderness-friendly hand crews, improving wetland function, and increasing resiliency to the drying and heating of the lands. And though they knew they would make mistakes, they also knew that they would continue to learn, and to improve, and that it would be good.

Halstead Meadow restoration, Sequoia National Park. NPS photo.

Erik Frenzel: Meadow Monitoring

Plant Ecologist, Resources Management & Science, SEKI

- SEKI has several long term datasets related to the monitoring of stock use.
- These include detailed records on overnight packstock use and grazing (1985 to present), end of season standing crop and bare ground (1995 to present), and plant species composition (1985 to present).
- There are also narrative and photographic records of conditions and management; some of these records are from the turn of the century.
- These datasets and records are georeferenced and can inform research into the role of disturbance for ecological studies.

Archeological Technician working on a prescribed burn. NPS photo.

Jessie Russett: Archeology and Fire

Archeologist, Resources Management & Science, SEKI

- The parks manage a diversity of prehistoric and historic archeological resources.
- The archeological survey data for these parks include 820 known archeological sites (two national register listed) and 28,901 total acres surveyed. However, only 3.34% of the parks' area has been surveyed.
- The archeology program has an important role to play with the fire management program, conducting pre-fire surveys before prescribed burns, assisting with mitigation actions to protect archeological resources during both prescribed and suppression fires, minimizing fire suppression impacts on archeological resources, and conducting post-fire surveys as fire can often expose previously unknown archeological resources or cause damage.

Paul Hardwick: Information Resources

GIS and Data Coordinator, Resources Management & Science, SEKI

- If you don't take good care of your data and keep it up to date it could take down your whole ship.
- SEKI archives have on-line finding aids that will point to the location of valuable historic information about the parks and their environments.

- SEKI has many people that collect and care for their data, but they are not programmers or developers so accessing their data can be difficult.
- SEKI needs assistance in developing best practices for making their data discoverable, accessible and usable.

NPS wildlife management staff take measurements of a sedated bear. NPS photo.

Danny Gammons: Bear Management

Wildlife Biologist, Resources Management & Science, SEKI

- There are a lot of bears and a lot of people in SEKI. Human-bear conflict is essentially inevitable.
- The parks have taken many measures to mitigate human-bear conflict (installation of bear-resistant lockers and dumpsters, extensive outreach efforts, dedicated bear management staff, etc.) and there was a steady downward trend in recorded human-bear conflicts during the last 2 decades.
- However, there are irruptions in human-bear conflict likely associated with natural food failures that periodically overwhelm the "defensive barrier" we have established--one such irruption was observed during the summer of 2015-- demonstrating that we cannot become complacent with our successes.
- In fact, contrary to the perceptions of many, over the last 60 years the number of recorded human-bear conflicts does not show a downward trend.

Erik Meyer: Post-fire Assessment Using Soundscapes

Ecologist, Physical Sciences Branch, Resources Management & Science, SEKI

- SEKI resource managers are using high resolution sound data to measure effects of the 2015 Rough Fire in Grant Grove giant sequoia forests.
- The sound files provide a measure of total acoustic biodiversity, which relates to animal diversity.
- Preliminary results indicate that biodiversity in giant sequoia forests that had a history of prescribed fire were less impacted by the Rough Fire than forests without fire for many decades.

Soundscape monitoring equipment at a Rough Fire site. NPS photo.

Christy Brigham: Why SEKI for Research?

Chief of Resources Management & Science, SEKI

Christy highlighted five reasons to conduct research in these parks:

1. Location, Location, Location
2. 70-100 years of data isn't good enough for you?
3. We're the government, we're here to help.
4. The parks provide reference conditions for other more altered study sites.
5. Make the world a better place, one research study at a time.

Sylvia Haultain: Introduction to Inventory and Monitoring

Program Manager, Inventory & Monitoring Program, Sierra Nevada Network

- National Park managers across the country need a broad-based understanding about the status and trends of park ecosystems. The Inventory & Monitoring program was established to meet this need, by systematically gathering and analyzing information on the plants, animals, and ecosystems that are within parks.

- Parks use this information for planning, research, education, and to help guide decisions related to park management. Results are also shared widely with other agencies, researchers, and scientists.
- Inventories help us understand the range of resources, and monitoring helps us understand how these resources are doing over the long term.
- We are part of a nation-wide program housed within the Natural Resource Stewardship and Science Directorate of the National Park Service. As one of 32 Inventory & Monitoring networks, the Sierra Nevada Network serves Cesar Chavez and Devils Postpile National Monuments, and Kings Canyon, Sequoia, and Yosemite National Parks.
- SIEN scientists focus on a suite of 'vital signs' that includes high elevation forests, wetlands, rivers and lakes, climate, and land birds, using protocols designed to reflect landscape level trends. The information we collect both complements and provides context for other research and monitoring efforts conducted within the parks. Towards this end, we work closely with agency, NGO, and academic partners to leverage information and resources.
- We're in this for the long-term, and to ensure that the work we do is relevant and accessible, dedicate a significant portion of our professional resources to data management and information sharing.
- Learn more at our website: http://science.nature.nps.gov/im/units/sien/

Andi Heard: High-elevation Lake Monitoring

Physical Scientist, Inventory & Monitoring Program, Sierra Nevada Network

- The Sierra Nevada Network (SIEN) monitors lake chemistry and amphibians at 76 lakes across Sequoia, Kings Canyon, and Yosemite National Parks.
- SIEN has collected nine years of data to date and welcomes researchers to utilize these data and conduct research that compliments SIEN monitoring.
- Research opportunities include, but are not limited to, vulnerability of lakes to algal blooms and subsequent loss of lake water clarity, synergistic effects of atmospheric deposition and a warming climate, cascading effects of atmospheric deposition and climate change on aquatic food webs, and expanding lake water temperature monitoring.
- For additional information and products about SIEN lake monitoring please visit the SIEN website (https://science.nature.nps.gov/im/units/sien/monitor/lakes).

Foxtail pine, Bighorn Plateau, Sequoia National Park. NPS photo.

Jonny Nesmith: Monitoring of Wetlands and High-elevation Forests

Ecologist, Inventory & Monitoring Program, Sierra Nevada Network

- The Sierra Nevada Network is collecting long-term monitoring data on high-elevation forests and wetlands to understand the current condition and long term trends of these sensitive ecosystems.
- Data are used by land managers to support management actions based on sound science and by researchers to better understand ecosystem processes and patterns and predict future conditions
- We are still in the early stages of data collection, but initial results suggest that high elevation forests and wetlands in Sierra Nevada Network parks (Sequoia, Kings Canyon, and Yosemite national parks) are in good condition despite ongoing impacts of climate change, invasive species, fire suppression, and introduced diseases.

Linda Mutch: Science Communication

Science Communication Specialist, Sierra Nevada Network

- Define your audiences.
- Target communication products to their needs.
- Use a variety storytelling techniques and tools to reach varied audiences and raise science literacy.

Community science project re-measuring giant sequoias. NPS photo.

Michael Mueldner: Internships and Community Science

Americorps DOI/VISTA Intern, Sequoia and Kings Canyon National Parks

- Use "community science" as more inclusive language than "citizen science".
- Examples of past projects include: newt phenological monitoring, dragonfly larvae mercury monitoring, measuring giant sequoias.
- iNaturalist is a great, free tool that can make data collection accessible to the public.
- Interns work throughout the year at the parks.
- SCA Centennial Volunteer Ambassadors help to increase volunteerism and bring the next generation of youth into the parks.
- Latino Heritage Internship Program: Highlights Latino history and involvement in the parks as well as promoting a deeper connection to the Latino community.
- Institute for Bird Populations: Bird monitoring interns gather field data on bird populations across the Sierra Nevada parks for the Inventory & Monitoring Network.
- MOSAICS in Science: Intern created a short film highlighting research done throughout the parks, to serve as an advertisement to attract more research to these parks.
- SEKI is a great place for internships and is looking to expand internship opportunities.

Invited Talks: Day 1

We present the abstracts for the symposium invited talks, organized by the main topic areas of the schedule. See Appendix II for a list of all symposium participants and contact information.

High Elevation Plant Communities and Values

Plug planting of wetland plants in Halstead Meadow restoration project. Photo by: Evan Wolf.

Evan Wolf: Meadow Restoration: Past, Present, and Future
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Researching and repairing legacy grazing impacts in Sequoia meadows

In conjunction with the analysis of Cahoon Meadow for potential ecological restoration, we conducted an investigation into the historical use of hand-built check dams to repair eroded meadows of Sequoia and Kings Canyon National Parks (SEKI). We found archived documentation that, for 34 years from 1948 to 1981, a summer-seasonal team of SEKI employees, the Soil and Moisture Conservation Crew (S&MCC), built and maintained check dams in 20 back country meadows and 1 front country meadow, and their erosion control efforts were requested, but never implemented, at an additional 33 meadows. S&MCC activities were focused on mitigating the impacts of grazing that occurred from ~1870 to 1985. Williams and Sugarloaf Meadows were the two longest-grazed meadows and received the most S&MCC check dam work. In 2015 we conducted field investigations in these two meadows, relocating as many dams as possible to determine how effective they were at accumulating sediment after 35 years of no maintenance. We found 41 S&MCC check dams, 35 in Sugarloaf and 6 in Williams, and measured their channel dimensions, slope, sediment accumulation, and functionality. All but 2 of the dams were non-functional, retaining no water, and even dams in small, shallow sloping channels had failed. The maximum sediment accumulation depth was 1.2 meters, just upstream of a dam built in 1948, in a gully that had been 2.5 meters deep. On average, the sediment depth accumulated behind dams was 26% of the former gully depth. Nowhere did enough sediment accumulate behind a dam to fill in its gully and restore the original level topography of the meadow. Although 30+ years of dam building and maintenance succeeded in locally depositing sediment to about a quarter of the eroded gully depth, the gully in Cahoon Meadow is deeper and wider than any of the dammed sections of either Williams or Sugarloaf Meadows. Wider, taller structures would be required in Cahoon's gully and these would be significantly more difficult to design, build, and maintain than the S&MCC dams and require 100 years or more to accumulate enough sediment to completely restore original topography.

Jeff Holmquist: Pack Stock Use and Invertebrates

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Do pack stock affect invertebrates and associated vegetation structure in subalpine wetlands?

Libella saturata, the Flame Skimmer. Photo by Jeff Holmquist.

Sequoia and Kings Canyon National Parks were ideal for addressing this question, because a) there was a 20-year database of stock usage, b) there were meadows with little grazing over the last 20+ years that could be contrasted with grazed meadows, c) there is a long winter with no stock use, and d) the start of grazing for each meadow is controlled. We separated a) long-term effects of pack stock grazing, manifested in early season prior to stock arrival, from b) additional pack stock grazing effects that might become apparent during annual stock grazing, by use of paired grazed and reference wet meadows that we sampled at the beginning and end of subalpine growing seasons. Litter cover and depth, percent bare ground, and soil strength indicated negative responses to grazing. In contrast, fauna showed little response to grazing, and there were overall negative effects for only three arthropod families. Mid-season and long-term results were generally congruent, but there were trends of lower mid-season invertebrate abundances across species and lower invertebrate diversity across assemblage metrics. Treatment x Season interactions were almost absent. Effects on vegetation structure appear to have only minimally cascaded into the arthropod assemblage and were not greatly intensified during the annual growing season. We also contrasted effects of equine grazing on both subalpine vegetation structure and associated arthropods in a drier reed grass (*Calamagrostis muiriana*) dominated habitat versus a wetter, more productive sedge habitat (*Carex utriculata*). Grazing effects were greater in sedge than in reed grass. Conversely, negative grazing effects on arthropods, albeit limited, were greater in the drier reed grass, possibly due to microhabitat differences. The differing effects on plants and animals as a function of habitat emphasize the importance of considering responses of both flora and fauna, as well as multiple habitat types, when assessing potential stressors. The above work assessed responses of flora and fauna at the landscape scale. Our related work in Yosemite National Park showed that stock effects are greater in heavily used patches and that stream fauna below fords, in meadow-associated streams, are likely more affected than terrestrial fauna in grazed wetlands.

Ron Goode: Restoring Biotic Cultural Resources

North Fork Mono Tribe
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Restoring biotic cultural resources

The North Fork Mono Tribe has been engaged in restoration work since 1991 with saving indigenous sycamore trees from mistletoe, to recreational trail work and now restoring a sedgeroot bed. From 2003 on the Tribe is now restoring meadows, oak orchards, deer grass, and cultural resources for the Sierra National Forest. This year we restored a huge meadow burned by the Willow Fire using sedgeroot to restore it.

Jeff Jenkins: Sociocultural Values Mapping

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Assessing landscape values for Sequoia and Kings Canyon National Parks

Sequoia and Kings Canyon NPs are currently facing climatic impacts that threaten the parks' ecological resilience, economic viability, and ability to meet its mandate to provide recreational opportunities. These issues such as tree disease and the potential for large-scale fire weren't envisioned at the scale they exist today when the SEKI General Management Plan was authorized in 1999. I provide an overview of how landscape values mapping, a type of public participation GIS, can be used by SEKI natural resource managers to identify issues, set planning goals, and prioritize the value of projects. Specifically, I will relate this method to the NEPA stakeholder engagement process given the likelihood that SEKI will begin a General Management Plan update in the near future. Landscape values mapping is a method used to assess the value of locally significant features that provide a sense of place, including aesthetic, economic, educational, health, recreational, social, and wilderness qualities. Assessing these sociocultural values across the landscape fills an important gap that can complement existing planning efforts which rely on environmental layers such as fire risk, tree disease/mortality, wildlife habitat, water quality, and ecosystem services. I provide a step-by-step summary of what is required to carry out landscape values mapping with the public at SEKI, including an explanation of how stakeholders can give input on activities and their values through large-format print maps at meetings or through a set of emerging online mapping tools.

Emily Moran: Modeling Seedling Survival

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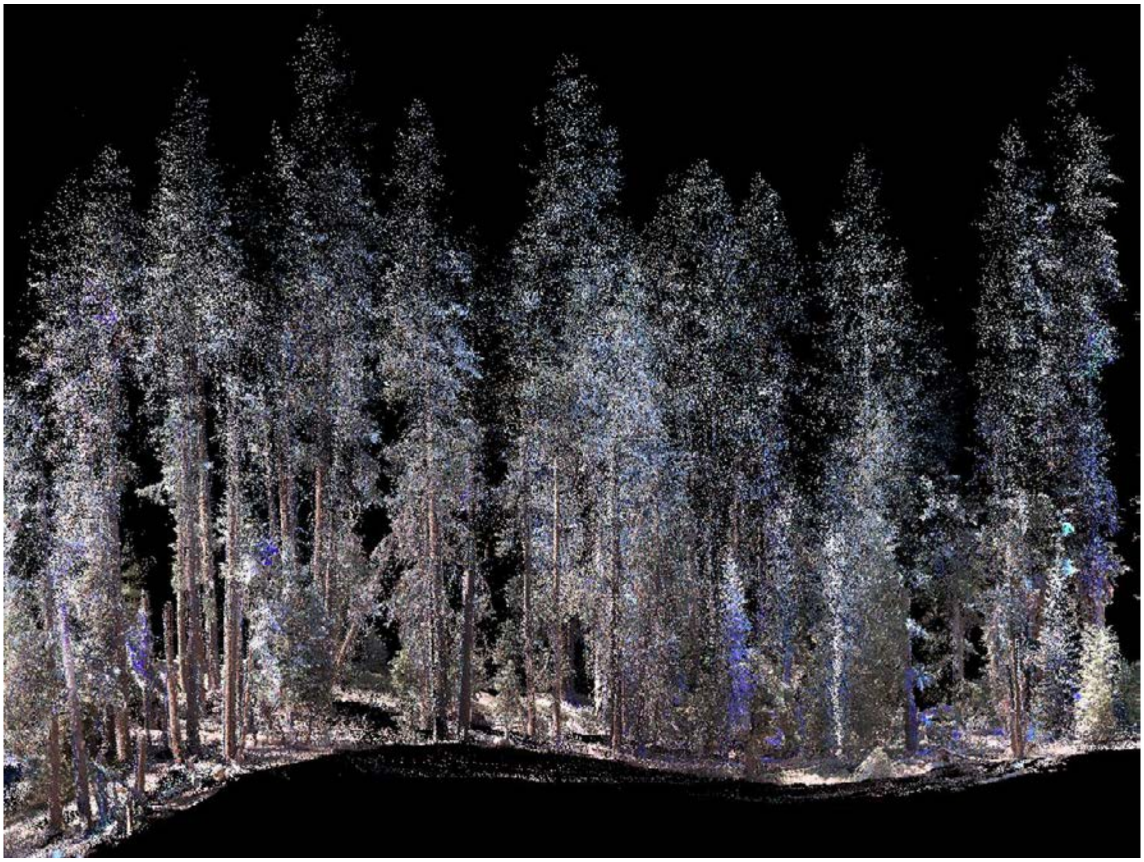
Modeling seedling survival in coniferous forests of the Sierra Nevada

Juvenile tree survival and growth deserve greater attention as management practices are re-assessed in light of climate change. Seedling establishment is essential for population persistence and spread, and the relative performance of different species and genotypes can strongly influence future community composition and eco-evolutionary interactions. In the forests of the Sierra Nevada, the ability of seedlings to establish following severe fire that removes nearby seed sources has long been an issue of concern. A dense canopy resulting from lack of fire could also reduce growth and survival, while moderately shady microclimates may help seedlings to survive by reducing the rate of water loss. From 1999 to 2009, the USGS monitored seedlings in more than a dozen long-term plots in Sequoia and Kings Canyon and Yosemite National Parks, and some of these plots experienced low- to moderate-intensity fire during this period. We are model seedling and sapling survival as a function of species, size, and various environmental variables. Preliminary results indicate that mortality rates increased for most size classes over the 11-year period. As expected, smaller seedlings experienced higher mortality, fire in the current or preceding year increased seedling mortality, and these factors interacted. Of the climate variables tested, average annual temperature and climatic water deficit best predicted survival, with the former having a positive and the latter a negative effect. Somewhat surprisingly, adult basal area within 10 m had a small but positive impact on survival of larger seedlings (>25 cm) of most species, indicating a facilitative effect even for "shade intolerant" species such as ponderosa pine. We are currently investigating whether this facilitative effect was more pronounced in dry or hot years. Smaller seedlings tended to experienced lower survival in areas of high adult basal area. We will discuss implications of these findings for forest dynamics and management under future climates.



Example of digital representation of red fir forest. Image by: Danielle Svehla Christianson.

Danielle Svehla Christianson: Digital Representations in Ecology
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Responsibly harnessing the advantages of digital representations in ecological study

New technologies capable of collecting and analyzing increasingly finer resolution observations are being employed to study the effects of climate change and other stressors on ecosystems. Many of these new tools, such as laser scanners, utilize cutting-edge digital platforms for representing the data, including through novel forms of visualization. As part of a project to understand seedling recruitment, I scanned a 4-hectare area of red fir forest in Sequoia National Park with a terrestrial laser scanner, also know as LiDAR. I analyzed the resulting 3D point cloud to quantify forest structure. I completed the analysis in 2D on a personal computer and in 3D with the UC Davis KeckCAVES immersive virtual reality platform. Now, drawing on science and technology studies' critique of representations in scientific practice, I explore the advantages and potential risks associated with the use of laser scanning and similar technologies using the Sequoia National Park data as a case study. My aim is to foster a conversation within the ecological community about the responsible use of these visualizations because how we represent the natural world with data influences not only how science is practiced but also how it is communicated to managers, policy makers, and the public.

Pohlia cruda. Photo by: Paul Wilson.

Paul Wilson: Liverwort and Moss Diversity
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Diversity of mosses and liverworts along a 3000-m gradient

Patterns of diversity in bryophytes (mosses and liverworts) were studied along a 3000-m gradient in Sequoia National Park. In Sequoia, climate varies from the foothills with their dry summers and cool winters, to the alpine peaks with their short summers and deep snow cover. Bryophytes are thought to do best when the climate is cool and humid. The lower elevations present highly suitable winters compared to the higher elevations (given that the bryophytes are dormant during the dry season). The effect of elevation was predicted to be greatest in microhabitats that dry out quickly, whereas it ought to be ameliorated for bryophytes that live in streams. Similar theorizing addressed how other aspects of the microhabitat adjust the suitability of the environment to bryophytes. Elevations from 380–3556 m a.s.l. were surveyed in 250 plots. Within each plot, every bryophyte was identified along with the wetness of its microsite, shadiness, incline, and the type of substrate. Species richness within plots decreased with increasing elevation. As plots became wetter and shadier, richness increased. Incline did not have an effect on richness independent of shadiness and wetness. The effect of elevation interacted with several microsite variables. For example, species richness decreased with elevation in dry microsites but remained the same in wet microsites across elevation. Sunnier and inclined microsites also decreased in richness with increasing elevation. Epiphytes disappeared above about 2000 m. Bryophytes on rotten wood had highest richness at intermediate elevations. Rock microsites remained relatively unchanged in species richness across elevations, and soil bryophytes had greatest richness at low elevations.

Xanthoria sorediata, crustose lichen. Photo by: Jason Hollinger.

Nastassja Noell: Lichens as Bioindicators

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Alpine Lichens and Climate Change - 1955 to present: Preliminary results from Mt. Whitney, Kearsarge Pass and Bishop Pass

Alpine areas are significantly threatened by climate change. Lichens, a group of symbiotic organisms widely used as biomonitors of air and habitat quality, have the potential to be sensitive bioindicators of climate change in alpine areas, giving conservation managers early warning signs of climatic changes. We present preliminary results of lichen inventories conducted in 2016 on the summit of Mt. Whitney, Kearsarge Pass and Bishop Pass and discuss how these modern surveys compare with baseline inventories conducted in 1955 by lichenologist H.A. Imshaug. We compare these findings with preliminary results from other sites in Washington, Nevada and California and discuss issues in methodology and the potential of measuring changes in alpine pollutant loads by performing analyses on baseline and modern collections.

Introduction: Day 2

Prior to second day of symposia talks, Koren Nydick showed a video "Find Your Science" that was created by Ellen Esling, an intern who worked with the park through the Mosaics in Science Internship Program. The purpose of the video was to attract scientists to do needed research in Sequoia and Kings Canyon National Parks. It highlights the opportunities to conduct a variety of projects in diverse landscapes, park staff who welcome the contributions of outside scientists, and existing datasets that can complement or be a starting point for research projects. Once the video is finalized, it will be available on the parks' science and research website: https://www.nps.gov/seki/learn/scienceresearch.htm.

Koren and Christy also reminded participants to visit the interactive posters designed by Erika Williams, SEKI Visual Information Specialist. The posters asked people to respond to the following questions:

1. Research: How can we engage volunteers to help with research and monitoring? What projects align best? Tell us about a project idea.

2. SLC: Science Learning Centers support and connect research and education. How can we work together to build capacity and excitement to grow our Science Learning Center? What do we need AND how can we work together to make it happen?

3. Based on your skills and interests, what could you do to help SEKI engage people about climate change and other stressors? Pick one answer.

    - Write an article for SEKI's research and science web page
    - Give a presentation or lead a field trip
    - Help create and/or deliver curriculum-based education for K-12
    - Provide internships for young adults.
    - Other ideas (sticky notes)

A summary of responses to these posters can be found in Appendix III.

Invited Talks: Day 2

Current Stressors to Forest Systems

View of tree mortality from the crown of a giant sequoia, Sequoia National Park. Photo by: Anthony Ambrose.

Adrian Das: Severe Drought and Tree Mortality
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A system under stress: severe drought and tree mortality in Sequoia National Park

California is experiencing a drought of a severity unprecedented in the instrumental record. Not surprisingly, the drought has had substantial effects on California forests, including large increases in tree mortality, particularly at lower elevations. Some evidence suggests that such droughts may become more common in a changing climate. In that light, the consequences of the current drought may be highly relevant to our understanding the future of forests in the Sierra Nevada. We established a network of plots in an area experiencing elevated tree mortality in order to quantify the effect of the drought on species composition and size structure. We also took advantage of long-term forest demography plots located in the same area to study how drought mortality differed from typical background mortality. We found substantial differences in tree mortality among species, both in overall mortality rates and the size structure of that mortality. Pines showed the highest levels of mortality, with most of that mortality occurring in the largest size classes. In contrast, cedar mortality was concentrated in the smallest size classes, and firs experienced relatively equal mortality across size classes. Plot data indicated that increases in overall mortality were associated with strong increases in biotic attack, and there was evidence of substantial increases in the activity of insects normally considered minor contributors to tree mortality. These results suggest that drought mortality likely differs in important respects from those of other disturbances, such as fire, and that previously unexamined biotic factors may lead to unexpected outcomes. In addition, our results may have implications for understanding drought vulnerability, particularly with regard to tree size. We argue that understanding biotic interactions will be critical for improving our ability to forecast future mortality.

Jeff Lauder: Drought Resilience in Conifers

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Drought resilience of Sequoia National Park conifers: using tree rings and xylem anatomy to identify drought-tolerant forest stands

Drought response varies considerably among tree species. Some trees exhibit conservative growth strategies, growing slowly through multiple environmental conditions. Others exhibit more aggressive strategies of growth heavily dependent on water availability. With projected rises in drought intensity and duration, understanding drought responses in conifers is an essential step toward modeling and predicting whole-forest response to changing climatic conditions. Sequoia National Park contains multiple conifer species with different but overlapping elevation distributions. Here we present preliminary findings from a study of forest stand drought resilience at current species distribution centers and boundaries for three major Sierra Nevada pine species: ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), and western white pine (*Pinus monticola*), as well as neighboring species. We tested the hypothesis that individuals of each species show higher growth and drought resilience at upper elevations of their distribution by using dendrochronological techniques. We measured ring widths before, during, and after significant drought years, including the current drought, in sampled increment cores from each of the three target species and co-occurring species within each target species elevation band: Ponderosa-only, Ponderosa-Jeffrey boundary, Jeffrey only, and Jeffrey-White Pine boundary. Tree ring xylem measurements of selected cores were used for comparisons of growth versus cell anatomy across growth strategies and species. One complacent (i.e. drought-resistant) and one sensitive (i.e. drought-tracking) core per site was analyzed to measure tracheid diameter and cell wall thickness. Cell anatomy and ring width variation were then incorporated into estimates of drought "resilience". Resilience is classified as a combination of drought resistance (i.e. immediate drought response) and drought recovery (return to pre-drought growth patterns). Here we present preliminary findings that describe general trends of drought resilience by species and location, and discuss on-going work in the park and at other heavily instrumented sites in the Sierra Nevada Critical Zone Observatory (CZO) to begin to identify drought-resilient stands, populations, and individuals throughout the Sierra Nevada mountains. Results have significant implications in identifying management priorities throughout the Sierra Nevada, including identification of climate refugia and climate-sensitive regions, as well as for assisting in identification of drought-resistant phenotypes

Anthony Ambrose: Giant Sequoia Drought Response

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Ecophysiological responses of giant sequoia trees to severe drought

Hotter droughts associated with increasing global temperatures are emerging as one of the primary threats to forests throughout the southwestern United States. Understanding how trees respond to drought and how this response varies spatially is important for land managers to effectively manage and conserve these forests in a rapidly changing climate. We evaluated the responses of giant sequoia trees in Giant Forest, Sequoia National Park, to California's severe 2012-2015 drought as part of an ongoing collaborative research project with partners from the National Park Service, US Geological Survey, and Carnegie Airborne Observatory. The primary goals of this project are to improve our understanding of drought impacts on these trees and to map the spatial patterns of tree drought vulnerability across the forest. Survey maps prepared by the US Geological Survey in 2014 were used to select both seedling and mature giant sequoia study trees at sites exhibiting either high or low levels of leaf and small branch dieback. Study trees were sampled in the late summer of 2015, in the late spring of 2016, and again in the late summer of 2016. Leaf water potential, water content and other chemical traits were quantified at each sample period to provide insight into each trees' level of drought stress and physiological response. Both seedling and mature giant sequoia trees exhibited signs of severe water stress in the summer of 2015, with only a slight recovery in the late spring and summer of 2016. Tree water status was highly variable both within and among study sites. Leaf and branch dieback likely resulted from excessive xylem embolism in distal organs. However, stomatal closure combined with adjustments in leaf area appear to be effective mechanisms that allow giant sequoia trees to maintain a water status above a critical threshold beyond which severe damage to the water transport capacity of the tree would occur. This isohydric water use strategy likely helps giant sequoia trees survive severe drought, thereby minimizing the risk of mortality. Additional monitoring of giant sequoia responses to drought and potential recovery is ongoing.

Example of oak mortality in the Sierra Nevada foothills. Photo by: Bobby Kamansky.

Bobby Kamansky: Foothill Drought Response

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Foothill and valley oak woodland drought responses

This study investigates oak woodland mortality in response to climate, aspect, drought, soils and water management in the Kaweah Watershed in Tulare County. We explored several hypotheses relative to oak mortality in the Kaweah Watershed, (a) oaks die when a combination of heat and drought make soil water unavailable, causing trees to stress and die; (b) oak mortality is greatest in sandy soils near rivers because of groundwater elevation decline and mortality declines in poorly drained soils, away from waterways; (c) mortality could be caused by a combination of factors, including an increasingly dry and hot climate. We found variation in oak mortality in relation to tree size, smaller trees were both more numerous and had highest mortality - nearly 50% - while other size classes showed substantial mortality as well; soils, mortality was surprisingly low in clay soils with relatively high salt content; aspect, oak mortality was highest on south aspects at low elevations. In light of these findings, oak mortality is a major concern for communities and natural lands owing to impacts on scenic resources, carbon storage, water quality and quantity and wildlife habitat. Oak mortality can be reduced through restoration, stand and invasive species and water management.

White pine blister rust infection. Photo by: Joan Dudney.

Joan Dudney: White Pine Blister Rust

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White pine blister rust: the search for a silent killer

An exotic pathogen of grave concern to managers and scientists throughout the US and California is white pine blister rust (WPBR). The exotic fungus was first introduced into western North America in 1910. WPBR has since caused precipitous population declines in several species of white pines. For example, WPBR spread in *Pinus albicaulis* have been so severe that the U.S. Fish and Wildlife Service decided to place the species for listing under the Endangered Species Act in 2011. White pines typically act as critical foundation species, and their loss can have complex, cascading effects throughout ecosystems. Sequoia and Kings Canyon National Parks (SEKI), in California's Sierra Nevada mountain range, have an unusually rich complement of five white pine species that are all potentially threatened by WPBR. Although WPBR was first discovered in SEKI in 1969, it was not until the late 1990's that park managers established a baseline assessment of disease spread and severity. Now, twenty years later, we are investigating whether WPBR has spread further into remote areas of the park. Our preliminary data show a 60% increase of WPBR infection at higher elevations. Last summer, we also documented the southern-most WPBR infection in whitebark pine known to date. In addition, WPBR spread rates increased in lower elevation sugar pine populations. More broadly, our data show sugar pines have dramatically declined over the past twenty years. Their mortality rates have increased by 200% over normal background rates (i.e., 2% percent per year).

Kaitlyn Heck and Carley Messex: Climate Change and Corridors
UCLA Institute of the Environment and Sustainability

Finding connections for climate change: a corridor study for Sequoia and Kings Canyon National Parks

As part of a senior environmental science practicum, we are working on a year-long capstone program in the Institute of the Environment. In this projet, we are seeking data and other information to help identify corridors that may be important landscape connections for climate change adaptation. In one possible scenario, species may be able to migrate up in elevation. We need to know three things: 1) Are species outside the parks trapped? And what species? 2) What is the land cover and extent of fragmentation outside the park? 3) How do we connect these habitats to the park's lower elevations? We intend to research and summarize: Anticipated climatic change; possible impacts to species and the ecosystem; and the current state of habitat alteration/loss inside and outside the park. We will then decide on an approach for corridor analyis for our project area, the Kaweah River Watershed in Sequoia National Park.

Aquatic Ecosystems

Mountain yellow-legged frog. Photo by: Roland Knapp.

Roland Knapp: Mountain Yellow-legged Frog Research
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Preventing the extinction of endangered mountain yellow-legged frogs in Sequoia and Kings Canyon National Parks

A century ago, mountain yellow-legged frogs were abundant in lakes, ponds, and streams across the mid and high elevation portions of Sequoia and Kings Canyon National Parks (SEKI). However, due largely to the extensive introduction of nonnative trout into naturally fishless habitats and the recent spread of a highly virulent amphibian pathogen *Batrachochytrium dendrobatidis* across SEKI, mountain yellow-legged frogs have disappeared from more than 90% of their historical distribution in SEKI and rangewide, and in 2014 were listed as endangered under the U.S. Endangered Species Act. To prevent the extinction of mountain yellow-legged frogs in SEKI, an ambitious effort is underway to remove introduced trout populations from key habitats and reduce the negative impacts of disease. Mitigating the effects of disease is particularly challenging, in part because of the paucity of information about *B. dendrobatidis*. Nevertheless, several novel approaches are currently being tested in the field, including treatment of frogs during disease outbreaks, and rearing of frogs in captivity and their subsequent reintroduction into the wild. Collectively, these approaches show considerable promise for conserving and recovering mountain yellow-legged frog populations in SEKI and rangewide, and provide methods that can also be applied to the conservation of other threatened amphibian species worldwide.

Mary Clapp: Fish and Soundscapes

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Learning by ear: using acoustic data to investigate the impacts of non-native trout introductions on the adjacent terrestrial community

Non-native species introductions can have strongly disruptive cascading effects on native ecosystems, and these impacts can be exacerbated by environmental stressors such as climate change in unpredictable ways. Trout were introduced for recreational angling to the historically fishless high-elevation watersheds of the Sierra Nevada beginning the late 1800s, and their deleterious impacts on the abundance and distribution of native aquatic biota are well-studied. However, few studies have addressed how such a change to the aquatic ecosystem affects the adjacent terrestrial community, despite growing understanding of the importance of resource subsidies across aquatic-terrestrial boundaries. In particular, birds may opportunistically exploit large hatches of emerging aquatic insects as a valuable food source during their short summer breeding season, when nutritional requirements are high. Such hatches of large-bodied macroinvertebrates are reduced or absent in fish-containing lakes. I examined the extent to which the loss of the aquatic insect subsidy in fish-containing lakes has altered bird activity using both acoustic monitoring and traditional survey methods. I installed acoustic recorders, conducted multi-species point counts, and measured aquatic insect emergence at 6 pairs of fish-containing and fishless lakes within Sequoia and Kings Canyon National Park in 2014 and 2015. I used the Acoustic Complexity Index (ACI) to summarize diel and seasonal patterns in bird vocal activity, and ground-truthed this proxy for bird activity using a subset of acoustic data for which all calls were identified to species. I used multilevel models to investigate differences in ACI and traditional point count data between lake types. Initial analysis suggests that overall bird abundance at fish-containing lakes is lower than that at fishless lakes, and that some species respond more strongly than others to fish presence. Future work will address whether proximity to fishless lakes alters diet composition, body condition, and nesting &/or fledging success of birds breeding in alpine lake basins.

Steve Sadro: Climate Change and Emerald Lake

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Climate change in the southern Sierra Nevada: Effects of drought and climate warming on water temperature in snowmelt dominated Emerald Lake

We analyzed three decades of climate and lake temperature data from a high-elevation catchment in the southern Sierra Nevada of California to illustrate the magnitude of warming taking place during different seasons and the role of precipitation in regulating lake temperatures. Significant climate warming trends were evident in all seasons except spring. There were consistent diel patterns in

Digging a pit to collect snow samples for chemical analyses and measurements of atmospheric deposition. Photo by: Steven Sadro.

warming, with rates ~25% higher at night than during the day. Annual rates of warming were higher at sites above tree-line than below, similar to patterns of elevation dependent warming in other mountain regions. Although interannual variation in snow deposition was high, the frequency and severity of recent droughts has contributed to a significant 3.4 mm year -1 decline in snow water equivalent over the last century. Despite rates of climate warming considerably higher than global averages, 94% of variation in summer lake temperature was regulated by precipitation as snow: for every 100 mm decrease in snow water equivalent there was a 0.62 ℃ increase in lake temperature. Drought years amplify warming in lakes by reducing the role of cold spring meltwaters in lake energy budgets and prolonging the ice-free period during which lakes warm. The combination of declining winter snowpack and warming air temperatures has the capacity to amplify the effect of climate warming on lake temperatures during drought years. Interactions among climatic factors need to be considered when evaluating ecosystem level effects, especially in mountain regions. For mountain lakes already affected by drought, continued climate warming during spring and autumn has the greatest potential to impact mean lake temperatures.

Cascade Lake, Inyo National Forest. Example of high-elevation lake sampled for lake warming and nitrogen deposition research. Photo by: Marika Schulhof.

Marika Schulhof: Lake Warming and Nitrogen Deposition

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Effects of warming and nitrogen deposition on microbial communities in Sierra Nevada lakes

Climate warming and atmospheric nitrogen (N) deposition are two major environmental stressors affecting the sensitive alpine lake ecosystems of the Sierra Nevada. Climate change and nutrient pollution can shift food web structure and ecosystem function through bottom-up processes controlled by microbial communities that influence biogeochemical cycling and trophic structure. The purpose of this study was to determine the independent and interactive effects of temperature and N deposition on microbial community structure. We sampled thirty-five lakes across gradients in elevation (temperature) and N deposition (measured as NO3-) in Sequoia National Park, Yosemite National Park, and Inyo National Forest. We measured physical and chemical variables in lakes and microbial community composition via sequencing of 16S and 18S rRNA genes (prokaryotes and eukaryotes). Results suggest that both NO3- and elevation are significant drivers of community composition and some microbial taxa shift in abundance across these gradients. Better understanding how changes in microbial community composition may occur with warming and N deposition is important for management of Sierra Nevada lakes because bottom-up processes affect food web structure, ecosystem function, and recreational value of lakes via changes in water quality and fish biomass.

Wildlife

Rachel Mazur: Wildlife Management Priorities

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Juggling priorities while making a difference: the Yosemite strategy for managing wildlife

The national parks are tasked with preserving and protecting the wildlife therein, but what does that really mean? When the National Park Service (NPS) was established, that meant preserving the parks in the condition they were in when Euro-Americans arrived. Once the environmental movement started, the 1963 Leopold Report and other publications redirected the NPS to instead restore the parks to be "a vignette of primitive America," meaning to restore them to the condition they were in prior to the arrival of Euro-Americans. In the 80s and 90s ecologists wrote about how processes are more important than conditions. And more recently, guidance has fixated on climate change and resilience, but we are now questioning even the meaning of that. So where are we? In this talk, I will outline the goals of the Yosemite wildlife program and what we see as our mission and task for the next ten to twenty years.

Paul Heady: Winter Ecology of SEKI Bats

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Winter ecology of bats within a karst environment in the southern Sierra Nevada: implications for White-Nose Syndrome monitoring

Solitary Townsend's Big-Eared Bat hibernating, Sequoia Canyon National Park. Photo by: Paul Heady.

Improving baseline information regarding overwinter bat behavior in western North America is necessary to assess potential risk of impact of White Nose Syndrome (WNS) on western bat species. During the winter of 2014-2015, we surveyed 60 caves in Sequoia and Kings Canyon (SEKI) National Parks and recorded bat echolocation activity across an elevational gradient from 700-3100m to determine winter use of caves and winter bat activity. Less than 20% of caves (11/60) had bats from November-March and nearly half of these caves housed single individuals of Townsend's big-eared bat (*Corynorhinus townsendii*). The largest aggregation of bats was less than 10 C. townsendii and the only other species found in caves were two big brown bats (*Eptesicus fuscus*). The majority of caves had temperatures suitable for bat hibernation (0-14 C). Acoustic surveys showed seventeen species were active in the region from September-March. Our results suggest that while species richness and activity were high, the extensive cave habitats present were not used by large aggregations of bats for hibernation. Nor did we find evidence that western Myotis species used cave habitats in winter. Relatively high levels of winter activity, especially at lower elevations, also suggest that foraging occurred year-round. Lack of use of cave habitats as hibernacula by most western bat species requires that alternative methods of surveillance be developed for monitoring impacts of WNS in western habitats. Finding winter habitats of *Myotis spp* by radiotracking during fall and studying the winter hibernation habits of western *Myotis* should be a top priority for assessing potential risk of WNS to western bat faunas.

Thomas Munton: California Spotted Owl Research
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Twenty-Two Years of Spotted Owl Research in Sequoia and Kings Canyon National Parks
The status of the California spotted owl (*Strix occidentalis occidentalis*) in the Sierra Nevada is of concern because of the owl's association with mature conifer forests and a multitude of threats posed by timber harvest, fire suppression, fuels and forest restoration treatments, high severity wildfire, tree mortality caused by drought, climate change, barred owls and rodenticides associated with illegal marijuana cultivation. Four long-term demographic studies in the Sierra Nevada and southern Cascades have provided the sole source of empirical information on spotted owl population trends in this region. One of these studies was conducted in Sequoia and Kings Canyon National Parks on a 343 km2 study area (SKC) from 1990 through 2012 by the Pacific Southwest Research Station of the USDA Forest Service. Results from demographic studies indicate significant differences in owl demographic parameters between SKC and the other 3 studies on National Forests. Owls in SKC have higher adult survival than owls found on the 3 National Forest study areas. Further, the SKC population was stable or increasing during the monitoring period whereas all 3 population on National Forest lands were declining. Bayesian Markov chain Monte Carlo methods were used to estimate median realized population change (Δ_t) and the retrospective probability of decline. SKC was likely a stable or increasing population (median $\Delta_t = 1.25$, indicating a 25% increase in the population from 1993-2012), with a low probability of decline ($p = 0.09$). Two National Forest study populations were likely declining during a similar period (median $\Delta_t = 0.56$ and 0.69, estimated probability of decline was 0.1.00 and 0.97, respectively). SKC territory extinction rates declined slightly and colonization rates increased from 1993 to 2012, with little demonstrated change in SKC occupancy (~3% increase); however, Δ_t estimated from spotted owl territorial occupancy data may be less sensitive to population changes than estimates from banding data. A recent meta-analysis examining data from the 4 demographic studies in the Sierra Nevada found forests with medium (40-70%) and high (≥70%) canopy cover were important predictors of territory occupancy on all study areas and were positively correlated with occupancy. Given the importance of the SKC study because of its long history and value as a comparison to population trends on National Forest lands we recommend that the study be reinstituted.

Lacey Greene: Bighorn Sheep Demography and Population Modeling
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Demography and population modeling of Sierra Nevada Bighorn Sheep
Sierra Nevada Bighorn Sheep (SNBS) have gone through two major translocation efforts, during the 1980's and at present, beginning in 2012. Reviewing the population history since 1979, when relatively good population estimates were first compiled, provides perspective against which to measure the performance of our contemporary establishment of new populations within historic ranges. Thus, we present a demographic overview of the SNBS population as a starting point. Demographics provide an important management / evaluation tool as noted in the SNBS Recovery Plan. We employ minimum counts and marked resight methods of population estimation depending on logistical considerations for a given population. Using these data to evaluate the demographic trajectory of each population, we can begin to measure performance and long term viability of individual popuations. In order to establish new populations a variety of analyses were performed: evaluation of genetic diversity, population level effects of animal removals on source populations,

demographic viability of new populations, resource selection, and home range evaluation. After four years of data collection, we can review some of these model predictions against actual data and evaluate them. Our demographic data shows good agreement with the model predictions of modest effects on source populations. The growth of the new populations is not quite as robust as predicted, but we are still seeing positive growth which may benefit from augmenting the populations. While we don't have the final data to evaluate population genetics, we can look at demographic factors like breeding success, lamb: ewe ratios and yearling: ewe ratios to partially evaluate if the strategy appears to be effective.

Fire Ecology

Lupines in understory of a Sierra Nevada burn site. Photo by: Kate Wilkin.

Hugh Safford: Historical Forest Density Estimates

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Validating Voronoi-Area based estimates of historical forest density in California mixed conifer forests

In the western US, historical forest conditions are often used as references for restoration, because these forests are considered to be closer to their primitive state and less degraded by human activities. A major challenge is locating information on historical forest structure that can help guide restoration planning. One of the more intriguing sources of data is the General Land Office (GLO) survey work done in the late nineteenth and early twentieth centuries. The point- center-quarter methodology used by GLO to mark important survey points and inventory surveyed forests has been widely used to calculate approximate basal areas and estimate forest tree composition at broad spatial scales. However, the methodology and the small sample size (< 8 trees sampled per square mile) make forest density estimates a more difficult proposition, especially at finer spatial scales that are more meaningful for site-based restoration. Recently, Baker and colleagues developed a Voronoi Area (VA) based estimator for the GLO data that was claimed to accurately represent historical forest densities at relatively fine spatial scales. Baker et al.'s density estimates are (much) higher than any other historical or modern reference dataset, and have been used to cast doubt on the low forest densities targeted in most forest restoration projects. We carried out a validation of the VA estimator and three distance-based estimators using six forest stands of known density across a wide range of densities (161-791 trees ha -1) in the Sierra Nevada in California, US, and the Sierra de San Pedro Mártir in Baja California, Mexico. We found that the Voronoi estimator consistently overpredicted density – due primarily to its underprediction of the Voronoi area of large trees – and the Morisita estimator was the most accurate of the four tested. We also applied the VA and distance-based estimators to two large reference landscapes ("reference" = unlogged and with semi-natural fire regimes; locations were Illilouette Creek Basin, Yosemite National Park, and Sierra de San Pedro Mártir, Baja California) where we carried out the GLO field protocol on areas of 20-25 square miles. Similar to the stand-scale study, we found that the VA estimator did not reliably reproduce actual forest densities.

Kate Wilkin: Fire Restoration Effects on Understory Plants

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Drivers of understory plant communities in mixed conifer forests with long-restored fire regimes

Fire suppression caused large changes in forests, their understory plant communities, and a potential decline in plant biodiversity. We sought to understand past understory communities and their drivers in an arid mixed conifer forests with long restored fire regimes. This expansive and long-term study utilized natural experiments which were part of Wildland Fire Use program, including the Illilouette Basin in Yosemite National Park and Sugarloaf Valley in Kings Canyon National Park. The Wildland Fire Use areas began in the 1970s when the National Parks allowed lighting strike fires to burn and thus restored fire regimes. These fires reduced fuels and performed other ecosystem restoration functions such as opening canopies which foster the re-development of diverse forest understories. Understory plant communities were influenced by a combination of forest structure, environmental, plot-scale fire experience, and regional-scale fire experience within 50 and 75 meters. There were seven distinct plant communities which could explained by forest structure, elevation, local fire experience, and a diversity of regional-scale fire, also called pyrodiversity − the diversity of fire size, severity, season, and frequency. Broad community metrics (cover, richness Simpson diversity, and evenness) were also influenced by similar, but distinct environment, forest structure, plot-scale fire experience, and regional fire experience. Canopy cover, an indirect measurement of restoring fire as a process and its mixed fire severity, influenced plant communities. As canopy covered increased from 0 to 100%, understory plant cover decreased 7%, Simpson diversity decreased 0.09, and evenness decreased 0.11. Plant cover also influenced burn severity and number of times burnt, although to a lesser degree. Richness was increased by moisture, soil texture, and pyrodiversity. Based on our study, restoring mixed severity fire regimes can lead to an overall reduction of canopy cover and unique fire experiences within 50 and 75 meters, which in turn fosters diverse understories.

This late-seral red fir stand in Yosemite National Park was burned in the 1999 Lost Bear Bruno Fire and 1988 Horizon Fire. Photo by: Marc Meyer.

Marc Meyer: Fire and Red Fir Forests

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Structure, diversity, and health of red fir forests within active fire regime landscapes of the Sierra Nevada

The health of red fir (*Abies magnifica*) forests is declining in California under regional warming trends, recent drought, and fire exclusion. Increased use of wildland fire, especially wildfires managed for resource objectives, is one climate adaptation strategy that may restore the structure and health of red fir forests in the Sierra Nevada and other montane regions of California. We examined the influence of repeated burning on the structure and health of red fir stands by comparing twice burned and unburned stands in 18 separate, paired fires of Yosemite, Sequoia, and Kings Canyon National Parks. Burned red fir stands were characterized by lower tree densities and canopy cover, greater mean tree diameter, and fewer tree clusters than unburned stands. Twice burned stands were also higher in understory plant diversity, including herbaceous plants, shrubs, and tree regeneration. Forest health indicators, such as dwarf mistletoe or live crown ratings, were similar between burned and unburned sites. Our results suggest that use of wildland fire may restore red fir forest structure and understory composition within active fire regime landscapes, but it may not influence red fir forest health in areas of greater projected climate exposure. Nevertheless, fire use builds adaptive capacity in red fir forests by increasing tree species diversity, enhancing structural complexity, and reducing fuel loading.

James Bland: Post Fire Ecology of Galliform Birds

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New insights and emerging research needs on the post-fire ecology of galliform birds in the Sierra Nevada Mountains.

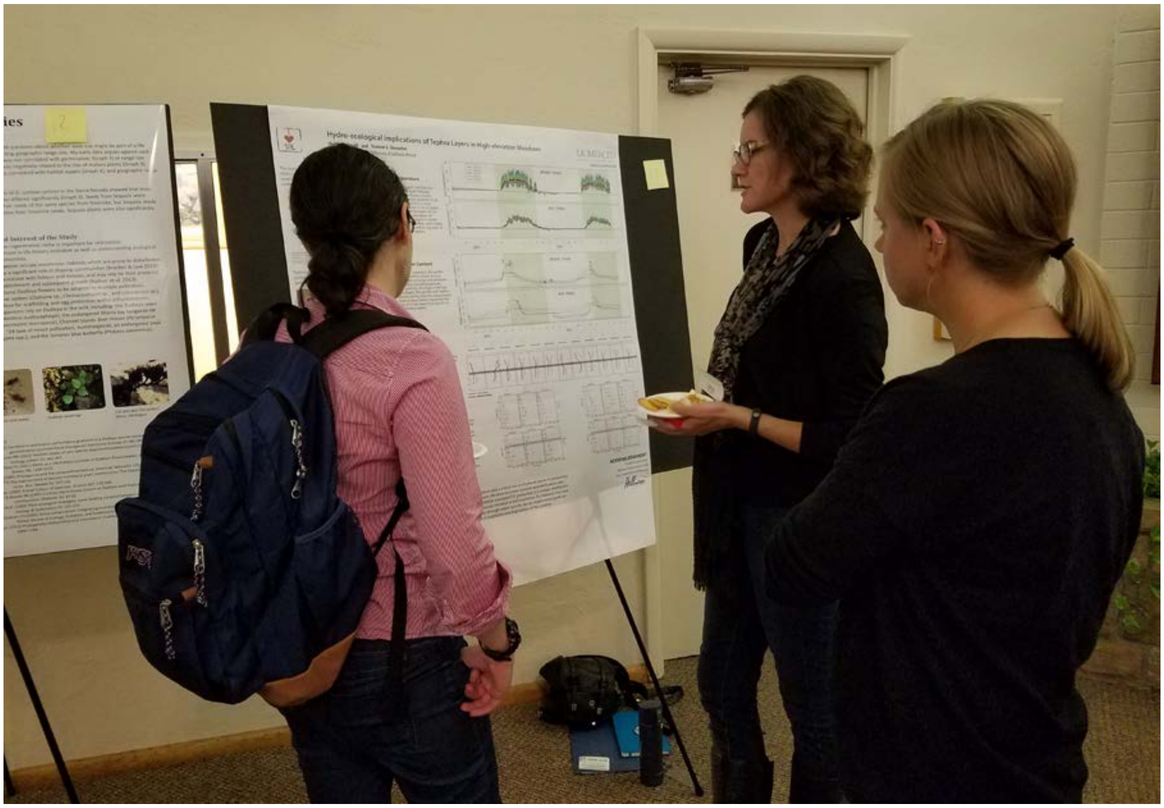
Six species of galliform (chicken-like) birds occur in the montane Sierra Nevada. Three are native and have adapted to regional environments over thousands of years, whereas the others are introduced and continue to expand their range with unknown ecological consequences. Most literature on the Sooty Grouse (*Dendragapus fuliginosus*) indicates it is most abundant in early forest seres. Studies I have conducted over the past 24 years (beginning in Sequoia National Park) show the Sierra Nevada subspecies (*D. f. sierrae*) is closely associated with old forest. Breeding males choose trees that average 1 m in diameter as songposts, and are positively associated with the abundance of large fir trees and logs, and negatively associated with past timber harvest. The Sierra Sooty Grouse is adapted to primary Sierra Nevada forest, where fine-scale succession places clusters of large trees in close proximity to canopy openings, creating the subspecies' characteristic niche gestalt. Much

Sooty Grouse habitat has been degraded on Forest Service and private land by removing the largest trees; the most likely cause of Sooty Grouse extirpation south of the Kern Gap. Where large firs remain, fire suppression is degrading habitat by allowing understories to become overgrown. Future research should focus on how fire maintains forest structure and composition in Sooty Grouse habitats, how local breeding groups respond to large catastrophic fires, and on refining census methods. The Mountain Quail (*Oreortyx pictus*) is well known to be associated with early shrub seres, but its population response to post-fire habitat succession remains unclear because efficient methods for assessing its populations and habitats are lacking. Game Bird Research Group recently began studying male vocalization patterns in order to develop better auditory census methods. Future research should focus on efficient methods to access shrubby vegetation on terrain too rugged to assess on foot. The Sooty Grouse and Mountain Quail are iconic, native, relatively abundant species whose populations are closely tied to natural Sierra Nevada fire regimes. Because they exhibit strong population responses along the full range of post-fire seres, they should be utilized to greater effect in managing Sierra Nevada National Parks.

Mountain Quail. Photo by: James Bland.

Poster Presentations

Twenty posters were available to view during the two-day symposium, and the informal poster presentations occurred during the evening of November 9th. The presentation categories are the same as those of the invited talks, with two additional topics added: Geology and Technology.



Poster presentations offered an opportunity to talk informally about Sierra Nevada research. Here, Chelsea Arnold of UC Merced discusses her poster on the hydroecological effects of tephra on subalpine meadows.

Aquatic Ecosystems

Andrea Heard & James Sickman: Nitrogen Assessment Points for Sierra Nevada Lakes
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National Park Service (Andi) and University of California, Riverside (Jim)
Nitrogen assessment points: development and application to Sierra Nevada Network lakes
Increased nitrogen (N) inputs to oligotrophic high-elevation lakes are contributing to long-term eutrophication, changes in nutrient cycles, and shifts in phytoplankton communities. State of California water quality standards do not adequately protect mountain lake ecosystems from atmospheric deposition, including lakes in national parks and other protected areas. The development of quantitative nutrient assessment points based on measurable ecological effects specific to high-elevation lakes is an important step in long-term protection of these ecosystems. We conducted in situ bioassay experiments during the phytoplankton growing season and modeled the response of phytoplankton to nutrient additions using algal growth models. Phytoplankton responded to nutrient

additions (N and N + phosphorus) in five out of seven experiments conducted in N limited lakes. Results were modeled using Michaelis-Menten, Monod, and dose response curves and used to calculate effective doses (ED) for excess phytoplankton growth. The 10, 50, and 90% ED estimates were determined for early and late hydrologic seasons. Results for the 10% ED were 0.33 (early) and 0.89 (late), the 50% ED were 1.0 µM (early) and 4.0 µM (late), and the 90% ED were 3.1 µM (early) and 18 µM (late). We then applied these assessment points to lake chemistry data from the National Park Service's Inventory and Monitoring program to assess the status of lakes across Yosemite, Sequoia, and Kings Canyon national parks. Mean nitrate concentration during the growing season was 4.58 µM and ranged from less than 0.04 to 11.8 µM (n = 75). The 10% EDs were exceeded by 28% (late) and 37% (early) of lakes, the 50% EDs were exceeded by 18% (late) and 29% (early) of lakes, and the 90% EDs were exceeded by 0.0% (late) and 21% (early) of lakes. Our results suggest that phytoplankton populations in many Sierra Nevada lakes are affected by N deposition based on exceedance of growth assessment points. The most sensitive lakes are typically found at higher elevations in watersheds with steep, north facing slopes and minimal vegetation.

Colleen Kamoroff & Caren S. Goldberg: eDNA as a Tool for Detection of Viable Individuals in Wilderness Restoration and Management

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An issue of life or death: the use of environmental DNA to detect viable individuals in wilderness restoration and management

Aquatic environmental DNA (eDNA) obtained from filtered water samples is a promising tool for monitoring invasive species, but application of this method is hindered by the inability to distinguish whether sources are alive or dead. We analyzed how the detection of eDNA from dead and live model organisms (*Carassius auratus*) differs depending on collection method and applied the resulting method in the field. We sampled 15 microcosms containing dead or live fish through time using different filter membrane types and pore sizes and at varying depths. We detected DNA from dead individuals less frequently and in lower quantities compared with live individuals; DNA from dead individuals was found only at the bottom of the water column. As pore size increased, the quantity of DNA captured decreased for both treatments. Because dead individuals were associated with less DNA, using filters with larger pore sizes decreased detection of dead individuals. We applied our findings to restoration sites across Yosemite and Sequoia Kings Canyon National Park where non-native fish were being removed to create habitat for two endangered yellow-legged frog species. We sampled completed restoration sites (sites containing only dead fish, N = 21) as well as active restoration sites (sites containing dead and live fish, N = 9) with 1.2 µm PCTE filters. Our field sampling accurately indicated the status of each site, with the exception of one low-level false positive and one false negative at a low-density site. Our results highlight that collection methods for eDNA can be tailored to maximize the utility of eDNA techniques in aquatic habitat conservation.

Andrew Rothstein: Population Genetics of Mountain Yellow Legged Frogs

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Population genetics of endangered mountain yellow legged frogs (*Rana muscosa* and *Rana sierrae*) in Sequoia and Kings National Parks

Mountain yellow-legged frog (*Rana sierrae* and *Rana muscosa*) abundances have declined rapidly due to threats from chytridiomycosis disease and predation from non-native trout introductions. Since initial surveys in 1924, declines across the Sierra Nevada range have been estimated at 90%, with much of this decline occurring within the last couple of decades. Sequoia and Kings Canyon NP contain the largest remaining populations of this species complex and subsequently is a primary

contributor for frog translocations and recovery efforts. However, given the limited knowledge of the genetic structure and variation of the species, researchers and managers have been restricted in translocations of frogs to avoid introducing novel genotypes to sub-populations. To address this issue, we developed a population genetic study within Sequoia and Kings Canyon NP of the mountain yellow-legged frog species that included sampling locations encompassing 48 drainage basins across three major rivers (San Joaquin, Kings, and Kern). Using a custom assay for the species, we applied genetic material from non-invasive swab samples to sequence 48 genomic regions and analyzed the distribution of genetic variation across the geographic region. Our results concluded three main populations clusters separated by the three major rivers. In addition, the species exhibited a strong pattern of isolation-by-distance. Preliminary evidence also revealed a dichotomy between the middle and south forks of the Kings River that split the two species, which was previously suggested from mitochondrial genetic work. However, separating populations between the San Joaquin and Kings river systems proved ambiguous as compared to previous genetic work; highlighting the importance of this study for management of frog populations. Developing a clear picture of the genetic variability and patterns associated with these managed populations will undoubtedly inform recovery strategies for this species.

Mary Toothman: Biotic and Abiotic Factors in Bd Outcome in Mountain Yellow Legged Frogs
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Biotic and abiotic factors in Bd outcome in mountain yellow legged frogs
Batrachochytrium dendrobatidis (Bd) is a pathogenic fungus that causes chytridiomycosis, a skin disease responsible for amphibian declines worldwide, including Mountain Yellow Legged (MYL) frogs, Rana muscosa and Rana sierrae, in California's Sierra Nevada mountains. Bd has been present in the northern Sierra for over 30 years, and most existing northern populations are persisting with sublethal infections at 75-100% prevalence. Bd only invaded southern parts of the Sierra less than 15 years ago, and has almost invariably driven these populations to extinction. Early lab experiments confirmed that 100% of naïve MYL frogs, regardless of source population, will succumb to chytridiomycosis without intervention. Subsequent experiments demonstrated, however, that 100% of naïve MYL frogs mount an effective adaptive immune response to a second chytrid exposure if their first infection is cleared before it causes mortality. What causes persistence or extirpation in MYL frog populations invaded by Bd? In my PhD work, I am examining variation in immunological and genetic factors between individuals and across populations, as well as environmental variability between lake habitats. My main research questions are: Is there a measurable difference in immune response of newly infected animals and previously infected animals? Is there any evidence for favorable genotypes in immunogenes or other genes of interest? Does the aquatic environment (water chemistry, substrate type, community composition) influence Bd's ability to persist outside the host? I hope to determine if any set of these host and environmental factors correlates to population-level MYL frog persistence with Bd. I hypothesize that some combinations of immune variability in frogs and environmental variability may push one population towards persistence with infection while others may facilitate population extirpation. The overall goal of my project is to add to a growing set of guidelines that allow conservationists to make decisions for successful repatriation efforts, as well as predict the impact of Bd outbreaks in naïve populations.

Current Stressors to Forest Systems

Rainbow DeSilva: Genetic Diversity, Gene Flow, and the Persistence of Long-lived Tree Species in an Era of Rapid Environmental Change

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Genetic diversity, gene flow, and the persistence of long-lived tree species in an era of rapid environmental change: Lessons for *Sequoiadendron giganteum*.

During this century, climate warming and altered precipitation patterns will lead to habitat changes that may be beneficial to some long-lived tree species and detrimental to others. Paleoendemics, with limited and disjunct distributions will face the greatest challenges as, migration rates will be too slow to keep pace with rapid environmental change and populations at the receding edges are eroded through maladaption. Giant sequoia (*Sequoiadendron giganteum*) is an iconic Sierra Nevada tree species with populations that tend to be small and highly fragmented (particularly in the northern range), making them especially vulnerable to environmental change. Thus, attention needs to be paid to mechanisms that can mitigate population extirpation. Important determinants of within-range persistence for giant sequoia include the existence of genetic variation that is suited to future conditions and the spread of these “pre-adapted” genotypes within current range boundaries by gene flow. Our ongoing research addresses 1) the levels and distribution of genetic diversity (adaptive and non-adaptive) throughout the range of giant sequoia, and 2) the dispersal distances of pollen and seed and consequent rates of gene flow across a highly fragmented habitat.

We utilize microsatellite markers and Restriction site Associated DNA sequencing (RAD-seq) to assess genetic diversity. Gene flow is assessed with DNA from germinated seeds, using multi-locus genotypes to characterize parentage and estimate dispersal distance.

Preliminary findings show that current levels of genetic diversity are determined, in large part, by population size. We anticipate that proximity to other giant sequoia populations, that is more important in the southern range of the species, is also an important driver of genetic diversity through genetic exchange among groves. Our research will show the spatial scale and limits to gene flow among geographically proximate populations and isolated groves. Also, we anticipate that smaller populations will draw pollen from a larger area due to a more limited local pollen pool. This research is essential for land managers with giant sequoia on their lands, as it will help them to prioritize giant sequoia conservation efforts by highlighting areas of high and low genetic diversity. Moreover, this research has the potential to improve tree-planting strategies by identifying gene pools as seed sources and planting strategies that promote maximum genetic diversity over future generations.

Qin Ma: Forest Growth Responses to Competition and Environmental Conditions

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Forest growth responses to competition and environmental conditions

Trees in the Sierra Nevada (SN) forests are experiencing rapid changes due to human disturbances and climate change. An improved understanding of how tree growth responses to internal and external controlling factors, such as tree sizes and competition, forest density, topographic and hydrologic conditions is essential for tree growth modeling. The Airborne Laser Scanning (ALS) system has advantages over traditional in-situ measurements in large-scale forest survey due to its efficiency and accuracy in three-dimensional tree structure delineation and terrain characterization. In this study, we took advantages of bi-temporal ALS data and successfully detected individual tree growth in height (ΔH), crown area (ΔA), and crown volume (ΔV) over a five-year period (2007-

2012) in two conifer-dominant forests in the SN. Results indicated ΔH was strongly sensitive to topographic wetness index ($R2 = 0.67$); whereas ΔA and ΔV were highly responsive to forest density ($R2 > 0.4$) and original tree sizes ($R2 > 0.8$). These correlations derived from ALS were consistent with in-situ tree height measurements. Our findings demonstrated the promising potential of using multi-temporal ALS for forest growth measurements and would provide some guidance for forest growth modeling and management.

Koren Nydick et al.: Using California's Hotter Drought as a Preview of the Future

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Using California's hotter drought as a preview of the future: the leaf to landscape forest vulnerability project

"Hotter droughts" (otherwise normal droughts whose effects on ecosystems are exacerbated by higher temperatures) are an emerging climate change threat to forests, with some of their earliest and strongest manifestations in the American West. Managers can increase forest resistance to hotter droughts, such as by thinning forests to reduce competition for water among the remaining trees. However, the task is so vast that managers often need to perform triage, deciding where on the landscape their limited funds will be best applied; that is, they need forest vulnerability maps to help them strategically target treatments. But at the spatial and temporal scales that matter most to trees and forest managers, our ability to use commonly-available data sources to produce spatially-explicit maps of forest vulnerability is, at best, quite poor. We have thus launched the collaborative "Leaf to Landscape" project, which applies a fundamentally different approach to mapping forest vulnerability to hotter droughts. By using California's 2012-2015 hotter drought as a preview of the future, we let the trees themselves provide a direct empirical basis for vulnerability maps and for improving our basic mechanistic understanding of the effects of hotter droughts on forests. Leaf to Landscape thus has three main data-collection components, designed to be integrated across scales – from tree leaves to entire forested landscapes: (1) tree physiology and chemistry (directly measured by climbing hundreds of trees of the Sierra's 10 dominant tree species), which is strategically co-located with (2) population monitoring (ground surveys of foliage dieback and tree death in permanent forest plots), thus providing calibration and validation for (3) high-resolution LiDAR + hyperspectral remote imagery. The remote imagery will allow us to scale up to determine spatial patterns of drought effects, and their correlates. Early results already provide some unexpected insights.

Yanjun Su: Vulnerability of Giant Sequoia Groves to Changing Climate and Severe Droughts

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Vulnerability of giant sequoia groves to the changing climate and extreme droughts during the last three decades

Giant Sequoia (*Sequoiadendron giganteum*, SEGI), the oldest and largest (by volume) living tree species on Earth, is a unique and significant natural heritage. In recent decades, the rising temperature and extreme droughts occurred in the Sierra Nevada, California have largely changed the living conditions of SEGI trees. However, how the SEGI groves responded to the changing climate and extreme droughts and which part of SEGI groves were more vulnerable are still unclear. In this study, we examined the vulnerability of SEGI groves through evaluating their changing patterns in wetness and greenness from 1985 to 2015 using time-series Landsat imagery. The wetness and greenness of SEGI groves were represented by the normalized difference water index (NDWI) and normalized difference vegetation index (NDVI), respectively. We found that the wetness and greenness of SEGI groves were sensitive to the changing climate, and their responses were highly elevation-dependent. The SEGI groves in high elevation zones were more vulnerable to the changing climate, and the elevation zone of 50% precipitation as snow (1700 m – 2100 m) was the transition zone from an increasing trend in wetness and greenness to a decreasing trend. Moreover, we showed the wetness of SEGI groves was significantly influenced by extreme droughts and was more vulnerable to droughts than non-grove areas. In the 2011 – 2015 drought, the drop of NDWI in SEGI groves was over 50% more than that in non-grove areas. The increasing temperature further intensified the influence of droughts on the wetness of SEGI groves.

Molly Stephens: Effects of Microhabitat: Conditions and Environmental Stress on Giant Sequoia Seedlings

UC Merced

Effects of microhabitat conditions and environmental stress on giant sequoia seedlings

Giant sequoias are an iconic plant species, drawing thousands of visitors to the Sierran national parks each year. Although we understand much about these trees, including the critical roles of fire and open soil in seedling germination, we have limited information about local environmental factors that promote seedling survival. Survey efforts in 2013 confirmed a startling dearth of young trees in the Merced and Tuolumne Groves relative to the Mariposa Grove, suggesting insufficient fire and excessive canopy cover in these groves as the cause. A surge in seedling abundance in areas of the Tuolumne Grove that saw a 2013 burn underscores this connection. For 2016, we undertook surveys to identify the microhabitat conditions that facilitate seedling success. We are evaluating which microenvironment conditions (above-ground temperature, and light; below-ground temperature and soil moisture) facilitated seedling recruitment in Tuolumne Grove, Yosemite National Park. We conducted a third year of surveys evaluating giant sequoia seedling recruitment and survival rates in areas with varied fire history and associated vegetation types. Additionally, we are estimating environmental stress (drought and nutrient) effects on seedling recruitment using stable isotope analysis of carbon and nitrogen. From this research, we hope to provide park managers with specifics about factors influencing seedling success. The results will inform decisions about fire management activities and other active restoration actions (for example, thinning of competing vegetation, sequoia seedling transplantation or thinning) that may be necessary to enhance seedling recruitment in giant sequoia groves.

Geology

Jade Star Lackey: Near Surface Origins Explain the Unusual Ores of Mineral King

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It’s in the water: near surface origins explain the unusual ores of Mineral King

The suite of base (Cu, Zn, Pb) and precious (Ag, Au) metals that brought intense mining interest to the Mineral King area in the late 19th century is unlike most in the rest of the Sierra Nevada. Several years of studies of the interplay of magmatism and metamorphism in the Sierra Nevada give an intriguing new picture of the unique conditions that formed these ores. Our maps of ores and associated mineral distributions, U-Pb zircon geochronology, and oxygen isotope geochemistry to trace fluid sources, reveal several new aspects of the Mineral King story. First, magmatism heated and metamorphosed pre-existing sedimentary rocks (slates, marbles, calc-silicates) in two episodes during the Cretaceous: 136–134 and 109–105 million years ago. Second, we show that the ores were primarily deposited at interfaces between marble bodies and granitoid bodies (plutons), as is the case of the Empire Mountain and White Chief mining areas. The reaction of the marbles and plutons, catalyzed by hydrothermal fluids, formed copious amounts of calcic garnet (grossular and andradite), pyroxene, and wollastonite, i.e. “skarn” deposits. The skarns are concentrated at structural irregularities, folds, and along bedding planes. Oxygen isotope studies of garnet and other skarn minerals show that the “secret” ingredient of the Mineral King hydrothermal systems was water derived from Earth’s surface, and not the water shed from crystallizing magmas. Such a finding requires that the rocks at Mineral King were close enough to Earth’s surface for rocks to maintain open porosity to allow infiltration of oxidized surface waters that caused Cu, Zn, Pb, Ag, and Au to deposit from solutions. Whereas most granitoid landscapes in the Sierra have seen 10-15 km of rock removed from above, Mineral King’s ores are unusually shallow, having formed within 3 km of the surface. Formation of the Mineral King skarns also resulted in massive release of CO2 from marbles. Thus, these rocks yield considerable information about the interplay of Cretaceous magmatism, metamorphism, and global climate change.

Kate Biacindo: Hydrology Ramifications from the karst inventory on Paradise Ridge
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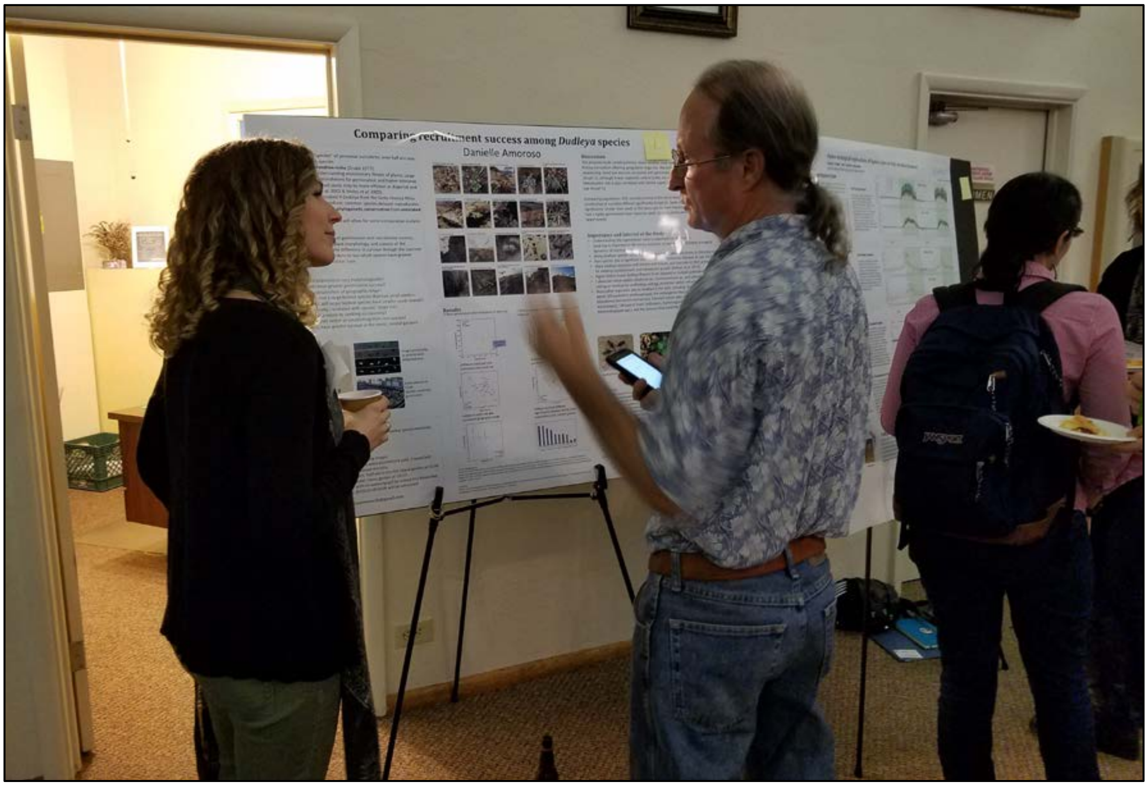
Hydrology ramifications from the karst inventory on Paradise Ridge

The Paradise Ridge-Milk Ranch Peak terrain located in Sequoia National Park was designated as Kreb Wilderness in 2009 (John Krebs Wilderness, 2015), With the recognition that wilderness-designated areas need to be inventoried for mineral and other resources (Fancy, Gross, & Carter, 2009), a karst research inventory was a likely candidate for NPS research. Karst aquifers contribute significantly to drinking water sources, and it is therefore important to monitor and maintain their natural state, especially in light of the long-term drought conditions that California is currently experiencing. The Paradise Ridge area can be seen as a prototype for California karst investigation as related to water resources, as it is an area which feeds the Kaweah Reservoir. Paradise Ridge typifies the hydrology of Sierra Nevadan rivers, which is controlled by three mechanisms: rainfall-runoff, snow accumulation with seasonal melting, and groundwater recharge, storage, and eventual discharge. As demonstrated in recent field documentation of how karst contributed to the temporal distribution of water in the Kaweah River basin (Tobin, 2013), it was found that the karst in this area contributed a large component of baseflow river discharge, going directly into rivers which fill the surrounding reservoirs. Methods and criteria for improvement of karst management have been suggested by many in the scientific community in order to assure the preservation of karst groundwater resources (Brahana, et. al, 2014; Panno & Luman, 2012). However, these methods have rarely been integrated into national groundwater protection policies. The Paradise Ridge inventory holds promise in this direction, as the state of California’s water resources has need of a new form of management in the face of continuing drought conditions. While the full karst inventory of Paradise Ridge may take up to seven years to complete due to the ruggedness of the terrain combined with weather conditions which limit accessibility to certain months of the year, two years of data have been collected. A typical karst research protocol will be discussed, along with the terrain quadrants of research, and how the findings relate to future karst endeavors and implications for the importance of park management of karst and wilderness areas.

High Elevation Plant Communities and Values



Danielle Amoroso, California State University, Northridge, discusses her poster on *Dudleya* with Denis Kearns, Bureau of Land Management.

Danielle Amoroso: Comparing Germination and Recruitment Success of Dudleya in California

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Comparing germination and recruitment success of *Dudleya* throughout California

Dudleya are amazing succulent plants. I grew seedlings that had not yet produced leaves beyond the cotyledon stage, and about half of them survived a brutal summer in southern California with only natural precipitation and scorching temperatures. Another point of interest is that the genus contains 45 species/subspecies that are themselves differentiated into local ecotypes. About half of the named taxa are threatened or endangered. The niches of the species vary from restricted to within a few miles of the coast to only living in the desert to being widespread. I found ecotypic differences between populations that are in the same species. *Dudleya cymosa* seeds from Sequoia were significantly smaller than seeds of the same species from Yosemite, but Sequoia seeds had a higher germination than Yosemite seeds. Sequoia plants were also significantly larger overall. Dorsey and Wilson (2011) studied how geographic range size was related to life history variables. They found that rare taxa tended to rush to reproduce, whereas common taxa delayed reproduction and instead grew larger body sizes. Dorsey and Wilson studied nine taxa of *Dudleya* that inhabit the Santa Monica Mountains. Following their study, I have compared the seedling ecologies of 21 populations of *Dudleya* across California. I collected seeds, measured germination, and then quantified probability of surviving throughout the summer in a coastal garden and in an inland garden. Seed size was correlated with mature plant body size: smaller seeds came from larger plants. I compared species that were coastal versus close relatives from inland. Generally, there were no significant differences in seed size, germination rate, or survival based on the range where the seeds originated. This is despite the finding that particular pairs of close relatives differ significantly¬—just not with coastal being consistently more or less than inland. Seedling biology is fundamental to understanding the macroecology of plants. Where a taxon can grow should be partially determined by where its seedlings can survive, particularly for plants that have such an extreme relation to desiccation. But, is this more an idiosyncratic matter of particular cladogenetic divergence or a general correlational trend?

Chelsea Arnold: Hydroecological Effects of Tephra in Sierra Nevada Meadows

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Hydroecological effects of tephra in Sierra Nevada subalpine meadows

Tephra from eruptions in the Mono-Inyo volcanic chain, dated approximately 720 and 1200 years before present, form widespread deposits in the high elevation meadows of the southern Sierra Nevada from Yosemite National Park south to the Kern River drainage. While their presence is well documented, their potential impact on the hydrology of the meadows has not been investigated. When desaturated, the tephra layer(s) acts as a hydraulic barrier that significantly restricts downward drainage from the top layer as well as evaporative loss from the lower layer. This barrier leads to the following important hydroecological implications: (1) Moisture available in the top layer is preserved from loss by deep drainage, preferentially helping plants with shallow roots and soil microorganisms that inhabit the top layer. This effect is pronounced during summer precipitation events. Almost all the precipitation that occurs after the water table has dropped below the tephra layer will be restricted to the top layer, providing competitive advantage to shallow roots. (2) Moisture stored below the tephra layer is preserved from evaporative loss when the hydraulic continuity at the tephra layer is broken. This "mulching" effect helps plants with deeper roots to utilize the soil moisture for much longer period. We found that as the water table begins its natural drawdown during the growing season, soil moisture levels follow that same trend. As the water table exceeds the depth of the tephra layer, the continuity between the layers is disrupted, not allowing further drainage from the top layer of the soil, or evaporative losses from the lower layer of the soil. We conclude that the tephra layer(s) can effectively buffer plant water stress by helping the soil maintain higher levels of moisture than would be expected during the summer season.

Technology

Melissa N. Ricketts: Nonimaging Optics in Lighting to Reduce Light Pollution in Yosemite National Park

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Nonimaging optics in lighting to reduce light pollution in Yosemite National Park

Light pollution has become a prominent issue, specifically in National Parks such as Yosemite, where visitors go to enjoy the natural 'night sky'. In an effort to reduce light pollution, a particularly obtrusive light source has been selected for retrofit. Using nonimaging optics and light emitting diodes (LEDs), light can be controlled to achieve a desired prescribed illumination distribution. This distribution possesses a sharp cut-off such that light leakage is minimal. Nonimaging optical designs are 3D printed, retrofitted into the candidate fixture, and tested in Yosemite National Park. The end goal is to drastically reduce and even eliminate the excess light from sources around the park.

Walt Holm: Small, Low Cost ROVs for Scientific and Archaeological Investigation

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Small, low-cost ROVs for scientific and archaeological investigation

For years, remotely-operated vehicles (ROVs) have been used to explore underwater sites for scientific, archaeological, and other purposes. Recent technology advances have improved the capability of ROVs, while greatly shrinking their size and lowering their cost. Small, battery-powered ROVs are now available that can be taken to remote sites, opening up areas for research that were previously unavailable. As an example, in August of 2015 a team of archaeologists and ROV operators packed deep into the Kings Canyon wilderness to explore the wreckage of a World War II B-24 bomber lying in Hester Lake, at an altitude of over 11,000'. Over a two-day period, multiple dives were conducted to survey the main body of wreckage and to scan the remainder of the lake bottom. The information captured gives new insight into the tragic fate of the bomber and her crew. The ROVs used, made by OpenROV of Berkeley, California, each weighed six pounds and cost approximately $1,500 to build.

Wildlife

Crystal Barnes: Adaptive Management of Climbing Closures to Protect Nesting Peregrine Falcons in Yosemite National Park

Yosemite National Park

Adaptive management of climbing closures to protect nesting Peregrine Falcons in Yosemite National Park

Climbing and helicopter activities pose a threat to the once-endangered Peregrine Falcon (*Falco peregrinus*) during the nesting season, and can disturb nesting birds to the point of causing nest failure. Yosemite National Park is well-known for its cliff faces and thousands of climbing routes, some of which are in close proximity to Peregrine Falcon nests. To protect nests from human disturbance, the Superintendent of Yosemite National Park temporarily closes cliffs to all human activity where Peregrine Falcons are nesting. To inform climbing closures and airspace closures, Yosemite biologists implemented a monitoring program in 2009-2016. Each year, biologists surveyed and monitored nest sites in cliff habitat during the closure period (March to July) to learn current information on nesting status, promptly re-open climbing routes where nesting is not occurring, and close climbing routes in areas where nest sites are discovered. When closures changed according to nesting status, the park's web manager posted updated closure information on the park's website. Law enforcement rangers enforced closures, detected closure violations, and cited climbing violators. From 2009 to 2016, the number of breeding Peregrine Falcon pairs increased from 8 to 14 and the number of climbing closures (initial) increased from 5 to 12 closure areas. As the number of nesting pairs increased, park biologists (1) re-evaluated and changed the date that closures were lifted; (2) tested disturbance levels of nesting pairs by working with climbing rangers to climb certain routes during observation periods; and (3) increased outreach and collaboration efforts with the climbing rangers and climbing community.

James Bland: Is the Sooty Grouse Old Forest Dependent?

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Is The Sooty Grouse Old-Forest Dependant?

Much of the literature on Sooty Grouse (*Dendragapus fuliginosus*) indicates the species is associated with open or early-successional forest. But I have shown it to be closely tied to elements of old forest – particularly very large conifers - in both the Sierra Nevada and North Coast Ranges of

California. I have also determined that a recent extirpation of Sooty Grouse from the Transverse Ranges was preceded by extensive harvest of primary-growth conifers. Here, I describe three studies I have conducted on this topic over the past 25 years.

Stephanie Eyes: California Spotted Owl Foraging Habitat Use in a Burned Landscape

Yosemite National Park

California Spotted Owl foraging habitat use in a burned landscape

Fire is a dynamic ecosystem process of mixed-conifer forests of the Sierra Nevada, however there is limited scientific information addressing wildlife habitat use in burned landscapes. Recent studies present contradictory information regarding the effects of stand-replacing wildfires on spotted owls (*Strix occidentalis*) and their habitat. While fire promotes heterogeneous forest landscapes shown to be favored by owls, high severity fire may create large canopy gaps that can fragment closed-canopy habitat preferred by spotted owls. We used radio telemetry to determine whether foraging California spotted owls (*Strix o. occidentalis*) in Yosemite National Park showed selection for particular types of fire severity within their home ranges. Our results suggest that spotted owls exhibited habitat selection within their home range for locations near the roost, edge habitats, and weak selection for lower fire severities. Although owls selected high contrast edges with greater relative probabilities than low contrast edges, we did not detect a statistical difference in these probabilities. Protecting forests from stand-replacing fires via mechanical thinning or prescribed fire is a priority for management agencies, and our results suggest that fires of low to moderate severity can create habitat conditions within California spotted owls' home ranges that are favored for foraging.

Ryan Leahy: Developing Technology Saves Yosemite Bears

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New Twists on Technology are Saving Bears at Yosemite National Park

In less than twenty years, Yosemite National Park reduced human-bear conflict from an all-time high of over 1500 incidents in 1998, to an all-time low of less than 100 incidents in 2015. While the majority of the change is attributed to the installation of bear-proof lockers and trash, increased trash pick-up, education, and bear management personnel on duty around-the-clock, a new emphasis on developing technologies is another critical component of that success.

In 2002, researchers from the National Wildlife Research Center began developing bear monitoring systems to detect radio-collared bears when they enter defined developed areas, and then send out alarms to park staff. These systems quickly increased the number of bears that could be tracked and managed by the Yosemite Bear Management Team. In 2012, the Bear Team upgraded and expanded the number of systems in the park.

In 2014, Yosemite purchased 15 GPS/Iridium collars to manage known food-conditioned and/or habituated bears in real-time. With hourly tracking, managers are now able to stay ahead of bears that are shifting food sources and proactively keep them out of developed areas in their path. Managers also use this technology to monitor conflicts in far-away wilderness areas of the park, as well as to answer a myriad of research questions.

In 2016, Yosemite will tie these technologies together. In 2005, Yosemite developed a relational database that could be accessed from hand-held PDAs to streamline field data collection. Now, that database, not to mention the hand-held units, will be upgraded to incorporate all data, and then interface with a web application that allows the public to not only enter observations, but to observe recent tracks of collared bears.

Bob Wilkerson, The Institute for Bird Populations, with his poster on Sierra Nevada bird monitoring.

Bob Wilkerson: Monitoring Sierra Nevada Bird Populations in an Era of Rapid Environmental Change

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Monitoring Sierra Nevada Network bird populations in an era of rapid environmental change

In 2011 we initiated annual, multi-species bird monitoring throughout the Sierra Nevada Network (SIEN) to assess population trends and inform future management decisions relating to factors such as climate change, visitor impacts, fire management, and introduced species. The project is a partnership between SIEN, its constituent parks (Sequoia and Kings Canyon National Parks [SEKI], Yosemite National Park [YOSE], and Devils Postpile National Monument [DEPO]) and The Institute for Bird Populations, which conducts avian point counts along 144 off-trail transects in SEKI and YOSE (24 transects are sampled annually and 140 transects are assigned to alternating panels that are sampled every five years) and 42 annually surveyed points at DEPO. Analysis of data collected during 2011-2014 yielded estimates of 4-year trends for 53 bird species at SEKI, 51 species at YOSE, and 43 species at DEPO. Ten of 11 species with significant trends at YOSE increased, as did 7 of 8 species at SEKI, and 12 of 13 at DEPO. However, the short sampling period means that individual years, especially beginning and end years, could have had unduly strong influence on trend estimates. More recently, we developed a Bayesian hierarchical N-mixture model that will likely be used for the SIEN bird monitoring program's next scheduled data synthesis in 2020. The new model, described in a manuscript currently under review, provides a powerful means of assessing spatiotemporal covariates of annual abundance (e.g., annual snowpack, number of years since fire, etc.), incorporates interval and distance sampling to estimate distinct components of detection probability, and accommodates count intervals of varying duration, annual variation in the length and number of transects surveyed, spatial autocorrelation, and random effects of observer and year. Future analyses will assess longer-term population trends and explore effects of annual climatic variation, changing fire regimes, and drought-related forest mortality. SEKI and other national parks provide critical reference sites for monitoring bird populations because the parks are among the few places in the United States where population trends due to large-scale regional or global change patterns are relatively unconfounded with local changes in land use.

Symposium Close

Christy Brigham and Koren Nydick gave some concluding remarks and facilitated a brief discussion at the end of the symposium.

Christy noted that in a lot of areas and through many different measurements, we are seeing change. It is unclear what it means, and what we should do about it. There were a lot of doom and gloom talks. To use an analogy, we are at the dead frog stage now, but hope to be in a recovery (from chytrid fungus, etc.) stage later.

Things to discuss include:

- What does change mean ecologically?
- What can we do about it, or should we do about it?
- How can we work together to communicate more about it?
- What we do is based to some degree on what our values are. [But scientists aren't trained to evaluate values.]

Koren noted that the talks were reflections on diversity. There were a variety of topics, including photosynthesis, mosses, lichens, aquatic resources, bugs, some physical science, and a little social science. There were different agencies, organizations, and perspectives. We heard about research as well as links to management. We invited students as well as senior scientists and professors, so had a range of ages. We had male and female presenters and participants.

In general, there was a common thread of love of science and special places. There were calls to reach out and tell our stories more broadly. She heard affirmation and enthusiasm for collaboration.

Christy and Koren invited input from participants.

Commentor 1: I care about resources. I work a lot with folks down the hill (in the valley). Many don't care. People care about ecosystem services. What is this watershed doing for water supply? The state cares about carbon storage. We need to put this work in a larger context that a broader audience will care about.
Communicating how we manage natural areas and learn from them is important. Anything we do is experimental. It's so unclear what the world will be like. We need to start bracing the public for what is ahead. With more severe fires and tree mortality, we can see things are changing. We are learning from everything we do.
Commentor 2: We need to take advantage of charismatic events, like tree dieback, to initiate conversations. Nothing beats bringing people into the field – students, children, troubled youth. I was once with Vance Vredenburg at one of the Sixty Lakes Basin areas before the frogs there crashed from chytrid. Mountain yellow-legged frogs were cascading ahead of me as I walked. That experience stays with me. We need to draw people into this place.

Commentor 3: Farmers are concerned about water and snowpack. We could talk about the albedo effect of dust on snow. Dust and snowpack relations might be something that could inspire people to work together. Policy and the common desire for more water and snowpack could be a powerful thing to talk about.
Commentor 4: I don't feel doom and gloom about what I'm studying. Things are changing, and it can be scary. Part of it is how you pitch it. We are learning exciting, cool things. What are we seeing, what does it mean, how do people feel about it? Talk about what's happening, and then what it means. Forests versus shrub fields. Why is the change interesting for a scientist? The value judgment is not always part of the narrative.
Commentor 5: The suggestions for making science relevant to a broader audience and improving science literacy are good. In the bigger picture, it would be great to bring young people in, to provide paid internships for local youth. This could play into diversifying people who do science, and by diversifying humans who do science, it can better serve the communities.
Commentor 6: Two weeks ago, high school students from San Francisco came to the park, and the education program worked with them. They each picked an animal that they got to know about through some activities. When we asked what they would monitor if they could only monitor one thing, most picked the animal they had studied. Once you get to know something, you care about it.

Christy encouraged continued engagement between the parks and participants in the meeting and gave a few examples of responses that had been given to the interactive posters (see Appendix III for a summary of responses to the posters). She asked scientists to consider what they can contribute to the parks through their research and other communications about it that may reach a broader audience. She mentioned that local National Public Radio reporter Ezra David Romero, who had come to the symposium the first day, had already produced a story that aired that morning (November 10th) on KVPR (Valley Public Radio).

Christy and Koren also mentioned a mini-grants program they are starting in partnership with Sequoia Parks Conservancy to support field work for undergraduate or graduate students. Grants would be around $2,000 so would fund small projects, or part of a larger study.

Denis Kearns, Bureau of Land Management Botanist, also encouraged scientists to consider working on BLM lands and mentioned the giant sequoia grove they manage in the Case Mountain area not far from Sequoia National Park.

Please contact Christy or Koren to help them get the "Find Your Science" video out to other schools or groups to encourage more research here. They want to build a bigger cadre of people doing research in these parks.

Two appendices developed after the symposium summarize recommended steps to prepare for a science symposium (Appendix IV) and post-symposium evaluations conducted via a Google questionnaire (Appendix V).

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Appendix I. Sequoia and Kings Canyon National Parks Symposium Schedule and Program

Symposium Schedule

Wednesday, November 9

8:00 AM	–	9:00 AM	Registration
9:00 AM	–	9:15 AM	Welcome, Goals, and Logistics
9:15 AM	–	10:15 AM	Keynote Addresses: Dave Graber & Jim Sickman
10:15 AM	–	10:35 AM	BREAK
10:35 AM	–	12:05 PM	Lightning Rounds
			See Below for Topics and Speakers
12:05 PM	–	1:00 PM	LUNCH

High Elevation Plant Communities and Values
1:00 PM – 4:10 PM

1:00 PM	–	1:30 PM	Evan Wolf: Meadow Restoration: Past, Present, and Future
1:30 PM	–	1:50 PM	Jeff Holmquist: Pack Stock Use and Invertebrates
1:50 PM	–	2:10 PM	Ron Goode: Restoring Biotic Cultural Resources
2:10 PM	–	2:30 PM	Jeff Jenkins: Sociocultural Values Mapping
2:30 PM	–	2:50 PM	BREAK
2:50 PM	–	3:10 PM	Emily Moran: Modeling Seedling Survival
3:10 PM	–	3:30 PM	Danielle Svehla-Christianson: Digital Representations in Ecology
3:30 PM	–	3:50 PM	Paul Wilson: Liverwort and Moss Diversity
3:50 PM	–	4:10 PM	Nastassja Noell: Lichens as Bioindicators
4:10 PM	–	4:30 PM	BREAK
4:30 PM	–	8:00 PM	POSTER SESSION and RECEPTION

Thursday, November 10

8:00 AM	–	8:30 AM	Registration
8:30 AM	–	8:40 AM	Welcome and Announcements

Current Stressors to Forest Systems
8:40 AM – 10:20 AM

8:40 AM	–	9:00 AM	Adrian Das: Severe Drought and Tree Mortality
9:00 AM	–	9:20 AM	Jeffrey Lauder: Drought Resilience in Conifers
9:20 AM	–	9:40 AM	Anthony Ambrose: Giant Sequoia Drought Response
9:40 AM	–	10:00 AM	Bobby Kamansky: Foothill Drought Response
10:00 AM	–	10:20 AM	Joan Dudney: White Pine Blister Rust
10:20 AM	–	10:25 AM	Kaitlyn Heck & Carley Messex: Climate Change and Corridors
10:25 AM	–	10:50 AM	BREAK

Aquatic Ecosystems
10:50 AM – 12:10 PM

10:50 AM	–	11:10 AM	Roland Knapp: Mountain Yellow Legged Frog Research
11:10 AM	–	11:30 AM	Mary Clapp: Fish and Soundscapes
11:30 AM	–	11:50 PM	Steve Sadro: Climate Change and Emerald Lake
11:50 PM	–	12:10 PM	Marika Schulhof - Lake Warming and Nitrogen Deposition
12:10 PM	–	1:10 PM	LUNCH

Wildlife
1:10 PM – 2:30 PM

1:10 PM	–	1:30 PM	Rachel Mazur: Wildlife Management Priorities
1:30 PM	–	1:50 PM	Paul Heady: Winter Ecology of SEKI Bats
1:50 PM	–	2:10 PM	Thomas Munton: California Spotted Owl Research
2:10 PM	–	2:30 PM	Lacey Greene: Bighorn Sheep Demography and Population
2:30 PM	–	2:50 PM	BREAK

Fire Ecology
2:50 PM – 4:10 PM

2:50 PM	– 3:10 PM	Hugh Safford: Historical Forest Density Estimates
3:10 PM	– 3:30 PM	Kate Wilkin: Fire Restoration Effects on Understory Plants
3:30 PM	– 3:50 PM	Marc Meyer: Fire and Red Fir Forests
3:50 PM	– 4:10 PM	James Bland: Post-Fire Ecology of Galliform Birds

Symposium Close

4:10 PM	– 5:00 PM	Next Steps and Opportunities

LIGHTNING ROUNDS
Topics and Speakers

Air Quality: Annie Esperanza

Contaminants of Emerging Concern: Erik Meyer

Mountain Yellow-legged Frog Management: Danny Boiano

Climate Change and Adaptation: Koren Nydick

Meadow Restoration: Athena Demetry

Meadow Monitoring: Erik Frenzel

Archeology: Jessie Moore

Information Resources: Paul Hardwick

Bear Management: Danny Gammons

Post-Fire Assessment Using Soundscapes: Erik Meyer

Why SEKI for Research?: Christy Brigham

Introduction to Inventory and Monitoring: Sylvia Haultain

High Elevation Lake Monitoring: Andi Heard

Forest Monitoring: Johnny Nesmith

Science Communication: Linda Mutch

Internships and Community Science: Michael Mueldener

POSTER PRESENTATIONS

Aquatic Ecosystems

Andrea Heard & James Sickman	Nitrogen Assessment Points: Development and Application to Sierra Nevada Network Lakes (1)
Colleen Kamoroff & Caren S. Goldberg	An Issue of Life or Death: The Use of Environmental DNA to Detect Viable Individuals in Wilderness Restoration and Management (2)
Andrew Rothstein	Population Genetics of Endangered Mountain Yellow-Legged Frogs (*Rana muscosa* and *Rana sierrae*) in Sequoia and-Kings National Parks (3)
Mary Toothman	Biotic and Abiotic Factors in Bd Outcome in Mountain Yellow-legged Frogs (4)

Current Stressors to Forest Systems

Rainbow DeSilva	Genetic Diversity, Gene Flow, and the Persistence of Long-Lived Tree Species in an Era of Rapid Environmental Change: Lessons for *Sequoiadendron giganteum* (5)
Qin Ma	Forest Growth Response to Competition and Environmental Conditions (6)
Koren Nydick et. al.	Using California's Hotter Drought as a Preview of the Future: The Leaf to Landscape Forest Vulnerability Project (7)
Yanjun Su	Vulnerability of Giant Sequoia Groves to the Changing Climate and Extreme Droughts During the Last Three Decades (8)
Molly Stephens	Effects of Microhabitat Conditions and Environmental Stress on Giant Sequoia Seedlings (9)

Geology

Jade Star Lackey	It's in the Water: Near Surface Origins Explain the Unusual Ores of Mineral King (10)
Kat Biacindo	Hydrology Ramifications from the Karst Inventory on Paradise Ridge (11)

High Elevation Plant Communities and Values

Danielle Amoroso	Comparing Germination and Recruitment Success of Dudleya Throughout California (12)
Chelsea Arnold	Hydroecological Effects of Tephra in Sierra Nevada Subalpine Meadows (13)

Technology

Melissa N. Ricketts	Nonimaging Optics in Lighting to Reduce Light Pollution in Yosemite National Park (14)
Walt Holm	Small, Low-Cost ROVs for Scientific and Archaeological Investigation (15)

Wildlife

Crystal Barnes	Adaptive Management of Climbing Closures to Protect Nesting Peregrine Falcons in Yosemite National Park (16)
James Bland	Is the Sooty Grouse Old-Forest Dependent? (17)
Stephanie Eyes	California Spotted Owl Foraging Habitat Use in a Burned Landscape (18)
Ryan Leahy	New Twists on Technology are Saving Bears in Yosemite National Park (20)
Bob Wilkerson	Monitoring SIEN Bird Populations in an Era of Rapid Environmental Change (19)

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Appendix III: Responses to Interactive Posters

Poster 1: Research and Volunteers

How can we engage volunteers to help with research and monitoring? What projects align best? Tell us about a project idea.

- Utilizing/encouraging use of pre-established citizen science tools like iNaturalist
- Promote community scientists. Have visitors take and see repeat photos with their phones through programs like Nerds for Nature.
- Increase general/garden experiments that don't require years of expertise but increase ecological knowledge and involvement.
- Native plant restoration and in-field monitoring of recruits
- Citizen Science opportunities. What (if any) aspect of your project could include volunteers…In other words, always include this question when developing projects. I am very interested in (if possible and appropriate) including volunteers in my project. (Hello! I'm Kestrel – Karyn O'Hearn (UCD) and will be working with Erik M. and looking at birds and acoustic data and fire!
- Monitoring and detection using smartphone apps. Citizen Science.
    - Another respondent added to this: Community!
- Cleanup projects make immediate impacts and can be easily incentivized.
- Special invite to SPC donors and members. (Scott Savastio)
- (Park visitors) Get volunteers to go out and record the soundscape of their favorite area/hike destination for 5-10 minutes, then upload to a server. Make an interactive park map with a listening station and head phones so all visitors can experience SEKI's soundscape. (mkclapp@ucdavis.edu. I would love to help implement this!)
- Find interns from Fresno State.
- Soundscapes and dark sky preservation: can we measure darkness and send info to Annie E?
- Volunteers love restoration projects. Planting plants is especially rewarding.
    - Another respondent added to this: Yes! Anything where lots of hands with minimal training can be used (tree planting and measuring, maybe meadow erosion filling…)
- Work with local tribes to recruit youth for entry-level jobs that may lead to future long-term positions.
    - Another respondent added to this: This is a good idea for other local, rural communities where jobs can be scarce (and hostility to environmentalists is sometimes high)
- Reach out to interpreters and do an "interp training" like USGS did with demogers
    - Another respondent added to this: Yes! Interpreters engage with so many visitors who return to parks yearly and would love to be as involved as possible.

Poster 2: Science Learning Centers

Science Learning Centers support and connect research and education. How can we work together to build capacity and excitement to grow our Science Learning Center? What do we need AND how can we work together to make it happen?

- Workshops to brainstorm ideas. Include all stakeholders: Ed, Interp, Scientists, Science Learning Center users
- Find public forums to present research and connect to learning opportunities to generate supporters for center
- Offer "A Day with a Scientist." Students go into the field with a scientist and help her/him collect data.

- Another responded added “Yes!!” to this.
- Offering free or cheap lessons for local community members
- Grow network of similar projects like museums, institutes, etc.
- It would be great to know how to connect with people experienced in making videos, outreach exercises, etc. Many scientists struggle to translate our work this way due to lack of time and training.
- Offer Community Science projects that connect to the park and offer 2-hour “How To” lessons on how to use App, etc.
- Programs designed to engage and recruit SPC members and donors. (Scott Savastio)
- A dynamic, energetic force of a leader, coordinator, teacher, mentor, friend. There’s such a person at Lodgepole. Ask Thiel!
- Provide housing for researchers working in the park and use that opportunity to have the researchers interact with students, interns, other researchers, etc.
    - Two respondents added a “Yes!!” to this.
- Make an app so people can feel involved.
- Support for first-time permit and wilderness applications.
    - Another respondent added “Yes!” to this.
- Share success stories for past projects to generate excitement for future projects.
- $

Poster 3: Engagement

Based on your skills and interests, what could you do to help SEKI engage people about climate change and other stressors? Pick one answer.

- Write an article for SEKI's research and science web page - *7 votes*
- Give a presentation or lead a field trip - *19 votes*
- Help create and/or deliver curriculum-based education for K-12 - *5 votes*
- Provide internships for young adults. - *11 votes*
- Other ideas (sticky notes)
    - Field work tours and interpretation
    - Help facilitate networking between managers, scientists, educators, and media
    - Write articles for the SEKI science web page (Linda)
    - Internships (Geologist-in-Parks/Mosaics) for I&M support

Appendix IV: Steps to Organize a Science Symposium

Sequoia and Kings Canyon NP

47050 Generals Highway

Three Rivers, CA 93271

Science Symposium Overview

December, 2016

OVERVIEW

This document outlines steps taken to organize the SEKI Science Symposium. It should be used in conjunction with planning templates available at:

S:\COMMON\Science_Symposium_Workshop\Organizing SEKI Science Symposium

INITIAL STEPS

1. Determine primary organizers and review this symposium overview document, and the planning template.

2. Hold initial meeting with primary organizers.

   A. Determine funding needs/availability

   B. Outline primary roles of each organizer (logistics, registration, abstract submissions, abstract review, abstract compilation).

   C. Consider potential venues.

   D. Set goals/ ideas for potential content of the symposium.

   E. Determine who else will be involved in planning and input.

   F. Determine potential event dates.

   G. Assign action items

      i) email to potential participants on date choices.

      ii) set up planning sheet (logistics person/ template already created and saved in S:\COMMON\Science_Symposium_Workshop\Organizing SEKI Science Symposium Transfer to google drive for ease of collaboration. Update as needed).

3. Hold meeting with additional staff.

   A. Set date for symposium.

   B. Brainstorm symposium content and potential speakers.

MILESTONES

ONE YEAR BEFORE

- Determine funding source(s) and set up purchase agreements.
- Apply for supplemental grants.
- Select dates.
- Check venue availability.

SIX TO TEN MONTHS BEFORE

- Notify potential invitees to save the date and expect a call for abstracts.

FOUR TO SIX MONTHS BEFORE

- Set submission deadline and send out a call for abstracts.
- Finalize website language and publish website.
- Open registration.
  * Note: Ensure that email is captured on both registration and abstract submission sheets.

THREE MONTHS BEFORE

- Abstract submission closes.
- Make decisions regarding presenters.
- Draft program schedule and notify speakers ASAP to determine final availability.

TWO TO THREE MONTHS BEFORE

- Ensure that all speakers are available.
- Contact speakers to ensure they are registered.
- Program should be nearly finalized.

ONE MONTH TO TWO WEEKS BEFORE

- Finalize program, solicit a print quote and send the program to print a minimum of 2 weeks in advance if printing out of house. (All printing was done in-house in 2016.)
- Send finalized instructions to all participants.
- Consider having speakers load presentations onto Google Drive one week before symposium. Then test them on the laptop you will use.
- Visit the venue to check out: seating, circulation, poster locations, side meeting spaces, and audio and visual equipment.

ONE WEEK BEFORE

- Final logistics should be well on their way, as under the action item template.

DAY BEFORE AND DAY OF SYMPOSIUM

- Final logistics, set up, presentation loading, smooth sailing.

Appendix V. Post-symposium Evaluation

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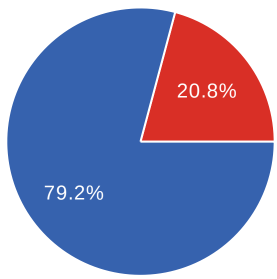
Edit this form

24 responses

Publish analytics

Summary

How well did the symposium meet your expectations?



Exceeded my expectations	**19**	79.2%
Met my expectations	**5**	20.8%
Fell short of my expectations	**0**	0%

In what way or ways did the symposium exceed, meet, or fall short of your expectations?

It had good science and interesting presentations.

The breadth of the topics discussed exceeded expectations

As an interpreter, it was very helpful that presenters were so approachable! I was able to develop a few great discussion topics for visitors after talking more thoroughly to a few presenters.

The level of interest and participation from outside researchers and partners exceeded my expectations. Excellent venue for learning more about current research projects.

Very high diversity of presentations, expertise, and general knowledge in the room. I appreciated the broad representations of academics, students, and land managers.

There was variety in content and style. Good breadth. The networking was also good. The packed schedule seemed to heighten the efficiency of all aspects.

I noticed and appreciated that many people were attentive to the whole program, not just "their" subject matter

High-quality talks, great venue, good job keeping us on schedule, just the right formal/informal tone, really well-planned. Suggestions: a) longer breaks to allow for more interaction (thus possibly reducing number of talks), b) it would be nice to have NPS personnel stay on at the retreat longer at the end of the day, because so much interaction occurred during, and after, dinner. Park staff missed out on a lot of that, and we missed having Park staff there. Had we all been at a meeting out of the area, those dinner/after dinner interactions would have naturally involved NPS staff. An inconvenience for local folks, to be sure, but it might be worth it. But those are small things-- it was an excellent symposium.

SEKI integration with scientists and the collaboration process is excellent.

The quality of the talks was outstanding. The conference site was beautiful and the the organization was top notch.

The environment to communicate

It was well organized and offered an excellent diversity of ideas and projects

Great mix of content, great facilitation by Koren and Christie (and others), nice to hear about outreach and science communication as priorities for SEKI

Presentations were all very informative and well-presented - I learned a lot about on-going research, that I was familiar with and completely unfamiliar with. A good mix of talks from lichens to remote-sensing. I liked the opportunities offered to students and younger scientists to present. It was well-organized and a great venue. And what a great group of people to be with post-election.

Excellent talks

I loved the keynote speaker & enjoyed the 20 minute presentations by scientists. St. Anthony's was a good site. I also appreciated the multiple times that presenters and Koren urged the audience to be involved in science in the park. I attended only on Thursday, but I'd like to see more about Citizen Science projects in the park & especially those the park can help facilitate (such as iNaturalist).

The subject matter ranged over a wide area of topics, the location was awesome, and many of the speakers spoke with compassion and gave creative talks.

I was very impressed by the quality of the presentations, both in terms of content and execution. Bravo to all presenters!

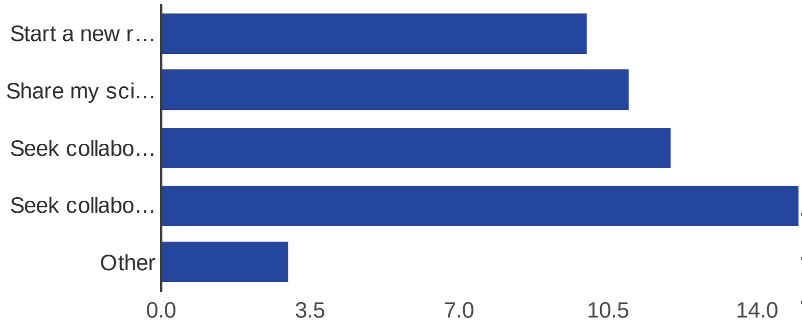
Wonderful venue, great talks

Gave a much greater overview of the breadth of scientific work being conducted and range of organizations/institutions involved than I expected.

More people attended than I expected and had a higher level of enthusiasm for SEKI research and education than I expected. The quality of the presentations was mostly very good (as expected). The one area that feel short of my expectations (really my hope rather than expectation) was that some SEKI staff outside the RMS and interpretation divisions would attend.

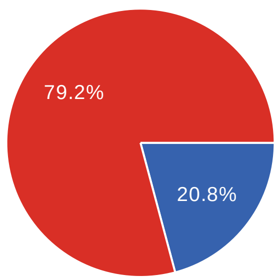
I figured it would be fairly focused on biology, which it was.

What steps do you plan to take to follow up on a new idea or a rekindled interest?



		.5%
		.8%
		.2%
Seek collaboration with scientists on a research idea	**15**	65.2%
Other	**3**	13%

How often should we hold the symposium?



Every year	**5**	20.8%
Every other year	**19**	79.2%

Is there anything else you would like to share with the organizers about the symposium program, location, logistics, or other?

just Thanks!

I think it was fantastic! Collaborating is super important in every field. Excellent location, coffee was a very nice bonus, great job all around. If I could suggest anything it would be that if the presenters chose a "take away" idea to mention it would be very helpful for interpreters wanting to share their information. As in, most presenters ended their talks with asking for funding or saying they are open to sharing their data, but what do they want the public to know? Some topics were easier to discern from others so a clear statement would be a nice shout out to those of us who are not directly science related but wanting to boost public support of the science community.

Consider a joint symposium with Yosemite, to learn more about what is happening on a regional scale and to identify areas of potential synergy

It was interesting having the student presentations interspersed with the scientists. The venue worked. Great job.

The format worked well and it was nice to have ample meal and break time to talk with other attendees

Maybe arrange a field study in the national park

I really liked St Anthony Retreat.

It's important to communicate well the intent of future symposia like this with the local park RMS staff. Some did not understand that the emphasis was on highlighting research from non-SEKI staff, and were not getting information about how to submit abstracts so felt a bit left out when the deadline had passed and they had not heard about how and when to submit an abstract -- emails seemed to be aimed more at outside researchers. While the lightning talks were great (went better than I expected and were enjoyable to hear), it's also of value to showcase local science that staff are doing - both NPS and USGS. Something to just communicate about more clearly for future symposia and perhaps get broader input from staff about what they'd like to see, what should the role be for locals vs. outside researchers.

The symposium was excellent, and all involved deserve a huge "thanks". The location was very convenient, but the people at St. Anthony in charge of accommodations weren't particularly helpful. They provided very little information following my room reservation (no confirmation of reservation dates, etc.). In addition, I ended up needing to stay for one night less than my original reservation, and never got reimbursed for the difference in cost between a two and three night stay. I realize that options for holding such an event are limited in the Three Rivers area, but St. Anthony has some room for improvement.

I very much appreciated the culture that was nurtured at the symposium - open minded and open hearted, land management as the primary root, folks eager to learn and share knowledge; and in an intimately sized group which facilitates conversation and great questions.

The location of St. Anthony's just outside the park was nice. There were pros and cons to the room - pros: small size allowed easy speaking without microphone and the room looked mostly full which is a boost of confidence for presenters; cons: the lighting was difficult for having a good view of the presenter and screen (high contrast of window light in an otherwis very dark room; little light on the presenter), and the projection screen was rather small. However, these are small details that did not detract from a great meeting! Thanks to all the SEKI staff who made this happen.

The projector could be a bit brighter (offer to change their bulb next time?). I'd be happy to see a field trip or two added for an afternoon "out". Logistically, sure it's complicated, but it seemed to be a perfect venue for a range of scientists discuss what they're looking at. I could see doing a hike up the Marble Fork trail out of Potwisha to get a range of scientific perspectives. More geologists would be good [Jade Star, here, by the way].

[Image]

Number of daily responses