Park News

Great Basin National Park
National Park Service
U.S. Department of the Interior

The Midden

The Resource Management Newsletter of Great Basin National Park

Treatment of Baker Lake to Restore Bonneville Cutthroat Trout

By Joseph Danielson, Biological Science Technician

In August and September of 2021, Great Basin National Park resource management staff collaborated with the Nevada Department of Wildlife (NDOW) to conduct a rotenone treatment in Baker Lake to remove the non-native Brook Trout and Lahontan Cutthroat Trout (LCT) that were introduced decades ago. The treatment was conducted as part of a larger initiative for the conservation of Bonneville Cutthroat Trout in their native range by establishing new conservation populations in Johnson and Baker Lakes. If successful, this project may increase the species resilience against the impacts of global climate change.

NPS Photo by Joseph Danielson

The Backcountry Horsemen of Nevada - High Desert Chapter were instrumental in helping get gear to and from Baker Lake.

This year's project started in the early summer with snorkel surveys in Baker Lake for LCT spawning behavior. Cold water and high elevation make using dry suits for extended periods of time challenging. Neverthess, Park staff made several excursions to the lake and observed instances of aggression, signs of fighting, and redd (nest) building, all of which are indicators of spawning.

Observing established redds or redd building was a primary goal during these spawning surveys because cutthroat trout typically bury their eggs in redds in cold, flowing streams, not in lakes. We think that since LCT have found a way to spawn in a lake with no flowing water then Bonneville Cutthroat Trout should find spawning success as well.

The water level at Baker Lake varies throughout the year with the highest lake volume occurring in the spring following snow melt and the lowest levels in the late summer and fall, depending on seasonal precipitation and the persistence of the previous year's snowpack. Calculating Baker Lake's volume at the time of the treatment was a necessary step to determine the amount of piscicide needed to effectively treat the lake.

One week before the treatment, Park staff conducted bathymetric surveys of the three distinct water bodies that make up Baker Lake. During these surveys, staff made a 5-meter grid of the lake and then accurately measured the depth of the lake to determine the lake's total volume and the volume of water in each distinct section of the lake. This allowed staff to apply a consistent concentration of rotenone throughout all sections of the lake.

During the same week, 25 Brook Trout and LCT were collected via angling to perform a bioassay. The fish were placed in buckets of water

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Baker Lake Treatment (continued)

with graduated levels of rotenone mixed from 0 to 2 parts per million of product. The fish were monitored for eight hours, and observations were recorded at set time intervals to see how they reacted to varying levels of rotenone. This told us what the minimum effective concentration of rotenone was, the total amount of rotenone needed to treat the lake, and gave us a baseline to determine how much rotenone was still in the lake water after the treatment.

Once this preliminary work was completed, the Backcountry Horsemen of Nevada - High Desert Chapter volunteered horses, mules, and personnel to haul hundreds of pounds of gear up to Baker Lake before the treatment and back down afterwards. Without their help it would have taken many days and people to hike everything needed to the lake.

On September 1, 2021 Park and NDOW staff began the multifaceted rotenone treatment. The lake's low water level and talus substrate meant that there was a large amount of interstitial water that would not be reached by diffusion of rotenone from the main body of the lake. This area was treated first on foot with pump sprayers. To treat the main body of the lake, we used an inflatable Zodiac boat with a trolling motor to distribute rotenone evenly throughout the lake.

Following the treatment, we surveyed for fish carcasses and counted 301 fish. These fish, along with the 25 used during the bioassay bring the total to 326, but there were likely more fish that were missed during counts. Approximately 13% of fish observed were LCT.

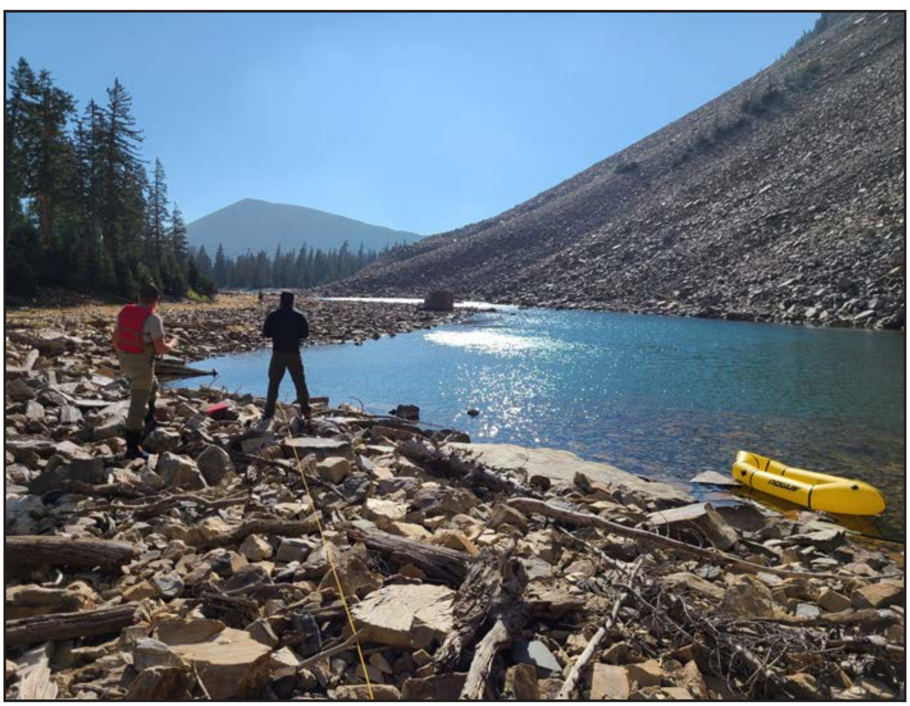
Although rotenone decays rapidly in the environment and a low

NPS Photo by Joseph Danielson

Getting ready for a snorkeling survey at Baker Lake

concentration was used during the treatment, we returned the following week to monitor the rotenone level in the lake. To check rotenone levels, Park staff hiked Baker Lake water four miles down to the nearest fish in Baker Creek to conduct bioassays. Fish tested during these follow-up bioassays exhibited signs that corresponded to non-lethal levels of rotenone, which indicated that the rotenone was breaking down as expected.

Rotenone does not affect fish eggs, and because Brook Trout and LCT spawn at different times of year, it is possible that eggs could have been fertilized and buried before the treatment. Park staff will conduct validation surveys in 2022 with gill nets and minnow traps to look for surviving fish. Another rotenone treatment will be done in 2022 due to the possibility of fertilized eggs hatching after the 2021 treatment. Bonneville Cutthroat Trout are scheduled for release into Baker Lake in 2023.



NPS Photo by Joseph Danielson

Staff performed bathymetry surveys to make calculations for the rotenone treatment.

Detecting and Forecasting Change in High Elevation Species

By Kelsey Ekholm, Biological Science Technician and Meg Horner, Biologist

NPS Photos by Kelsey Ekholm

Target high elevation plant species, clockwise from upper left: Pennel beardtongue, Nevada primrose, Nachlinger catchfly, and Holmgren's buckwheat

In collaboration with the University of Nevada, Reno (UNR) and botanist Jan Nachlinger, the Park initiated a project to assess current and future distributions of endemic alpine plants. Alpine surveys focused on finding four high elevation, endemic forbs found in eastern Nevada: Holmgren's buckwheat (*Eriogonum holmgrenii*), Pennell beardtongue (*Penstemon leiophyllus* var. *francisci-pennellii*), Nevada primrose (*Primula cusickiana* var. *nevadensis*), and Nachlinger catchfly (*Silene nachlingerae*).

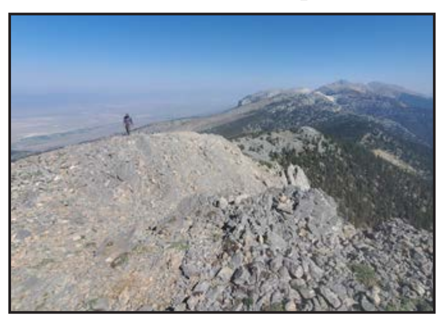
Fifteen years have passed since initial surveys were completed (2004-2006), providing an opportunity to document changes in distribution and model possible changes in the future.
All four target species are considered At-Risk by the Nevada Natural Heritage Program. Like other high elevation species, these plants are particularly vulnerable to climate change because they have evolved to a specific set of growing conditions and have a limited area for vertical migration. Using past and current distribution data and modeling future distributions will help the Park manage these unique species and understand how climate change could affect alpine ecosystems.

Crews worked through wildfire smoke this season to survey alpine habitat near Mt. Washington, Highland Ridge, Decathon Canyon, and Bald Mountain. When an individual plant was found, an area-constrained presence/absence survey for all four species was conducted. If a tiny Silene was observed, there was usually some cheering involved, as this species was particularly difficult to locate.

We surveyed over 1,300 acres and documented plants at locations from initial surveys as well as in new areas. More surveys are planned for next field season to document new localities and test model predictions.

NPS Photo by Kelsey Ekholm

Alpine plant survey crew near Lincoln Peak.



NPS Photo by Kelsey Ekholm

A member of the team walks along an alpine ridge during this summer's alpine plant survey.

New Technologies to Help Win the War against Cheatgrass

by Matthew Madsen, Professor, Brigham Young University

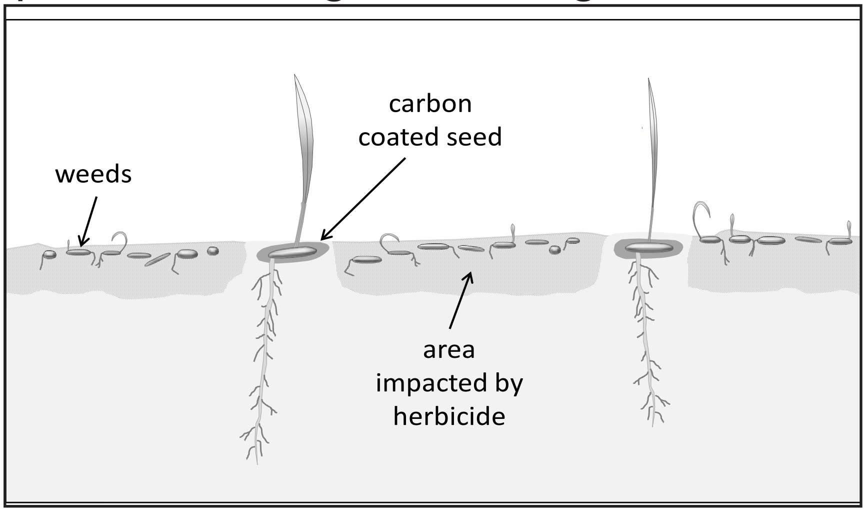


Figure 1. Illustration of an annual grass infested area that was planted with native seed coated in activated carbon. The site is treated with pre-emergent herbicide, which controls weed species while activated carbon deactivates herbicide in the immediate vicinity of the sown seed and allows for plant growth.

The sagebrush ecosystem is considered one of the most imperiled habitats in the United States. At one time, it covered over 150 million acres, but since European settlement, it has shrunk to only 56% of its historic range due to impacts from altered fire regimes, invasive species, conversion to conifer woodlands, and various human disturbances.

Research conducted at Great Basin National Park by graduate student Tyson Terry and others with Brigham Young University and the National Park Service evaluated new seeding technologies to help restore lost sagebrush habitat. Their work was focused on restoring areas that had been invaded by the exotic annual weed, cheatgrass (*Bromus tectorum*).

Seeding efforts in cheatgrass invaded areas typically fail due to high competition for limited resources. The use of soil-active herbicides is commonly needed to control cheatgrass prior to seeding. However, when seeding is performed concurrently with herbicide application, practitioners struggle with applying herbicide at rates sufficient to achieve weed control without damaging the seeded species.

Tyson's group tested two different approaches to lower the impact of pre-emergent herbicide on a native bunchgrass species, bluebunch wheatgrass (*Pseudoroegneria spicata*). Their first approach was to coat seeds with activated carbon. Activated carbon has a high adsorption capacity for many organic compounds, including many pre-emergent herbicides. When applied within a seed coating, activated carbon may limit the impact of a pre-emergent herbicide on seeded species (Figure 1).

The second approach the researchers took was to remove the herbicide from around the seed physically. This was accomplished by spraying the site and then creating a furrow that side-casted the herbicide-treated soil to produce a zone where seeds could be planted that would not be in contact with the herbicide (Figure 2).

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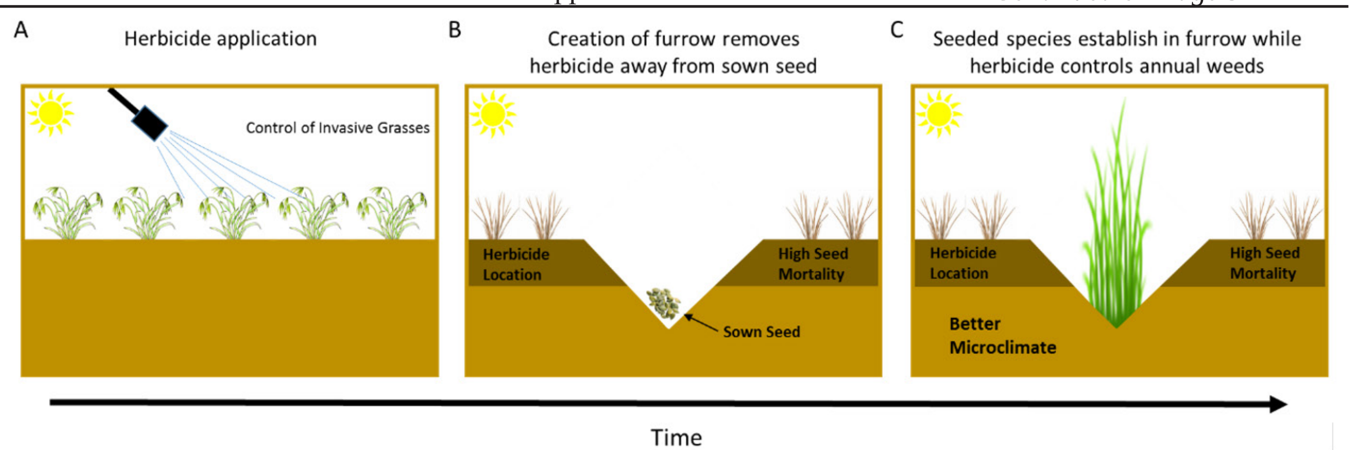

Figure 2. Illustration of a proposed technique to remove invasive annual grasses and seed desired species at the same time by A) spraying the site with a premergent herbicide, B) removing the herbicide within a deep furrow, which is planted with seed and C) provides a microsite for the seeds to grow while the herbicide controls invasive weeds in-between the furrows (Taken from Terry et al. In 2021a).

War against Cheatgrass (continued)

Photo by Tyson Terry

Figure 3. Students from Brigham Young University conducting research at Great Basin National Park.

This research demonstrated that activated carbon coatings and deep furrow treatments provide unique mechanisms for mitigating the effects of pre-emergent herbicide on seeded species and that the combination of the treatments was most successful. In this trial, when both activated carbon and deep furrow treatments were combined, there was a 7.7-fold increase in bluebunch wheatgrass biomass compared to untreated seed.

These innovative technologies have the potential to provide land managers with the tools they need to reclaim areas invaded by exotic annual grasses. Improved restoration success in exotic annual grass invaded sites will result in many benefits, including lower firefighting costs, improved forage production for livestock, increased recreational activities, and enlarged habitat for wildlife.

Citations:

Terry, J.T., M.D. Madsen, R.A. Gill, V.J. Anderson, and S.B. St. Clair. 2021a. Selective herbicide control: using furrows and carbon seed coatings to establish a native bunchgrass while reducing cheatgrass cover. Restoration Ecology: Published ahead of press. https://onlinelibrary.wiley.com/doi/abs/10.1111/rec.13351

Terry, J.T., M.D. Madsen, R.A. Gill, V.J. Anderson, and S.B. St. Clair. 2021b. Herbicide effects on the establishment of a native bunchgrass in annual grass invaded areas: indaziflam versus imazapic. Ecological Solutions and Evidence: 2021;2:e12049. https://doi.org/10.1002/2688-8319.12049

Researcher Awards

Congratulations to Zoe Havlena, a researcher from New Mexico Tech, who was recently awarded a prestigious NASA grant to fund her doctoral research in geomicrobiology. Zoe has been working for the last several years studying the geomicrobiology of Lehman Caves to help us better understand how the cave formed. This grant will help her continue her studies. She will be collecting and analyzing gypsum samples from four cave systems in an effort to shed light on how life could grow in harsh ecosystems, such as other planets or moons. Press release

Congratulations also to Louise Hose, retired NPS geologist (among other things), who was awarded the Meritorious Contribution Award from Geological Society of America for her lifetime of work in advancing karst science. In addition to a great variety of cave and karst work, Louise has chosen to spend some of her time studying the origins of Lehman Caves. She has rewritten much of the geologic history, which is featured in the new exhibits in the Lehman Caves Visitor Center as well as the Lehman Caves Virtual Tour.

NPS Photo by Gretchen Baker

Top photo: Zoe Havlena
Bottom photo: Louise Hose in the Gypsum Annex section of Lehman Caves.

Cool Bug Facts: The Pinyon and The Engraver

By David Greene, Biological Science Technician

The pinyon engraver beetle (*Ips confusus*) is a member of the Bark Beetle subfamily Scolytinae. These native beetles play an important role in pinyon-juniper forests by killing weak or damaged pinyon pine trees. This can improve habitat diversity, create canopy gaps allowing shade intolerant species in the seed bank to germinate, provide snag habitat, and contribute organic material to the soil, not to mention the beetles themselves are a part of the food web.

The beetles cause tree mortalities by boring into the living tissues of the cambium layer just below the bark. They feed on xylem and phloem, disrupting the transportation and storage of water, nutrients, and sugar.

Under normal circumstances, most healthy pinyons are not at risk of *Ips* infestations. However, beetle population booms, drought, comorbid fungal infections, or a combination of these can lead to an increased risk of infestation, even in healthy trees.

Pinyon pines respond to beetle attacks by creating pitch tubes – an inundation of sap at the site of the initial hole bored by the beetle (Figure 1). The sap defends the tree by pushing out the beetle and sealing the wound.

Water stress (i.e., drought) can compromise the effectiveness of the pitch tube defense, requiring less effort from the beetle for a successful infestation. Furthermore, slash left over from logging or thinning can provide a surplus of habitat for beetle populations to flourish. Pinyon engraver population booms can overwhelm even healthy trees, and often lead to widespread pinyon mortalities.

NPS Photo by G. Baker

Figure 1. Globs of sap formed by pitch tubes sometimes trap invading beetles.

If a beetle successfully bores into a pinyon, the sap that was once deployed as a defense now plays a role in attracting more beetles. The pinyon engraver bio-oxidizes terpenes present in the sap to produce pheromones signaling the location of a suitable host, which in turn draws free-flying beetles en masse to join the attack. As the number of beetles colonizing the ill-fated pinyon grow, so does the strength of the pheromone signal. Depending on environmental conditions and signal strength, some *Ips* species can detect and respond to this call from over eleven miles away.

Generally, it is the male beetles that colonize the tree. Upon entry,

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NPS Photo by David Greene

Figure 2. Pinyon engraver beetle nuptial chamber (a), egg galleries (b), and niches where eggs are laid (c).

Cool Bug Facts (continued)

their first task is to bore a nuptial chamber (*Figure 2a*). This is an area suitable for the male and two to six females to mate. After mating, each female bores an egg gallery (*Figure 2b*) out from the nuptial chamber following along the grain of the wood.

In the egg galleries, the female will etch around 20 to 30 small niches (*Figure 2c*) where a single egg, packed in with debris, is laid. The eggs normally hatch after seven days. The larvae pupate after three to six weeks and emerge from the tree as adults, then follow the pheromone trail to the next potential host tree where the cycle starts again. The year's first generation normally emerge in April or May, depending on temperatures. It is common for the pinyon engraver to produce three to four generations a year. Adults overwinter in the tree in sinuous feeding galleries.

Pinyon juniper woodlands' range spans across five states in the Southwestern United States. Within that range, around 15% of the land is occupied by the woodlands and play an ecological important role in the Great Basin region. At Great Basin National Park, pinyon juniper woodlands cover about 7000 acres or 10% of park lands. Drought conditions and increased temperatures due to climate change are predicted for the future, and we should expect to see ecosystems respond. The Park will likely see more evidence of pinyon engravers and impacts to pinyon pine woodlands in the years to come.

Learn more about insects, diseases, and drought impacts at the 2022 Forest Health BioBlitz, June 22-24.

Selected Publications about the Park

Burgoyne, J., R. Crepeau, J. Jensen, H. Smith, G. Baker, & S. D. Leavitt. 2021. Lampenflora in a show cave in the Great Basin is distinct from communities on naturally lit rock surfaces in nearby wild caves. Microorganisms, 9(6): 1188. Link

Cooper, C. S., D. F. Porinchu, S. A. Reinemann, B. G. Mark, & J. Q. DeGrand. 2021. A lake sediment–based paleoecological reconstruction of late Holocene fire history and vegetation change in Great Basin National Park, Nevada, USA. Quaternary Research, 1-15. Link

Dahle, J. R. 2021. Late Quaternary glacier and climate change in the northeastern Great Basin. Master's Thesis, North Dakota State University.

Hankin, L. E., & S. M. Bisbing. 2021. Let it snow? Spring snowpack and microsite characterize the regeneration niche of high-elevation pines. Journal of Biogeography, 48(8):2068-2084. Link

Hose, L. D., H. R. DuChene, D. Jones, G. M. Baker, Z. Havlena, D. Sweetkind, & D. Powell. 2021. Hypogenic karst of the Great Basin. *In* Field Excursions from the 2021 GSA Section Meetings, Geological Society of America. Vol. 61:77-114. Link

Koontz, A., W. D. Pearse, & P. Wolf. 2021. Pronounced genetic separation among varieties of the Primula cusickiana species complex, a Great Basin endemic. bioRxiv: preprint. Link

Ports, M. A. 2021. Terrestrial snails and slugs of Nevada, USA: an overview of taxa, biogeography, and habitat affinities. Western North American Naturalist, 81(3): Article 9. Link

Rodhouse, T. J., J. Lonneker, L. Bowersock, D. Popp, C. J. Thompson, G. H. Dicus, & K. M. Irvine. 2021. Resilience to fire and resistance to annual grass invasion in sagebrush ecosystems of US National Parks. Global Ecology and Conservation, e01689. Link

Tudor, A. R., S. Dascalu, R. M. Plotkin, A. W. Shaw, & A. E. Covington. 2021. User-guided development of a photometric pipeline for the Great Basin Observatory robotic telescope. American Astronomical Society Meeting Abstracts, 53(1): 127-06.

Lehman Caves Temp and Humidity before, during, and after Closure

By Gretchen Baker, Ecologist

Lehman Caves was closed to the public for 427 days due to COVID, from March 19, 2020 to May 22, 2021. This may have been the longest closure since the cave was opened for tours since 1885. (In 1944, during World War II, there were only 872 visitors for the year, so the cave was likely closed for a few months.)

Although this closure wasn't so good from the perspective of sharing one of the Park's great resources with the public, it did allow for some unique data collection in the cave (Figure 1). We've never really had a chance to collect baseline cave climate data, because it has people going in it nearly every day of the year, year after year.

Temperature and humidity dataloggers were installed in several locations in the cave in the summer of 2019 as part of the cave lighting project. They recorded hourly temperature and relative humidity data.

During normal operations (pre-closure), the data showed daily fluctuations (Figure 2). The temperature next to the Doghouse relay station goes from about 52°F to 60°F every day. Humidity drops from near 100% to less than 80% (and sometimes less than 70%) every day. Why? When the electricity to the cave is turned on, it goes to a main transformer at the Giant's Ear and then goes to four relay panels. A small heater is installed in each relay panel

NPS Photo by Gretchen Baker

Figure 1. Electrical relay panel in the Doghouse, Lehman Caves, site for the datalogger recordings in this article.

to help keep the electronics in it dry. So heat is being added to the cave not only due to lightbulbs and human bodies, but also due to these heaters.

If you take a closer look at Figure 2, you can see that the fluctuations are bigger on the left-side of the graph than the right-side. Can you guess why? The answer lies in the x-axis, the date. On November 1, the number of cave tours goes from 4 to 1, so the lights are left on for less time. This results in smaller temperature and humidity fluctuations.

One last thing to point out on this graph. What happened at the red arrow? The temperature stays high and the humidity low. If you guess that the lights were left on over night, you are correct. It has a big impact on the cave. What about at the purple arrow, where temperature stays low and humidity high? That's Thanksgiving, one of the three days of the year that the cave is normally closed.

Let's move now to 2020, when the cave closed. We're going to specifically look at March through December (Figure 3). First, check out the blue line, the temperature. It stays nice and flat for most of the time period. The relative humidity, the orange line, stays at 100% for a few months. The little blips you see on the right are when the lights were turned on to do cultural resource surveys and quarterly biomonitoring. The stretch from March to October with the lights out provided time for the cave to settle into what we might call its baseline, where it's not being impacted from tours or infrastructure.

Finally, let's look at what happened in 2021, when the cave reopened to fewer tours (Figure 4). In January and February, the temperature (blue line) is very stable at about 52°F. In March the lights were turned on for a few days for cultural resource work, and the temperature and humidity fluctuate more. Then the lights were off until May, when training occurred. Once regular tours started at the end of May, we saw the same pattern as before, with huge daily fluctuations of both temperature and humidity.

One other thing to note: if you look at the minimum temperature (blue line), once the lights are turned on daily for tours, do you see a trend? There's a slight increase each day in the minimum (and maximum) temperatures. That means the cave temperature is never really

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Lehman Caves Temp and Humidity (continued)

recovering, it just keeps getting warmer over time.

Reducing these temperature and humidity fluxes is one of the goals of the new cave lighting system. Hopefully we can help restore a more natural cave climate by having the lights on less (only when we need them) and by eliminating extra heaters in the cave by using newer technology.

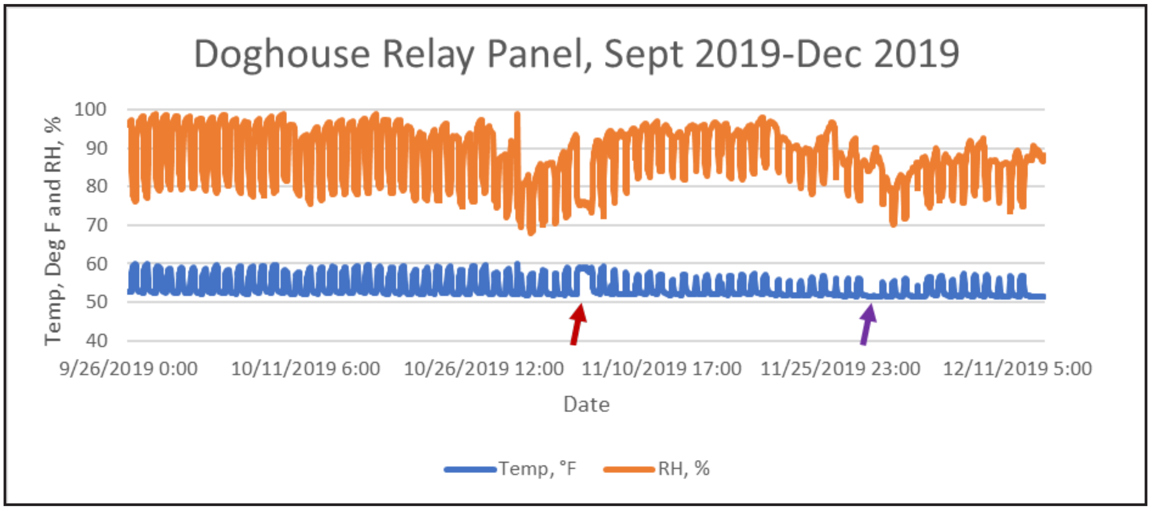

Figure 2. Temperature and humidity in Lehman Caves at the Doghouse during "normal" conditions, from September 2019 to December 2019. Note the daily fluctuations in temperature (from about 52 to 60 degrees F) and relative humidity (from near 100% to below 80%) due to the lights on in the cave. The red arrow shows when the lights were left on overnight and the purple arrow shows when the lights were left off on Thanksgiving Day, when the cave was closed.

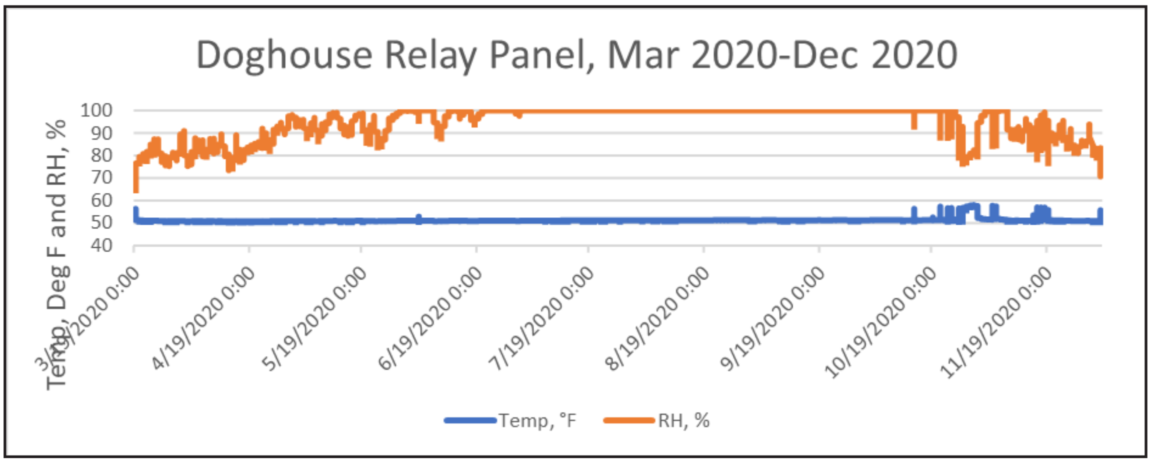

Figure 3. Lehman Caves temperature and humidity at the Doghouse relay panel during cave closure from March to December, 2020. Note how both temperature and relative humidity stay near constant.

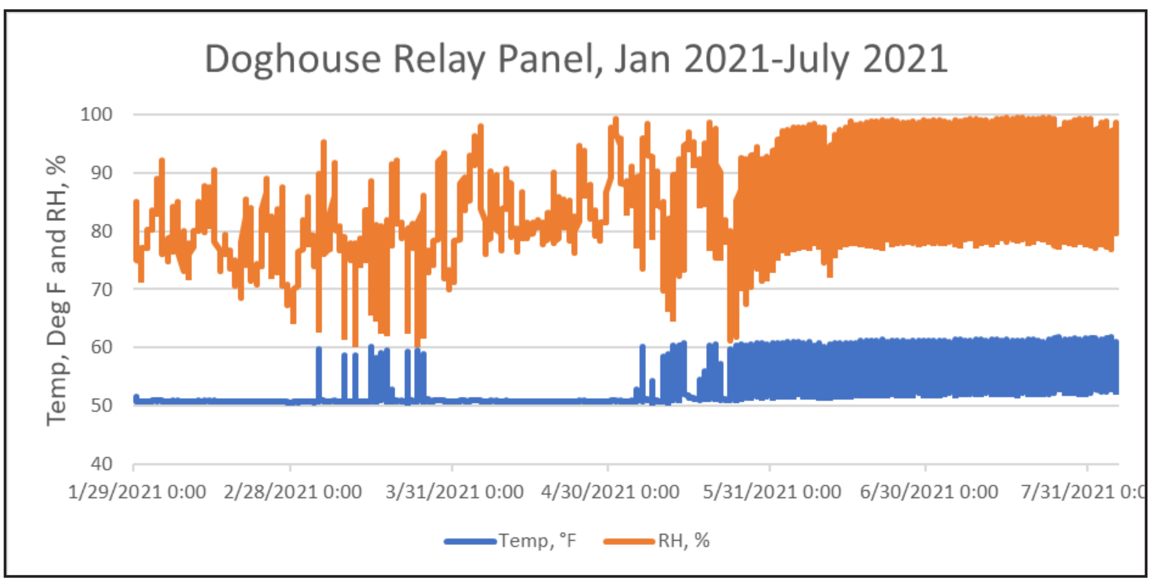

Figure 4. Temperate and humidity at the Doghouse, Lehman Caves from January-July 2021. It is easy to find when regular tours start at the end of May and the pre-closure trend returns.

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The Midden is the Resource Management newsletter for Great Basin National Park.

A spring/summer and fall/winter issue are printed each year. The Midden is also available on the Park's website at www.nps.gov/grba.

We welcome submissions of articles or drawings relating to natural and cultural resource management and research in the park. They can be sent to:
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Or call us at: (775) 234-7331

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What's a midden?

A midden is a fancy name for a pile of trash, often left by pack rats. Pack rats leave middens near their nests, which may be continuously occupied for hundreds, or even thousands, of years. Each layer of trash contains twigs, seeds, animal bones and other material, which is cemented together by urine. Over time, the midden becomes a treasure trove of information for plant ecologists, climate change scientists, and others who want to learn about past climatic conditions and vegetation patterns dating back as far as 25,000 years. Great Basin National Park contains many middens.

Great Basin National Park

2021 Reptile BioBlitz Results

by Bryan Hamilton, Wildlife Biologist and Gretchen Baker, Ecologist

NPS Photo by Gretchen Baker

A BioBlitz participant visits with a kingsnake up close.

The thirteenth annual BioBlitz at Great Basin National Park was held on June 11-13, 2021 and focused on reptiles under the direction of park wildlife biologist Dr. Bryan Hamilton. Over 60 people attended the three-day event, contributing over 1,000 volunteer hours.

Participants found five of the nine species of snakes known to inhabit the Park and eight of the nine species of lizards. Photos are available on iNaturalist.

The snake species found during the BioBlitz:

- Longnose snake
- Gopher snake
- Striped whipsnake
- Great Basin rattlesnake
- Wandering garter snake

The lizards:

- Great Basin whiptail lizard
- Desert Horned lizard
- Northern side-blotched lizard
- Sagebrush lizard
- Collared lizard
- Blue-tailed skink
- Leopard lizard
- Western Fence lizard

Many thanks to all the trip leaders and speakers for sharing their knowledge and making this such a fun event.

Thanks also to our sponsors, the Great Basin National Park Foundation and the Western National Parks Association.

Upcoming Events

December 15, 2021: Snake Valley Christmas Bird Count. Help count winter birds in and near the Park.

January 24, 2022: 100th Anniversary of Lehman Caves National Monument designation (celebration to occur on August 6)

March 2-3: Lehman Caves Lint Camp. This will be a smaller version than in the past and will depend on COVID conditions. Email GRBA_LInt_Camp@nps.gov for more info.

June 22-24: Forest Health BioBlitz. Get ready for the 14th annual BioBlitz and see the Park through fresh eyes. Email GRBA_BioBlitz@nps.gov for more info or check out the BioBlitz webpage.

August 6, 2022: Celebration for the 100th Anniversary of Lehman Caves