Sierra Nevada Network
Inventory & Monitoring Program

Inventory and Monitoring Division
National Park Service
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The Sierra Nevada Monitor

Newsletter of the Sierra Nevada Network

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Sierran High Elevation Pines Still Relatively Healthy

Foxtail pine in the Upper Kern River drainage, Sequoia National Park. NPS photo by SIEN forest crew.

Whitebark pine low, shrubby growth form (krummholz), Kuna Crest, Yosemite National Park. NPS photo by SIEN forest crew.

Whitebark pine and foxtail pine grow at high elevations in rugged, rocky terrain with harsh weather and short growing seasons. The seeds from these trees provide food for birds and mammals and their canopies provide shade that helps slow snowmelt, their branches and trunks provide structure important for wildlife habitat. These iconic trees contribute to the scenic beauty and character of Sierra Nevada wilderness.

In most of their range, which extends from the Sierra Nevada to the North Cascades and Rocky Mountains, whitebark pine have declined in response to multiple factors, including infection from the non-native white pine blister rust and outbreaks of mountain pine beetle. In the southern Sierra Nevada, both whitebark pine and foxtail pine have remained healthy, as these stressors have been rare. However, increasing white pine blister rust and mountain pine beetle occurrence coupled with climate change impacts, may cause future declines.

The Sierra Nevada Network Inventory & Monitoring Program (SIEN) participates in a collaborative monitoring project that tracks change in high elevation white pines across several Pacific West Region national parks. Sierra Nevada white pines include whitebark, foxtail, limber, western white, and sugar pine.

Recently, SIEN Ecologist Jonny Nesmith co-authored a paper published in a special issue of *Forests* dedicated to whitebark pine ecology and restoration. The paper summarizes stand structure and condition for whitebark pine and foxtail pine in Sequoia, Kings Canyon, and Yosemite national parks, based on an initial assessment of monitoring data collected between 2012 and 2017.

To learn more about the stand structure and condition of these parks' high elevation white pine forests, download a publication brief or visit this website to read the paper. If you have questions, contact Jonny Nesmith.

What's Inside?

Staff Updates

Jenny Matsumoto Retires


Jenny Matsumoto

Jenny Matsumoto, who retired on May 31st, joined the Sierra Nevada Network (SIEN) in 2010 to provide administrative support, in a position shared between SIEN and the Sequoia & Kings Canyon National Parks (SEKI) Environmental Compliance Office. Jenny supported the SIEN team in all things administrative and also willingly lent a hand wherever there was a need, whether it was helping out with a seasonal training session, troubleshooting equipment meltdowns, helping keep us organized, or fixing any multitude of things (she was very handy and always knew where the tools were).

Starting in 2003, Jenny also volunteered with the SEKI Critical Incident Stress Management team, providing debriefings for park staff after high-stress incidents as well as family liaison support.

Jenny's career with the National Park Service spanned 28 years. She started as a seasonal interpreter at Lassen Volcanic National Park in 1983, and subsequent jobs took her to Saguaro, Sequoia & Kings Canyon, Yellowstone, and Crater Lake national parks.

Much of her career was in interpretation, but being part of a dual career marriage provided opportunities to work in various positions in resource management, maintenance, and administration.

When asked about highlights from all her years with the NPS, Jenny said, "Without a doubt it was the people I was able to work with. I am most grateful for the many wonderful and dedicated people who have been a part of my life in the NPS, and that will be what I miss the most."


Jenny, practicing for retirement, rides off into a dust storm on a camel in Morocco, March 2019.

Jenny and her husband will stay in Three Rivers, California for now, so we are grateful we will still have Jenny in our social lives, if not our work world. We will so miss Jenny's generous spirit at work, and all the extra helpful things she did for us, in addition to the often thankless administrative tasks that made our lives easier.

Kristin Weikel Returns

Kristin Weikel, Logistics Technician, returned on May 13th for her third season of supporting the logistics that are so critical to a successful field season. Kristin helps project leads communicate with and track crews, manages gear (repair, replacement, checkout/checkins), provides project data management support, prepares crew wilderness tracking forms for Dispatch, helps prepare food caches, communicates with wilderness rangers and maintenance staff to coordinate gear and food transport, participates in before and after-field tour safety briefings, occasionally transports crews to and from trailheads, assists with crew training, and just generally jumps in where needed to keep the field season running smoothly. We are thrilled to have her back. Over the winter she adopted a new dog, worked on art and home projects, traveled, and kept busy with her 3-year-old son Reid!


Kristin and her son Reid visiting Washington, D.C.

Roxanne Kessler Embarks on 10th Season

Roxanne Kessler, Wetlands Crew Lead, has returned for a tenth season at Sequoia and Kings Canyon National Parks. For the past five of those years, she has worked with SIEN on four different monitoring projects, giving her unusually in-depth knowledge of our program.

For the past two years she was the field lead for our wetlands monitoring project, navigating the challenging logistics of 2017, with a large snowpack, high-flowing streams, and late-season wildfires. In 2015, she worked part of the season with wetlands and the second half as the lead for our SEKI lakes monitoring crew. In 2016, she provided support for both birds and wetlands projects, and again served as SEKI lakes lead. Her first year with SIEN was on the high-elevation forest monitoring crew in 2014.

Prior to working for SIEN, in 2013 Roxanne worked with SEKI's Plant Ecology program to assess the accuracy of the detailed wetlands map that serves as the basis for our wetland monitoring sampling frame, and supported the parks' prescribed fire program as a Fire Effects Monitor from 2010-2012. Roxanne has returned for 10 seasons because she loves the "natural space of the Sierra Nevada and the great community of people who work here". While she is ultimately aiming to settle in the San Francisco Bay Area near friends and family, SIEN staff are grateful she has returned again to provide field season support and wrangle wetlands data.

Roxanne Kessler at Lake Italy, Sierra National Forest.

Anne Kelly, Sierra Nevada Field Station Director Moves on

This summer we bid a fond farewell to Anne Kelly, director of UC Merced's Yosemite and Sequoia-Kings Canyon Field Stations, which are part of the University of California Natural Reserve System (http://ucnrs.org). These field stations, operated in partnership with the National Park Service, are dedicated to facilitating and promoting research and education programs that foster better stewardship and management of natural areas in the Sierra Nevada.

Despite enduring fire, flood, drought and two record-breaking winters during her four-year tenure as director Anne has brought tremendous energy to the network. From introducing countless students to the Sierran parks, facilitating research projects both large and small, to developing a Code of Conduct for field stations that has been recognized by the National Science Foundation as a model for field stations throughout the world, Anne has established the Sierran field stations as vibrant centers for conducting science and mentoring students in service to parks.

Perhaps most notably, Anne played a key role in facilitating the establishment of the UC Merced/SCICON Field Station, a partnership between the university and the Tulare County Office of Education's acclaimed outdoor education program. The recently established field station will engage students and educators at the primary, secondary, and postsecondary levels in research and career development, while also providing a site for UC scientists to study the unique ecological issues of the Central Valley.

Anne Kelly in Yosemite National Park.

Along with being a skilled PhD scientist, flyfisherwoman, hunter, and motorcycle rider – Anne is a cellist. She has played with bluegrass bands in Utah and in the West. Near her Wawona home, she could often be found accompanying Tom Bopp, the famous pianist in the Wawona Hotel. Where will we have to go next to hear her play? After taking a well-deserved break, in August Anne will be starting in her new role as co-director of the Desert Studies Center, a field station of the California State University located within the Mojave National Preserve, at the oasis of Soda Springs. Congratulations, Anne, and thank you for all of your support and inspiration!

What's Going on in the Field?

Birds

This spring, the Institute for Bird Populations (IBP) has returned for the eighth season of bird monitoring in these parks. The crews are being led this year by Rae Engert, who has returned for a third year working with IBP, and her second tour with SIEN. Rae is teamed up with Mikeala Kropp, who graduated from Carleton College in MN and will be spending her first Sierran summer with Rae in Yosemite (YOSE). Patrick Carr (most recently from Flagstaff, AZ and a graduate of the University of Connecticut) and Quinn McMahon (a graduate of Western Washington University and who recently spent a winter as a fisheries observer in the Bering Sea) are also both new to the Sierra and are stationed in SEKI. The crews completed their training in recognizing birds by sight and sound by mid-May, and started visiting transects at the end of the month despite the unseasonably cold and wet weather.

Along with the annual panel sites, this year will include the first revisit of alternating panel 5 in SEKI and YOSE, which will conclude the second complete rotation of the bird monitoring panels in SIEN. We will then pause our field data collection in 2020 in order to focus on a year of analysis and synthesis.

Left to right: Quinn McMahon, Patrick Carr, Bob Wilkerson (IBP Staff Biologist), Mikaela Kropp, and Rae Engert (Crew Lead) during a training day in Giant Forest, Sequoia National Park. NPS photo by: Sylvia Haultain.

High Elevation Forests

Forest crew members will travel to remote high elevation stands of foxtail pine and whitebark pine and collect data on forest condition, insects and disease, and the growth, death, and establishment of individual trees. 2019 is the seventh field season for this project, and the crew will make the first complete re-visit of our panel 1 plots. The crew lead is Sean Auclair, back for his sixth season of Sierran forest monitoring and research projects. Zoe Klein is returning for her second season with SIEN and first season as an NPS employee after starting last year as a Geoscientist-in-the-Parks (GIP) intern on our wetlands crew. David Barasch joins the crew as a GIP intern, working his first season in the Sierra Nevada. David has a B.S. in Geology from U.C. Davis. He has most recently worked as an analytical chemist in the metals department for a private lab and has been a physical science technician with USGS, assisting with metal bioavailability research on aquatic invertebrates in mine and agriculturally impacted sites.

The crew will be helping pilot a giant sequoia monitoring project in SEKI while waiting for the snow to melt at the parks' high elevations.

Jonny Nesmith, SIEN Ecologist and Project Lead, is also completing a final report to the U.S. Forest Service on a white pine blister rust survey conducted in 2013-2017.

2018 forest crew members Sam Zuckerman and Rosa Cox coring a whitebark pine near Charlotte Dome, Kings Canyon NP, for a project investigating the drought tolerance and vulnerability in whitebark pine stands. Photo by: Sean Auclair.

Lousewort, Yosemite NP. Photo (cropped): Sam Zuckerman.

Wetlands

This season is a "rest" year for wetlands project field sampling. This will provide time for Roxanne Kessler, who has previously worked on SIEN forests, lakes, and wetlands crews for five seasons, to assist Jonny Nesmith with data management and analysis along with providing field season preparation support for the lakes project.

What's Going on in the Field? *(continued from page 4)*

Lakes

2019 marks our 12th lake monitoring field season! This season we have two crews, both based out of our SIEN office in Sequoia, that will be traveling to 25 lakes across Yosemite, Sequoia, and Kings Canyon. Our crew leads are Dustin Garrison, returning for his second season with the lakes crew, and Alex Studd-Sojka, former SEKI frog crew member that we persuaded to join I&M. Their National Park Service (NPS) field partners are Anna Shampain, also former SEKI frog crew, and Lindsey Scott, new to the NPS but not rugged field work! The Geoscientist-in-the-Parks interns, Kelly Bessem and Gordon Gianniny, will be joining our crews after graduating this spring with degrees in Climate Science (MS) and Geology (BS), respectively.

Annually, crews collect data on a suite of measures to monitor water chemistry and amphibians. 2019 is the second year of an NPS -U.S. Geological Survey (USGS) Water Quality Partnership research grant focused on better understanding algal blooms in mountain lakes in Sierra Nevada and Rocky Mountains. We are surveying for algae along lake shorelines and conducting productivity experiments at SIEN sites, which is providing us a spatial snapshot of algae presence and productivity across the parks. This research is a collaborative effort between SIEN, USGS, SEKI, YOSE, Colorado State University, and the University of California.

2018 lakes crewmember Isabel Christy ready to collect a mid-lake sample. Photo by: Glauco Puig-Santana.

Our lake monitoring provides managers with a snapshot of current lake resource condition, and we are building a long-term dataset to examine trends. We have learned that up to 37% of the lakes in the parks are affected by high nutrient concentrations. Nutrients from agricultural, mobile (vehicles), and industrial sources throughout California drift into the parks via air currents and are deposited in high elevation areas where they can contribute to increased algal growth in remote mountain lakes.

Rivers

Middle Fork of the San Joaquin River, Devils Postpile National Monument, March 1 snow survey. Photo by: Monica Buhler.

SIEN, YOSE, and Devils Postpile National Monument (DEPO) work collaboratively to measure streamflow at three river gaging stations on the Tuolumne River and the Middle Fork of the San Joaquin. YOSE Resources Management and Science field technicians, Rachel Hallnan (crew lead), Brooke Maushand, and Matthew Warbritton will be measuring streamflow this summer at the Tuolumne River at Tioga Road Bridge station and upstream at the Lyell Fork of Tuolumne below Maclure. Student Conservation Association interns Peter Fahey and Jillian Henrichon will be measuring streamflow along the San Joaquin in DEPO.

Data from two of the sites can be observed in near real time on the California Data Exchange Center and USGS National Information System websites:

Tuolumne River at Tioga Road Bridge: http://cdec.water.ca.gov/dynamicapp/staMeta?station_id=TUM

Middle Fork of the San Joaquin River near Mammoth Lakes CA: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=11224000&agency_cd=USGS. The Sierra Nevada Network River Hydrology Monitoring Protocol reports on streamflow data from 14 gages in and near SIEN parks. The additional eleven gages are operated by cooperators and data will be shared with SIEN annually. This is one of the network's newer protocols and the first hydrologic summary report will be completed this year.

The Many Faces of Soundscapes

When you enjoy a park landscape, you often take a photo of the view. Part of the experience is also what you hear. Imagine the sounds that might accompany this view. Photo by: Sam Zuckerman.

Biological, geological, and human sounds make up the soundscape of a place. Visitors to these parks may enjoy frog choruses in meadows, morning birdsong, and sounds of flowing water as part of their park experience. Recording these soundscapes in Sequoia and Kings Canyon National Parks is valuable for ecosystem monitoring and public engagement. From early detection of invasive species to multimedia visitor center exhibits, soundscape recordings are a vital and emerging tool for national park management.

In the face of large scale disturbance from climate change, drought, wildfire, and invasive species, park managers can use soundscape recordings as a highly effective tool for monitoring and visitor outreach. We are currently deploying acoustic recording units (ARUs) in Sequoia and Kings Canyon National Parks (SEKI) to document and quantify ecological change. We use high quality soundscape recordings to connect in-park and virtual visitors to resource issues and experiences via web features, social media outreach, and visitor center exhibits. The following are a few examples of how park staff are currently implementing these techniques:

Relating Acoustic Indices to Animal Biodiversity

The traditional survey methodology (such as point counts) for obtaining avian species richness and diversity remains valuable and is widely used across the Sierra Nevada region. However, these techniques are limited to a snapshot in time, and potentially biased by survey disturbance, observer error, biological (such as behavior), and environmental factors (for example, climate). To complement these traditional methods, passive acoustic monitoring techniques have emerged to provide high resolution continuous biodiversity information across large spatial and temporal scales.

Acoustic indices, which are mathematical summaries of acoustic energy known to be related to avian diversity, are calculated from acoustic recordings to monitor trends in biodiversity. In other words, the greater the number and types of vocalizing species calling at a given time, the higher the acoustic index value will be from a recording (and vice versa). We recently compared human-trained survey results to over 60 unique biodiversity indices across a variety of habitats in California (9 Sequoia & Kings Canyon sites), Colorado, and Florida. When compared to trained technicians, acoustic indices successfully predicted the diversity of avian calls in terrestrial recordings (Buxton et al 2018).

A Case Study: Post-fire Recovery

From July 31 to November 5, 2015, the Rough Fire burned 151,623 acres in the southern Sierra Nevada. Nearly 9,500 acres were within Kings Canyon National Park, extending into the Grant Grove area where giant sequoia forests have been routinely managed with prescribed fire. To assess how the biodiversity in the sequoia forests of Grant Grove responded to the Rough Fire, we placed ARUs in areas with and without prior fire management activities. We have since compiled daily passive acoustic recordings at 9 locations over 3 years. This has resulted in nearly 12 TB of raw acoustic data, which is analyzed weekly to calculate biodiversity indices for every 10 minutes.

The resulting information reveals the pulse of an ecosystem in a time series display of biological activity (Figure 1). This approach is akin to monitoring ozone, particulate matter, or weather data, except the values represent the sound energy from vocalizing species (Figure 2). Preliminary results indicate that without a history of prescribed fire, areas that also experienced the Rough Fire showed an immediate and sharp decline in acoustic diversity when compared to similar sites that were previously burned (Figures 1 and 2). This effect has lasted for 3 years and also resulted in a shift in bioacoustic phenology, where peak activity was delayed by a month.

Soundscapes *(continued from page 6)*

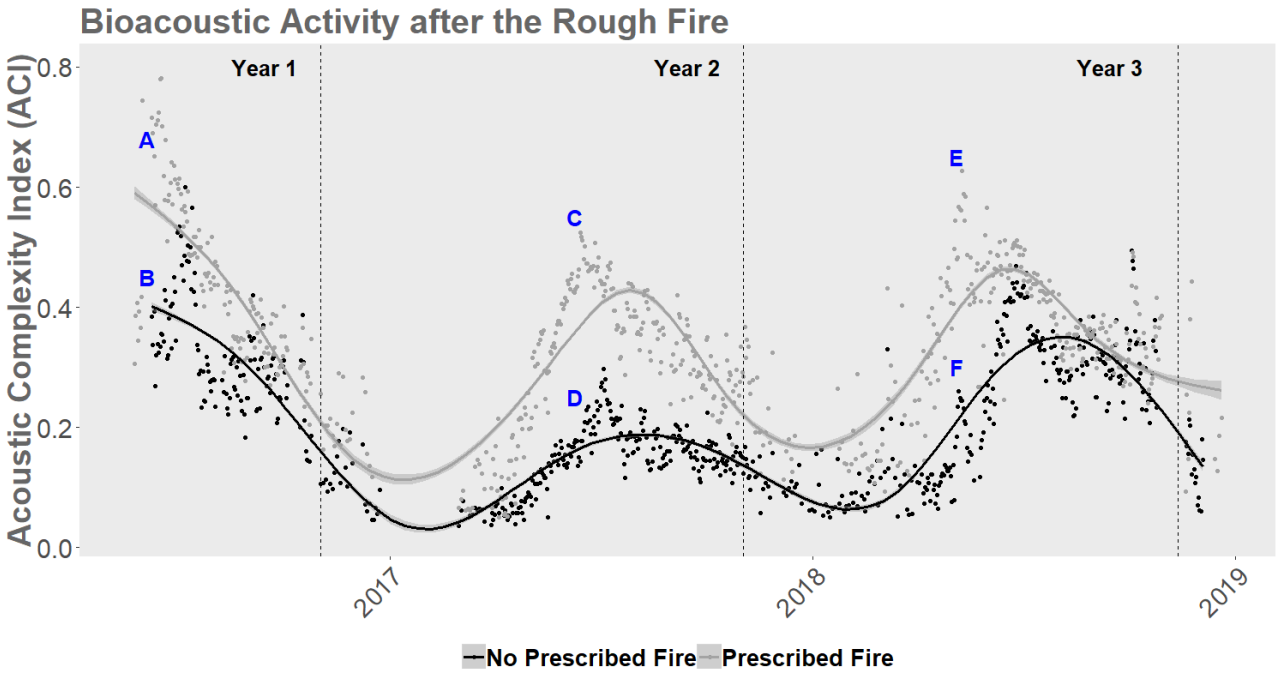

Figure 1. Mean daily bioacoustic activity using the acoustic complexity index (ACI) in giant sequoia forests of the Grant Grove area, Kings Canyon National Park, in the 3 years following the Rough Fire. The ACI is a mathematical summary related to avian diversity. The ACI is calculated from audio files, such as the ones shown in Figure 2 below.

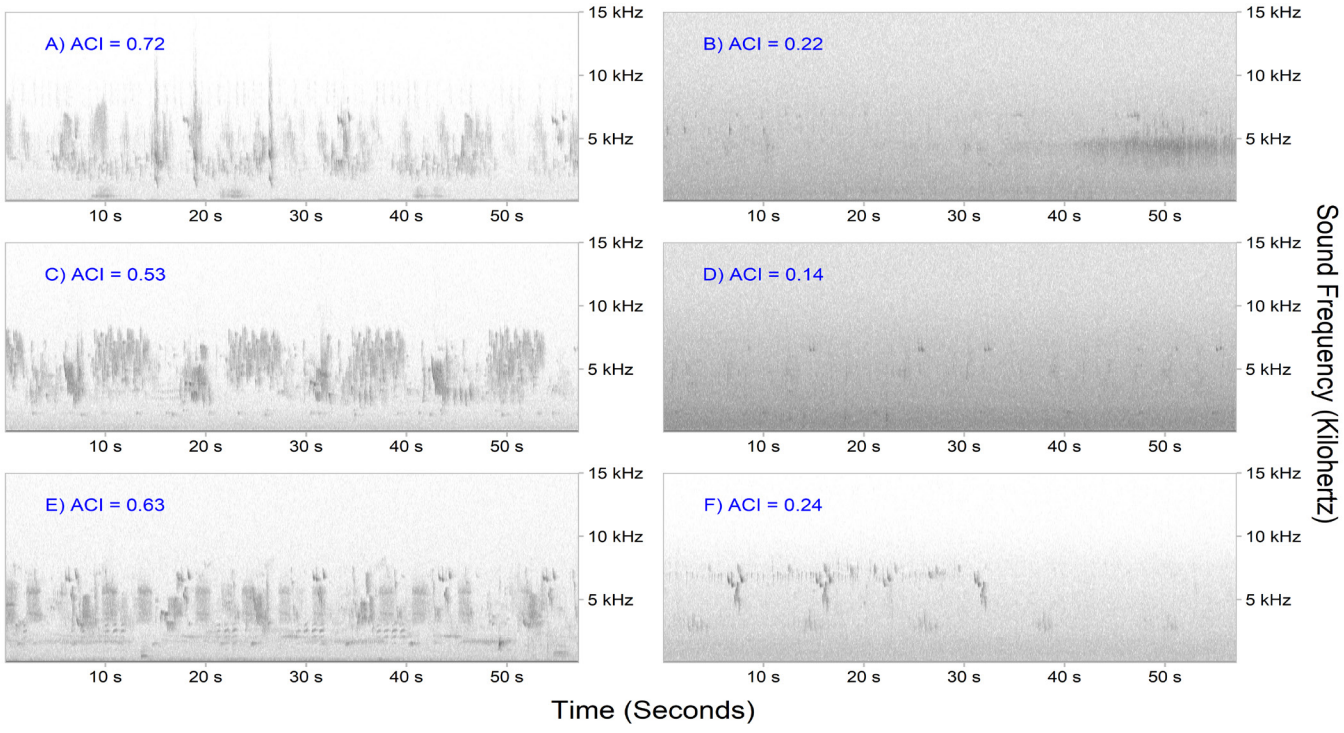

Figure 2. Audio files of recorded raw sound can be visualized in spectrograms that display distinct and repeated patterns of animal calls. Each of the spectrograms above represents a 1-minute-recording from giant sequoia forests where the Rough Fire burned in Kings Canyon National Park. Panels A-F correspond to their respective placement in the time series graph in Figure 1, and demonstrate the bioacoustic activity behind the ACI calculation. The spectrograms on the left side are from an area with a history of prescribed burning, while the ones on the right were recorded in an area that had not burned for decades prior to the Rough Fire.

Soundscapes *(continued from page 7)*

Automated Species Detection

While acoustic diversity indices provide high resolution biodiversity information, this metric is not valuable if single species monitoring is needed. Fortunately, it is also possible to identify and quantify vocalizing species with distinct and predictable vocalizations by scanning and validating their occurrences from acoustic recordings. We are currently doing this for over 600 thousand bat calls, and are developing methods to investigate the occurrence of several bird species for the Rough Fire project. Recently, researchers have developed a rapid and dependable method to detect California spotted owls and invasive barred owls from landscape scale acoustic monitoring in the northern Sierra Nevada (Wood et al. 2018). Thus, this noninvasive monitoring strategy can be easily implemented in the future in SIEN parks for monitoring of spotted owls and early detection of barred owls.

An Unrivaled Ecosystem Archive

Park managers routinely refer to archived data to understand how current conditions deviate from historical. For example, lake sediment cores provide a glimpse into past atmospheric deposition of nutrients and metal pollution. Tree-ring cores provide an archive of climate, drought, and fire history. Cave stalagmites can provide information on past climatic events. These methods have been instrumental in comparing current environmental conditions to the past, but none can provide the resolution of acoustic monitoring, where extended moments in time can be recorded and saved, preserving patterns and behaviors of vocalizing animals, as well as providing high resolution documentation of species biodiversity and richness. Through effective data management practices, we hope that future park managers will have a documentation of past ecosystems, and be able to utilize these recordings in ways that cannot be currently imagined.

Interactive Visitor Experiences

From the California quail's iconic 'chi-ca-go' call sounding through the foothill blue oaks to the Sierra bighorn sheep's rut battles booming over the rocky alpine, the sounds of Sequoia and Kings Canyon National Parks connect park visitors to the varied park landscape. Such distinctive sounds were recorded in the parks throughout 2017 and 2018 in order to share a representation of the SEKI soundscape with a wider audience, including visitors at park information centers as well as online visitors who may never be able to experience the parks' wildlife, giant sequoias, lakes, or other resources first-hand. These high-quality, targeted audio and video recordings are being used in interpretive programs

Dr. Jacob Job, Research Associate, Colorado State University, doing audio recordings in Kings Canyon National Park. Photo by Carlos Linerus.

and visitor center design. They are also being shared via a number of digital products including a story map that showcases highlighted sounds on a virtual tour through the different park elevations and habitats, a digital sound library that presents all recorded sounds via an interactive web map, and an approximately 8-minute video portraying the parks' soundscape that will be shown as part of an exhibit in the Grant Grove Visitor Center. These products aim to engage online and in-park visitors in new and innovative ways.

References:

Buxton, R. T., McKenna, M. F., Clapp, M. , Meyer, E. , Stabenau, E. , Angeloni, L. M., Crooks, K. and Wittemyer, G. (2018). Efficacy of extracting indices from large-scale acoustic recordings to monitor biodiversity. Conservation Biology, 32: 1174-1184. doi:10.1111/cobi.13119

Wood, C.M., Popescu, V.D., Klinck, H., Keane, J.J., Gutiérrez, R.J., Sawyer, S.C. and Peery, M.Z. (2019). Detecting small changes in populations at landscape scales: a bioacoustic site-occupancy framework. Ecological Indicators. Volume 98, 2019, Pages 492-507, ISSN 1470-160X

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Published Products

The following paper, published in a special issue of Forests *journal, documents the status of both whitebark and foxtail pine in Sequoia and Kings Canyon and Yosemite national parks, based on monitoring data collected from 2012-2017.*

Nesmith, **J. C. B., M. Wright, E. S. Jules, and S. T. McKinney**. 2019. Whitebark and foxtail pine in Yosemite, Sequoia, and Kings Canyon national parks: Initial assessment of stand structure and condition. Forests 2019, 10, 35; doi:10.3990/f10010035.

Just have time for a brief version? Download the publication brief.

Interested in more information about whitebark pine? This entire issue of *Forests* was devoted to the ecology and restoration of whitebark pine. Visit the Forests journal website to explore this special issue.

The following annual report captures the highlights from our white pine monitoring project for 2017.

Nesmith, J. C. B. 2018. Sierra Nevada Network white pine monitoring: 2017 annual report. Natural Resource Data Series NPS/SIEN/NRDS—2018/1194. National Park Service, Fort Collins, Colorado.

We completed a publication brief on a lakes publication highlighting improved lake water quality following the enactment of the 1970 Clean Air Act and Amendments.

- Download Environmental policy making a difference: The Clean Air Act and mountain lakes.

The following datasets have been published in the Integrated Resource Management Applications and are available for National Park Service users:

- Landbird Monitoring Database 2011-2016 (NPS internal only): https:/irma.nps.gov/DataStore/Reference/Profile/2259644. This dataset includes Devils Postpile National Monument, Sequoia & Kings Canyon National Parks, and Yosemite National Park.
- White Pine Community Dynamics Monitoring Database 2013-2014 (NPS internal only): https://irma.nps.gov/DataStore/Reference/Profile/2253821. This dataset includes Sequoia, Kings Canyon, and Yosemite national parks.

Sierra Nevada Network

The Sierra Nevada Network is one of 32 National Park Service inventory and monitoring networks that monitor vital signs to assess the condition of park ecosystems and contribute to a body of scientific knowledge that informs park management decisions.

Parks in the network are:
*César E. Chávez National Monument (CECH)
Devils Postpile National Monument (DEPO)
Sequoia & Kings Canyon National Parks (SEKI)
Yosemite National Park (YOSE)

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*Established in 2012, César E. Chávez NM is not included in the vital signs monitoring program.

2018 wetlands crew enroute to site. Photo by: Wesley Meyers.

Lake crew member near Crabtree Lake. Photo by: Talia Chorover.