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Maintaining Our Trails

By Melissa Green

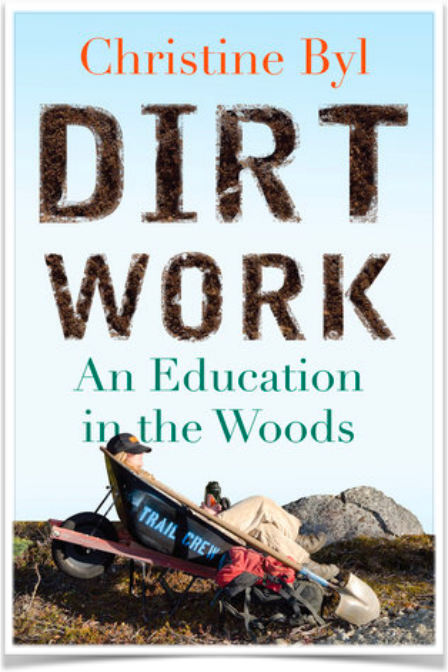
When Gila Backcountry Horsemen (Gila BCH) Trails Director Gerry Engel worked for the United States Forest Service in 1980's, he took for granted that the trails on his map were clear and passable. Now, decades later, a backpacker who ventures into the Gila Wilderness encounters many trails overgrown or non-existent. Since the Forest Service funding for trail maintenance dried up, this is, sadly, the case for many wilderness areas and public lands in the U.S. Given that the Forest Service is no longer able to provide the necessary trail maintenance, new solutions must be found. Those solutions are becoming more clear.

Cycle of not maintaining trails

As you know, funding for trail maintenance has decreased substantially over the past 2 decades, while outdoor recreation continues to increase. Lacking the funds to maintain trails has resulted in many trails become "unfollowable" or dangerous. That funnels the increasing numbers of trail users onto the few remaining trails. This, in turn, causes overuse on these trails along with resource damage to the natural environment. In some areas of the US, this overuse creates the need for permits. The Gila region does not need to go through this cycle. If we can keep a wide range of trails open and advertise all the options appropriately, we will protect our natural resource and keep outdoor recreation available to all.

In *Dirt Work: An Education in the Woods* , Christine Byl explains some of the important aspects of trails and why they need to be maintained.

- "When a tree falls on the trail, hikers don't climb under or over it, they go around. The impact broadens. In highly used areas without maintenance or planned layout, the damage to vegetation and topography can be extreme...."
- "Trails get people to places for experiences, and experiences in places help people know places and people who know places will sacrifice so these places can thrive."



In summary, a well dispersed, well maintained trail system prevents overuse issues and damage to the natural resources. The Gila already has a well dispersed trail system. We just need to maintain these trails.

This is where volunteer trail organizations come in. Having volunteers to work on the trails is key, but having people with trail knowledge to organize the trail projects is even more important. I am hopeful that my recent collaboration with Gerry is creating a path forward and creating a space for other interested volunteers to make a difference.

Here is a little of the back story

I worked on the Forest Service Trail Crew in the Gila and Aldo Leopold Wilderness

Melissa Green, photograph by Gabe Etengoff

for over a decade. I am often described as the opposite of a CDT through-hiker; I hike most areas of the Gila and Aldo Leopold Wilderness and explore as many random canyons and mesas and deer trails as possible.

My work on a Forest Service trail crew started in 2005 and continued for more than a decade. The actual boots on the ground work was funded by grants written by permanent Forest Service office employees. The reduced budget for clearing trails has been an issue since around 2000.

During my time with the Forest Service, I helped create free resources to help trail users plan their trips amidst deteriorating trail conditions. This included a trails clear map, trail not recommended list, trails incorrectly mapped, water updates and more.

When funding for the Wilderness Trail Crew disappeared, I knew that I could not walk away from the trails in the Gila and watch them disappear. Joining forces with Gerry and Gila Back Country Horsemen was a natural move for me.

Gerry worked for the Forest Service for thirty years, mostly in the Gila National Forest, where he was a District Ranger on two districts and Acting District Ranger on the Wilderness District. He often rode his horse on the weekends to explore some of the areas of the national forest that he managed and because he enjoyed being in the woods. When he retired in 2005, he wanted to ride his horse even more but was running into problems with trail conditions which made horse riding hazardous. So, he created a trails program within Gila BCH. He has been organizing trail projects for Gila BCH members for over 17 years, removing thousands of logs and preventing many trails from becoming impassable. On a yearly basis, Gila BCH has logged between 40 and 100 miles of trail.

This work was helpful for all trail users but not enough to keep trails open. Brush and erosion on the trails caused other issues that were not being addressed. In addition, the active members of BCH are only getting older and not many younger equine people are joining (a nation-wide problem for Back Country Horsemen in general).

Gerry Engle, photograph by Gabe Etengoff

Moving Forward United

Rather than create yet another non-profit, I decided to work under the Gila BCH non-profit status and join forces with them. As a result, Gila BCH now brings together both equine-riders, hikers and bikers (in non-wilderness) to do many types of trail work, including brushing, tread, trail marking and logging. Our joint efforts have proven to be very efficient. A typical trail project adventure starts with some in depth preparation.

Trail Project Prep

Before the trail project begins, I flag the trail, sometimes re-finding obliterated sections of trail. I identify the trail work needed and write it on pin flags.

Those who are not interested or are unable to volunteer on trail projects but still want to support trails, help make food for the trail projects. This yummy homemade food is made ahead of time and then vacuum sealed and frozen. This makes cooking in the backcountry much easier. Simply heat the meals in boiling water, cut open the vacuum sealed bag and place it on a plate. It looks like it just came out of the oven. A meal could include beef stew, lasagna, cavatini, egg dishes, burritos and more. Eating well after working hard on the trail all day is imperative. (See photo on following page.)

Gerry and I perform outreach to find volunteers to work on the trails. Some of our volunteers are individuals from the general area – Tucson to ABQ to El Paso and all the towns in-between. We have been able to attract a diverse group of people to do this work, as shown by the group photos at the middle and lower left of the following page, which I took. As part of our outreach, we work with a variety of groups including New Mexico Volunteers for the Outdoors (NMVFO), Continental Divide Trail Coalition (CDTC), Southern New Mexico Trail Alliance (SNMTA), the Silver City Bike group, and more.

As a side note: all these groups are quality organizations. We recommend checking out their other trail projects if you are interested in doing trail work in other areas.

Photograph by Richard Boren

The Trail Project

The equine riders, organized by Gerry, pack the yummy food along with the tools and some gear in to the base camp for the trail project. (Photo bottom right, by Richard Boren.) Hikers can see more remote parts of the national forest while not having to carry in all their gear. Often the hikers do some trail work as they hike to the base camp. (Photo above by Gabe Etengoff.)

While out on the trail, the equine crew focuses on cutting out the big logs with a 2-person crosscut saw. (Photo at top of following page by Tim Trofe.) The hikers/bikers do the tread work, brushing, and small log removal. (Photo at the bottom left of the following page by the author.) This is made more efficient because of the flagging I performed prior to the project. The volunteers work their way down the trail, reading the flags to determine what

work is needed at specific sections. I join other experienced trail people to provide oversight and perform trail work. No trail experience is necessary to join a trail project. Trail maintenance skills and safety trainings are a part of each trail project. Volunteers are encouraged to work at their own pace and focus on the trail skills they enjoy. Some of my "before and after" photos of trail maintenance are shown on the previous page and to the right. The emphasis is on quality over quantity. For example, if we brush a trail, it is done so that we don't need to return for several years. We brush to the Forest Service standard of 6 ft (or generally arms outstretched). This allows pack animals, which are wider than hikers or equine riders, to travel the trail without getting caught on the brush or branches.

The trail projects vary in the time required. Some, close to Silver City, are only one day. More remote projects can be 6 or 7 days long. Sometimes it takes an entire day to hike into the base camp in remote parts of the Gila Wilderness. (Base camp photo by Richard Boren, to the right.)

A majority of the bigger volunteer trail projects are conducted during February to May and late August to November. The goal is to run a lot of trail projects during the optimal months while generally avoiding June through August. June gets quite hot; some water sources dry up and the dry lightning starts. In July and August there is the hazard of lightning and heavy rains – not very conducive to trail work.

Accomplishment - Spring 2021

Between February and May of this year, Gila BCH has significantly improved over 70 miles of trail, removed over 1000 logs, performed extensive brushing, and more. This was accomplished by over 5000 volunteer hours.

During this period, our work in the Black Range included: Railroad Canyon # 128, Gallinas Canyon # 129, and East Railroad # 130. (See map at this link.) The Forest Service will be continuing to work in that area, making more improvements on the Gallinas Canyon Trail and reopening the Crest Trail, connecting all 3 trails, hopefully in October. This will open up the loop options in this area.

During this time, Gila BCH also provided their yearly Forest Service approved chainsaw and crosscut 3-day training. These trainings are required for those who want to chainsaw or supervise the use of the crosscut. (Photo by Richard Boren, to the right.)

After the Trail Project

Reopening a trail does little good if no one knows the trail has been improved and is passable. In fact, having people hike on a trail after reopening it

can be critical to keeping the trail open and visible. Trail users keep the trail tread visible. Re-digging trail tread is one of the most labor-intensive jobs in trail work.

To educate the public about recent trail work, we have created a Gila Trails Info website. See www.gilatrailsinfo.org. Here, you can find a frequently updated trails cleared map, water availability updates, trail mileages, trails not recommended, trails incorrectly mapped and more. To stay updated about our most recent trail work, check out the trail focused Facebook page – www.facebook.com/gilatrailsinfo/. This includes trail work done by various groups, individuals, and the Forest Service.

Choosing Trail Projects

If you are reading this article, you probably are wondering when we will work on such and such trail. There are a few criteria we use in deciding which trails to work on.

1. Gila BCH works on trails throughout the Gila National Forest (GNF) to promote dispersed use. Additional attention has been given to improving trails throughout the Gila Wilderness, since the 100-year anniversary is in 2024. The map link of recent trails which have been worked on shows dispersed trail maintenance.

2. Safety of volunteers. In some areas of catastrophic burn, the trees are falling fast. While it is exciting to reopen these disseminated trails, it is important to wait for more of the trees to fall before it is safe to be working in those areas.

3. Benefits multiple trail users.

4. Our trail work will last a while. Therefore, we often do not work on trails overtaken by locust. Locust can grow back to full height within a few months of being removed. Locust typically continues growing back until it has been shaded out by other vegetation. So, work removing locust only lasts a short while. We currently do not have a big enough workforce to frequently tackle this type of work.

5. Accessibility of getting to the trail work.

6. List of back-up trail projects. There are many unforeseen circumstances that can cause a trail project to be canceled, such as weather, flooding, drought, fires and more. To be most efficient, we have back-up trails to work on if a project needs to be canceled.

If you do have a certain trail you would like to see reopened and you have trail condition information regarding this trail, feel free to contact Gila BCH with this information. We do not make any guarantees, we do what we can. You can make email inquires at groundworktrails@gmail.com.

More about the Gila BCH

Gila BCH is committed to protecting the access of equestrians to public lands. They are devoted equestrians who love to ride and explore new trails. This work benefits all trail users.

Gila BCH is a chapter of the New Mexico BCH, which is part of Back Country Horsemen of America.

BCH of America is an active advocate for trails, trail maintenance and the preservation of our public lands on a national level. They assist with organizing and funding various trails grants in addition to their policy work.

Getting Involved

Want to get involved? You could help out in multiple ways. Cook meals at your home, provide us with updated trail and water info. Submit a report here or email. Or join us on the trail by being a trail volunteer or help with packing in gear and tools. Sign up here.

The future of how trails will be maintained and how our public lands will be managed is unknown. The Great American Outdoors Act has allocated funding to help with the deferred maintenance. This is a step in the right direction but does not address the trail skills and wilderness primitive skills (use of crosscuts) that are being lost. For now, Gerry and I are creating a path forward into unknown territory. We shall see where it leads to. For now, we are pleased that we have been able to help. My before and after photos, below, show our work. Please join us in this endeavor. The right photo composite shows work on the Gallinas trail in May of this year.

Patagonia Picnic Table Effect

The fabled Patagonia Picnic Table Effect may be just that, a fable. The fabled fable originated in the 1960's when birders flocking to the picnic area just east of Patagonia, Arizona, to see a Rose-throated Becard began to find all sorts of other rare birds. From that, the idea that the number of observers was tied to the number of rarities observed originated. Jesse Laney, et al*, at Oregon State University, reviewed the records associated with 273 sightings of "mega-rarities" and found that there is "little evidence for improvement in discovery rates of additional rare birds" when birders migrate to the site of a rare bird sighting.

A summary of the subject article argued that the research debunked the "hot hands" effect, that fable of probability which is well understood. The article does not make that specific claim, and I have never heard that explanation for the Patagonia Effect. I have always understood the effect to be caused by: 1) more people see more birds; and 2) the underlying (usually weather) conditions which contributed to the presence of the initial rare bird potentially apply to other rare birds. Both of these factors may be true in any particular case but appear to be trumped by the general findings.

Most of the article addresses birder behavior, what motivates birders, what influences their decision to flock to a rare bird site, and for what length of time that behavior continues. It is well done and informative.

Anyone who is interested in the socio-economics of birding should delve into this article in detail. The economics of birding and birdwatching are certainly documented in many sources, but this particular study goes into much more detail about what the draw is, how long it lasts, and what influences its magnitude. These factors have a direct economic effect on communities which attempt to exploit this particular study of natural history for their economic benefit.

This study addresses the factors associated with "rare bird sightings", not with the sustained economic advantages associated with offering a "natural experience" of some type. However, when a community provides for natural history experiences and enjoys the sustained economic benefits associated with that offering, it is more likely to enjoy the periodic jump in economic activity associated with the sighting of a rare bird.

A multifaceted economic development program, which includes natural history programs, provides sustainable long-term benefits to communities.

**The influence of rare birds on observer effort and subsequent rarity discovery in the American birdwatching community.*
Jesse A. Laney, Tyler A. Hallman, Jenna R. Curtis, and W. Douglas Robinson, *PeerJ - Life and Environment,* January 21, 2021.
Graph below, from the article.

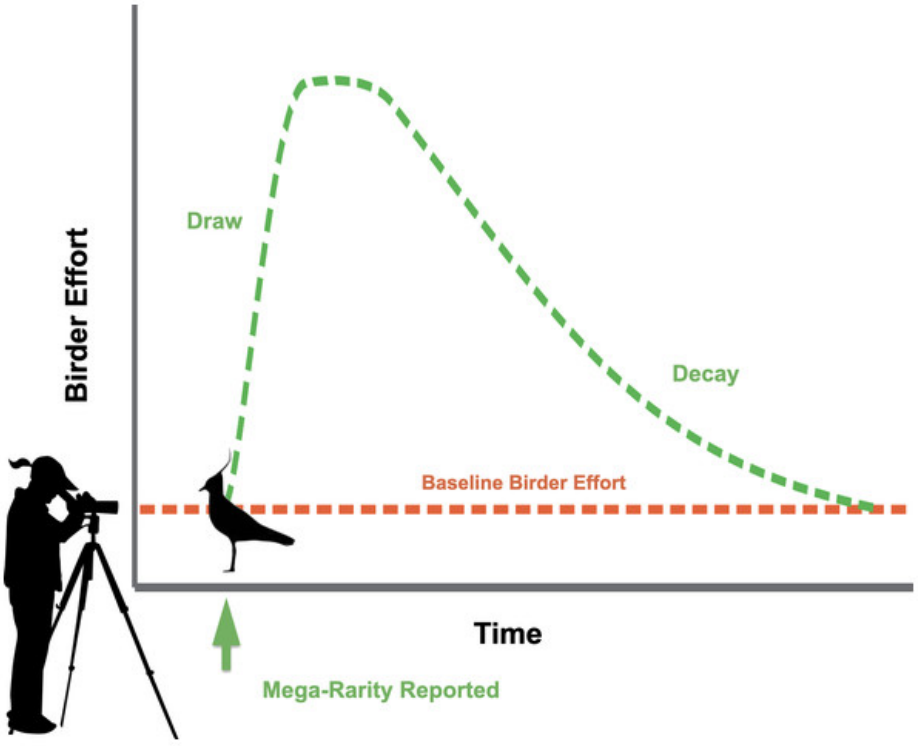


Figure 1: Hypothesized behavioral dynamics of birders when rare species are discovered. Dashed green line represents birding effort when rarities have been discovered, including the draw following initial report of rarity and the decay in effort over time. Dashed orange line represents the baseline birding effort at a given location. Northern Lapwing silhouette clipart ©Adobe Stock. Birder silhouette clipart source: https://openclipart.org/detail/222259/lady-spotting-scope.

Aldo Leopold – His Legacy Part 6

by Steve Morgan

In January of 1918, Aldo Leopold began a new job, Secretary of the Albuquerque Chamber of Commerce. Leopold brought strong skills in organization and public relations to the position. He had struggled with the decision to leave the Forest Service, but he had a growing family to take care of. Also, he was only looking at this as a temporary job until the soldiers returned from the war and the Forest Service projects could resume. But as was Leopold's way, he threw himself into his new responsibilities.

In 1918, Albuquerque was a growing city of around 15,000 and to quote Leopold was "spiritually alive". Leopold soon had several projects he promoted. One area that he sought to change was the divide he saw between the businessmen and everybody else. He said, "To remedy this unnecessary cleavage in our population, the trade, craft and labor organizations should be represented in the Chamber of Commerce. I know of not one project of our Chamber in which the farmer, the carpenter, and the brick mason is not just as vitally concerned as the banker or the merchant."

Leopold was also concerned with the "Americanizing" of the city by not embracing its New Mexican cultural blend of Hispanic and Pueblo architecture. He proposed hiring a city planner to guide the growth in a manner that would create pride in their heritage. Leopold envisioned an Albuquerque city plan that would provide for the gradual acquisition of a system of open space and parks to be within easy walking distance of every home in the city. Of this system, the Rio Grande Park would be an integral part of the plan. He actually started this planning along the river when he was still working for the Forest Service in 1917. He saw the park as "being primarily for the man without a car." He noted that "the man with a car does not need it. Just a trail along the bank and clean woods and waters. All shooting should be prohibited. There are herons, beaver, muskrats, songbirds and killdeer there now, and with proper protection there would soon be ducks, snipe and other wildlife." This was quite a departure from his earlier thinking about hunting but showed his growing concern for the overall health of wildlife habitat. His vision for an open space park system along the river took hold in Albuquerque. If you visit the river today, you'll find a well-developed trail system running through the Rio Grande park, Aldo Leopold Forest, and the Rio Grande Nature Center. His planning lives on.

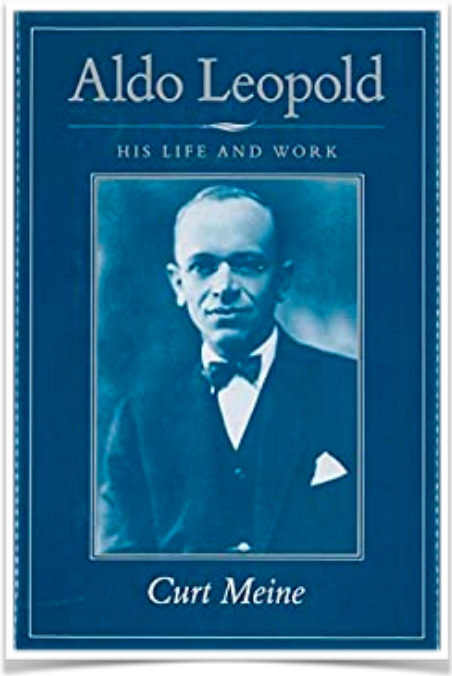
One of his more ambitious projects was to drain the Rio Grande Valley, creating more agricultural land. In the summer of 1918, he helped organize a conference to publicly discuss this project. In the press release he sent out, Leopold said, "If we don't drain, then what? The handwriting is on the wall. A rising water table, a rising crop of salt grass, alkali, and mosquitos, and an agricultural area gradually approaching zero. If we do drain, then what? One of the richest valleys in the West – every acre worth $200, and if properly farmed, paying a profit on that evaluation."

In 1918, this draining a wetland for agricultural use was considered progressive conservation; the wise management of a natural resource to provide a common good. As Leopold did many times in his life, however, he later radically changed his thinking about a topic. For example, he was an avid promoter of predator control and yet in his latter years, came to realize the importance of predators in the natural ecology, hence his statement, "The last word in ignorance is the man who says of an animal or plant, what good is it? If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."

He also wrote that "indiscriminate wetland draining is a primary factor in the destruction". This was a major reversal of his earlier thinking. Leopold showed the unusual ability to change his mind. He often took years to do this, but this allowed him to adjust his thinking when confronted with new information.

It was during this time away from the Forest Service that he first really started publishing articles that expressed his views. They were his early attempts to chart a future course for the conservation of wildlife in America, and to explain his view of the role of wildlife in modern society.

In October of 1918, Albuquerque and all of New Mexico was experiencing something similar to our current situation with COVID-19. The so-called Spanish Flu* had been hitting the East Coast hard and eventually made it to the



southwest. By November, over 15,000 New Mexicans had fallen ill and perhaps a thousand had died.

This was happening in Albuquerque while Leopold was working for the Chamber, but curiously, I have not found any reference from Leopold's writings about this. Albuquerque was not hit as hard as some of the surrounding towns. They only had 923 confirmed cases and 167 deaths. Their city government enforced several measures which sound very familiar to us in 2021: all public gatherings were prohibited, mask use was encouraged and quarantined homes were identified by signage.

When 1919 arrived, Leopold found himself near the end of his obligation to the Chamber, and with the Forest Service regaining its workforce from the end of the war, he was anxious to rejoin the Service. On August 1, 1919, Leopold rejoined the Forest Service as the Assistant District Forester in Charge of Operations.

These were times of rapid changes in our country. Leopold went, in a short ten-year period, from being a greenhorn Forest ranger to Forest Supervisor and now, the number two position on the district. Our next Legacy story has him traveling on inspection tours of all eleven national forests in District 3, spread out through Arizona and New Mexico.

NOTE: Much of the data this article is based on, came from Curt Meine's book: "*Aldo Leopold – His Life and Work*". Some information about the open spaces in Albuquerque came from the City of Albuquerque website. Information about the Spanish Flu in New Mexico came from the article by State Records Administrator Rick Hendricks. Ph.D titled, "The Spanish Flu Pandemic 1918-1920".

*Editor's Note: The "Spanish Flu" probably started in the United States, perhaps in Kansas (see Barry and others) or in New York City. At this point the exact location in the United States is difficult to discern. It probably evolved in 1915 or before and became more virulent in some varieties. Like the Covid-19 virus, however, its origins may remain unknown.

A Warming Desert - Mammals and Birds

We all use the term "niche", as in "biological niche". Joseph Grinnell is credited with developing the concept and did much to popularize its use. He did many other things, as well: he edited *The Condor* (Cooper Ornithological Club) for more than 30 years (1906-1939); he was the director of the Museum of Vertebrate Zoology at the University of California, Berkley, also for more than 30 years (1908-1939); and (shades of Aldo) argued against the National Park Service predator control program. Most importantly, for the purposes of this article, he performed an extensive survey of California fauna, starting in 1908.

Grinnell's survey was extensive, comprehensive, and extremely well documented. Eric Riddell, et al., ("Exposure to climate change drives stability or collapse of desert mammal and bird communities", *Science*, Volume 371, Issue 6529, February 5, 2021, pp. 633-636) used Grinnell's data as a point of comparison for recent field assessments. Riddell et al. focused on mammal and bird populations in the Mojave Desert at the locations Grinnell had surveyed. The current survey found that when compared to Grinnell's survey the same locations had 40% fewer bird species now than then. Comparing mammal species, Riddell et al. found that the populations of 27 species had remained stable, the populations of 3 species had declined, and populations of 4 species had increased. During the last 100 years (Grinnell vs. Riddell), the average temperature in the Mojave Desert increased by about 3.5° F, and moisture levels are significantly lower.

As part of the study, Riddell measured the heat transfer attributes of the feathers of 50 desert bird species and the fur of 24 small desert mammal species. The team also surveyed bird and mammal behavior as it relates to temperature control.

The physiology and behavior of these two faunal groups probably explain the changes in their populations. Birds must expend energy to cool themselves (dilating blood vessels to increase evaporate cooling from their legs and mouths, for instance) while many of the small mammal species burrow into the ground and rely on the insulation of the earth to remain cool. At the same time, they tend to be nocturnal in habit.

The study also found that the mammal species which tended to burrow more shallowly were more likely to experience temperature stress.

Although it may be lost in the broader findings, the fact that Riddell was able to compare exact sites (because of the thoroughness of Grinnell's documentation) and make comparisons

Joseph Grinnell, 1915, in the Sierra Nevadas.

on a "microhabitat" level is significant. Riddell et al. note that "Despite diverse strategies used by animals to reduce exposure to lethal temperatures and desiccation, species inhabiting a site are typically assumed to experience similar magnitudes and rates of exposure. However, comparisons of exposure among taxa at the same sites - especially where climate change has pushed organisms toward their physiological limits - are lacking and are rarely connected to long-term community responses." (p. 633) Their study addressed this specific issue.

The study controlled for habitat disturbance (grazing and fire)

and other conditions that might affect the populations of the subject species.

Reductions in precipitation were found to be more significant for bird species than for mammal species. "For desert birds, however, a reduction in precipitation drove the community collapse over the past century…the effect was compelling at sites that both warmed and dried, which suggests that birds are particularly vulnerable to increased water requirements for evaporative cooling….Cooling costs were higher in birds than in mammals by a factor of 3.3 across a representative landscape, and climate change increased these costs by 58.5% for birds but only 17.4% for mammals." (p. 633-635)

Of the 34 small mammal species in the survey, a third are found in or near our area. The survey found that the populations of *Dipodomys merriami*, Merriam's Kangaroo Rat; *Microtus longicaudus*, Long-tailed Vole; *Microtus montanus*, Montane Vole; *Mus musculus*, House Mouse; *Otospermophilus variegatus*, Rock Squirrel; *Peromyscus truei*, Piñon Deermouse; *Peromyscus boylii*, Brush Mouse; and *Reithrodontomys megalotis*, Western Harvest Mouse remained stable. The population of *Neotoma albigula*, White-throated Woodrat, increased, and the populations of *Onychomys torridus*, Southern Grasshopper Mouse, and *Peromyscus maniculatus*, North American Deer Mouse decreased. When applied to our area, these findings should be considered indicative rather than definitive. (A number of conditions, including varying soil depths, may affect outcomes.)

The article also reports on the findings of the authors' MSOM's, taxa-specific, dynamic multispecies occupancy models, determining which species are likely to share burrows.

In the graphic below, gray lines connect species that are more likely to persist (likely to be present from one sample period to another) or colonize the same site. Red lines connect species that are unlikely to colonize the same sites. AMLE = White-tailed Antelope Squirrel; NELE = Desert Woodrat; DIDE = Desert Kangaroo Rat; MICA = California Vole; PELO = Little Pocket Mouse; CHFO = Long-tailed Pocket Mouse; and DIPA = Panamint Kangaroo Rat. The "A" graphic captures the likelihood of persistence, while "B" captures the likelihood of colonization. (The graphic shown below is from the online supplementary material associated with this article.)

In the April 2020 issue of *The Black Range Naturalist* ("A K-Rat Mound is a Busy Place") Harley Shaw explored the activity at a Banner-tail Kangaroo Rat mound near Hillsboro (pp. 12-13). He documented the "comings and goings'"at the mound in terms of a number of species (including predators) and the timing of visits. His findings are both supportive of, and additive to, the findings described in Riddell et al.

Coati Watch
Photographs by Tom Lander

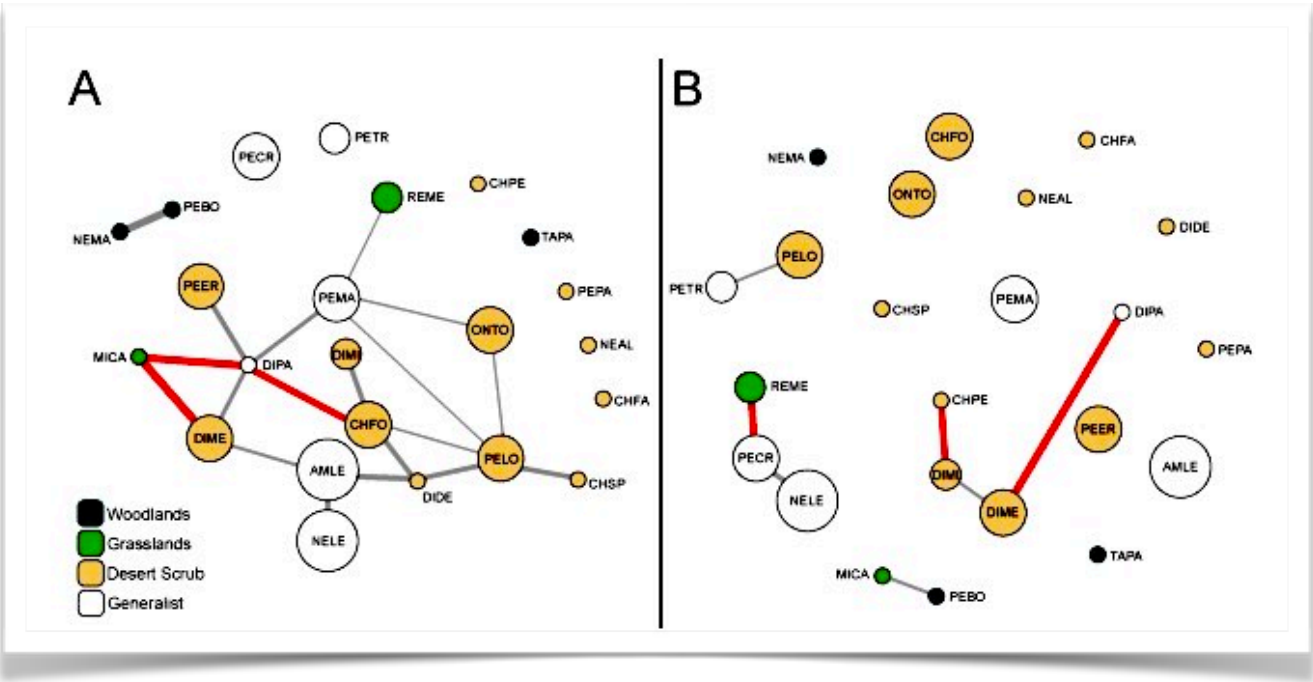
In mid-February of this year, Tom Lander (Kingston), saw two White-nosed Coatis, *Nasua narica*, near MP 43 on NM-152. He was able to photograph one. (See photos next page.) We continue to monitor sightings of this species in the Black Range. The Black Range is at the edge of this species' range (shown on the following page) and our efforts, hopefully, will help describe the possible range expansion of this species as our temperature rises. (Or, to the contrary, how coatis distribute themselves at the margin of a stable range.) If you know of a sighting we have not documented, please let us know. Some recent sightings are listed below.

The White-nosed Coati is in the *Procyonidae* family, which also includes raccoons and ringtails in our area. Other common names include Coatimundi and *Tejón,* which is also the term for badger.

Other Sightings

In addition to the Coati sightings reported in previous issues (April 2019 and December 2020), the following are worth mentioning:

- February 2018 - Southwest Canyon - SW of Kingston, by Devon Fletcher;



- **Periodic sightings in the lower Animas (between I-25 and the Ladder Ranch);**
- **Ranch hands in the Nutt Grasslands reported a group of a dozen or more in about 2002 (per Randy Gray);**
- **Photo from Lake Valley, by Matilda Holzwarth, in about 2004 (per Randy Gray);**
- **ca. 2016, one in Lake Valley Ghost Town and one in Berrenda (per Randy Gray);**
- **March 15, 2020, Lake Valley Ranch, one on the patio (per John West); and**
- **March 7, 2021, tracks (photos below and the following page) in SW Canyon, 1.5 miles SW of Kingston (per Barnes/Hallgarth).**

Please keep your sightings coming in; we are beginning to establish a good record. The ebb and flow of their numbers (or at least the sightings) from year to year is especially interesting.

By IUCN Red List of Threatened Species, species assessors and the authors of the spatial data., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=12190592 - download 2/23/21.

Footprint photos (above and preceding page), Southwest Canyon, east slope of Black Range, March 7, 2021

Litocala Moth - *Litocala sexsignata*

Beauty, and the unexpected, sometimes come in small packages. In the January 2021 issue of this magazine, Ron Parry introduced the world of moths, and his excellent website, Southwestern Moths, to us. In the April 2021 issue, moths and their place in the web of living things were discussed as part of a series of articles about plantings. On March 7, 2021, the *Litocala sexsignata* shown here and on the following page was photographed in Southwest Canyon, southwest of Kingston by about two miles, at an altitude of about 6,500 feet.

The articles in the last two editions of this magazine were an inspiration: why not try to photograph small flitty brown things?

The moths were present where bedrock forced the water to the surface of the canyon bottom. Just a tickle of water running over the marble but lots of thick grass on the stream edges. The *Litocala* were not present at other locations.

The moths would flit about, rarely flying more than 20′ before landing and crawling into the grass. Sometimes they would land on a rock or on the mud. Not always easy to see. Did I mention they were small?

This species is the only one of the genus which is found in North America, primarily in the western part of the United States but into northern Baja California.

The authoritative website bugguide.net, notes that the adults fly from March until June. The species is diurnal and often nectars at flowers (including willow catkins, per Pacific Northwest Moths). It is often seen sipping water from mud. The larvae feed on oak.

The beauty of this creature would be missed if it did not periodically become the focus of our attention.

Not all moths are small, however. The wing span of moths can be as small as 2-3 mm or as wide as 150 mm.

Penstemon spinulosus
by Bob Barnes

John Hubbard's article on this topic in the October 2020 issue is a wonderful example of part of the scientific process - that part which is about questioning, about testing the known, about clarity. He distilled the issue(s) surrounding a *Penstemon spinulosus* specimen collected in New Mexico down to its core and refused to find an answer when the available information did not provide an answer. He suspected that the specimen might have been mislabeled as to where it was collected.

I knew that I could not add anything to the botanical taxonomy question, but everything else just seemed like a good mystery. So I went exploring, knowing that the digital world had grown immensely since Hubbard wrote the original article. The first step in the process was to track down the type specimen, which is shown on the following page.

The specimen sheet indicates that the specimen was collected in the Santa Magdalena Mountains of New Mexico during June 1881 by G. R. Vasey. This information is found on the lower right of the sheet.

Wooton and Standley described the specimen as *Penstemon spinulosus* in 1913. That this is the specimen used is confirmed by the handwritten note above the U. S. National Herbarium stamp on the lower right of the sheet.

David D. Keck used this specimen to determine that the plant was properly described as *Penstemon heterophyllus* Lindl. subsp. *spinulosus* in 1931. The annotation label at the center bottom of the specimen sheet documents this determination.

In 1941, F. W. P. annotated the sheet (lower left) noting that the specimen was apparently from Marin County, California and was probably collected by G. R. Vasey in 1880.

Enlargements of these notations are shown following the specimen sheet.

The second step in my exploration was to determine if G. R. Vasey was collecting in the Magdalena Mountains in June 1881.

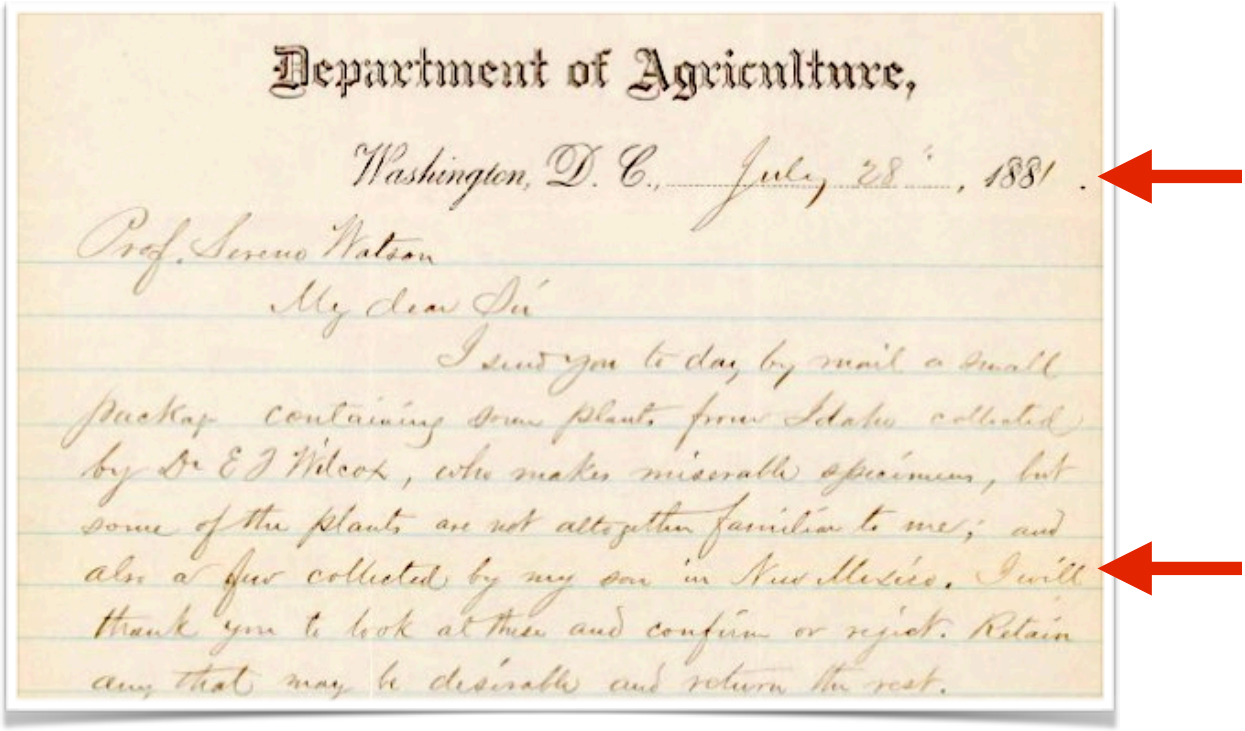
G. R. Vasey, based on a review of his personal correspondence, was in Washington, D. C., during June 1881.

In correspondence to Prof. Sereno Watson, dated July 28, 1881, he noted that he had sent (to Watson) some specimens his son had collected in New Mexico. (See below.)

I conducted a specimen sheet search in an attempt to determine if Vasey (father or son) was collecting in the Magdalena Mountains in 1881 (or 1880). G. R. Vasey was an authority on grasses, and I found the specimen sheet shown on page 18 without too much difficulty. It is the type specimen for *Poa arida*. It confirms (something) and confuses in its own right. The notations at the bottom of this specimen sheet are shown on page 20. They indicate that the specimen was collected at Socorro, New Mexico in May 1881 by G. R. Vasey.

The *Poa arida* specimen sheet demonstrates that G. R. Vasey was collecting in the Magdalena Mountains in the summer of 1881.

Three species are represented on this specimen sheet (causing me some angst at first). At the top center of the specimen sheet one of the three species is identified as *P. californica*. Since I am not a botanist, that is not what excited me. Nay, it was the fact that it was collected by S. B. & W. F. Parish from San Bernardino. They had collected the specimen in the San Gorgonio Mountains of Southern California in April 1882. This may indicate that specimens were being intermingled, both in terms of collectors and collection locations.


Department of Agriculture,

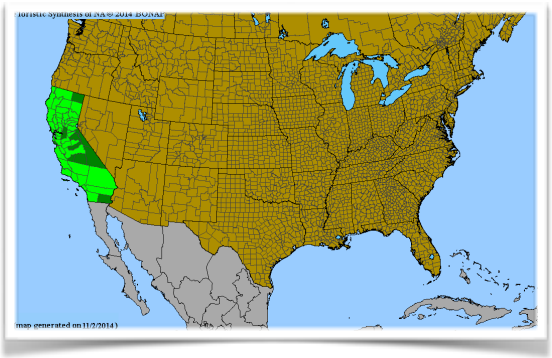
Washington, D. C., July 28th, 1881.

Prof. Sereno Watson

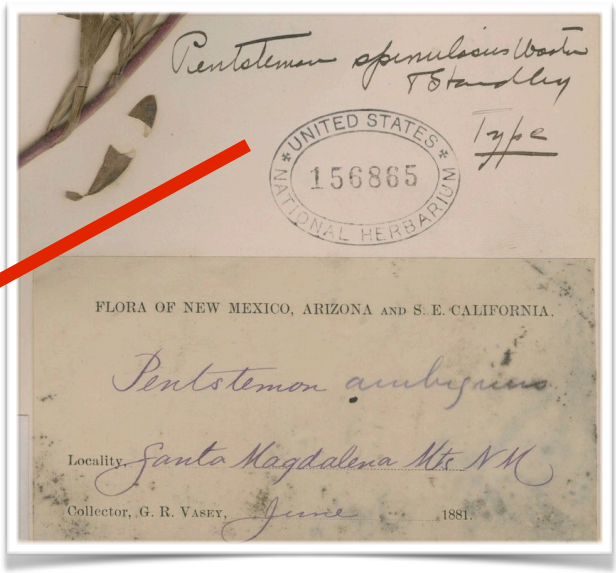
My dear Sir

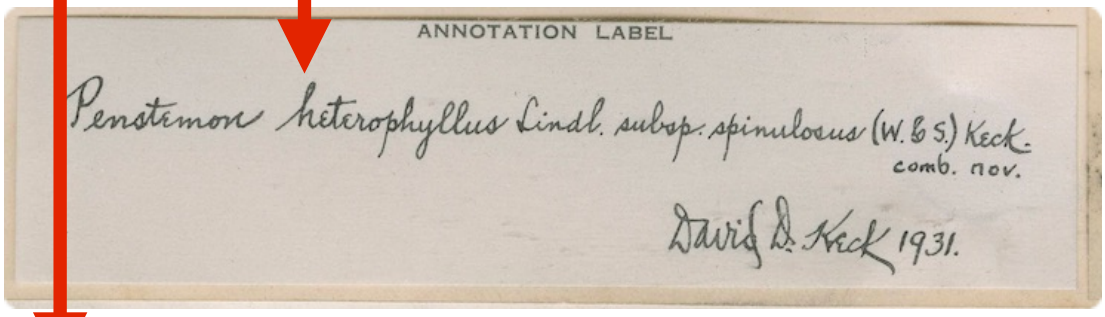
I send you to day, by mail a small package containing some plants from Idaho collected by Dr E J Wilcox, who makes miserable specimens, but some of the plants are not altogether familiar to me; and also a few collected by my son in New Mexico. I will thank you to look at them and confirm or reject. Retain any that may be desirable and return the rest.

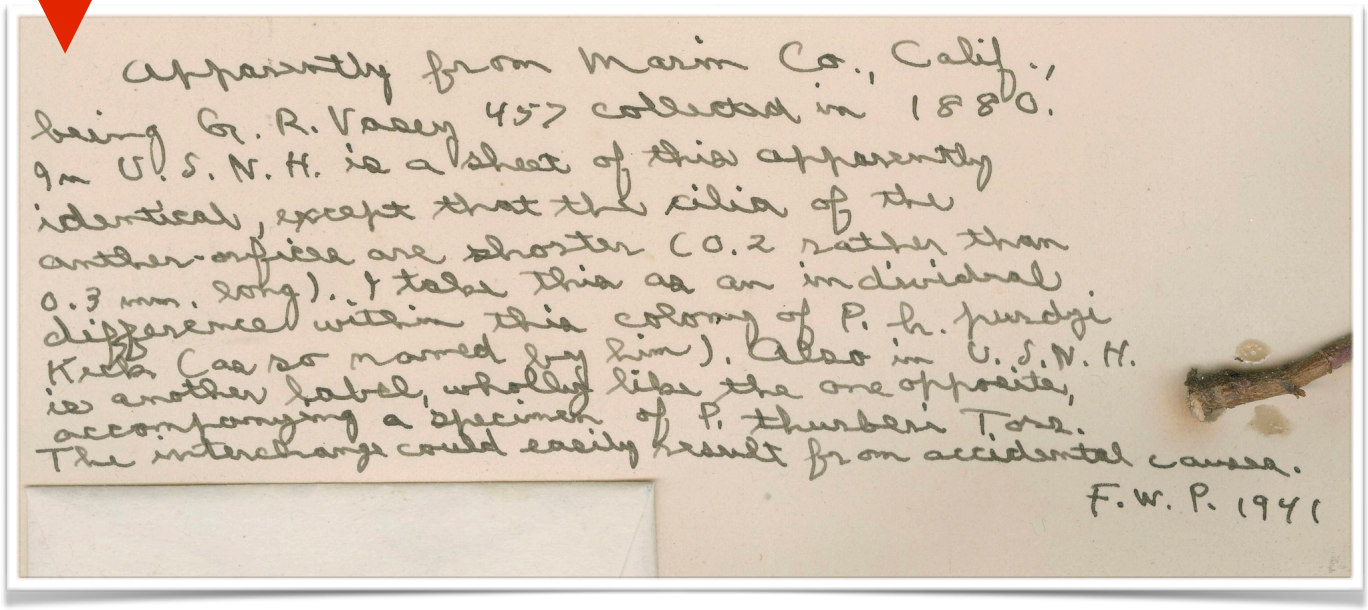
Holotype for Penstemon spinulosus Wooton & Standl. U.S. National Herbarium specimen, barcode 00122382



The range of P. heterophyllus as shown by BONAP.







THE NEW YORK BOTANICAL GARDEN
copyright reserved
0 1 2 3 4 5 6 7 8 9 10 cm
NEW YORK BOTANICAL GARDEN 00431214
NEW YORK BOTANICAL GARDEN 00431212
Type
IMAGED
NEW YORK BOTANICAL GARDEN 00431213
PLANTS OF SOUTHERN CALIFORNIA.
No. 1547
Poa Californica
(Atropis. Thurb)
San Bernardino April 1882
Coll. S. B. & W. F. Parish, San Bernardino.
Poa secunda ssp secunda ?
Poa arida Vasey isotype!
Poa Andina, Nutt!
f. Scribn
COLLEGE OF PHARMACY HERBARIUM
DEPOSITED 1948
IN
THE NEW YORK BOTANICAL GARDEN
FLORA OF NEW MEXICO, ARIZONA AND S. E. CALIFORNIA.
Poa andina var.
Locality, Sierra Magdalena Mts N.M.
Collector, G. R. Vasey, June 1881.
FLORA OF NEW MEXICO, ARIZONA AND S. E. CALIFORNIA.
Poa andina var
Locality, Socorro N.M.
Collector, G. R. Vasey, May 1881.

Specimen sheet of *Penstemon heterophyllus*, collected by G. R. Vasey, in Marin County, California, during 1880. The specimen referred to on the specimen sheet of P. spinulosus shown on pages 15 and 17.

There are several specimens sheets held at Yale University which identify the collector as George R. Vasey, from June 1881, collected in the Magdalena Mountains of New Mexico, including at least one (other) penstemon - *Penstemon ambiguous*.

At this point in my search I was wondering if these were cases of shared collector cards. I have come across several instances, from 1840 to about 1870, where the collector identification cards placed at the bottom right of specimen sheets were shared, sometimes indiscriminately.

The other possibility I began to consider was that the son mentioned in George R. Vasey's letter of July 28, 1881, the son who, in New Mexico, had collected some of the specimens being sent to Watson, was also named George R. Vasey.

George R. Vasey Jr. was born in August 1853 and died in May 1921. He was also a plant collector.

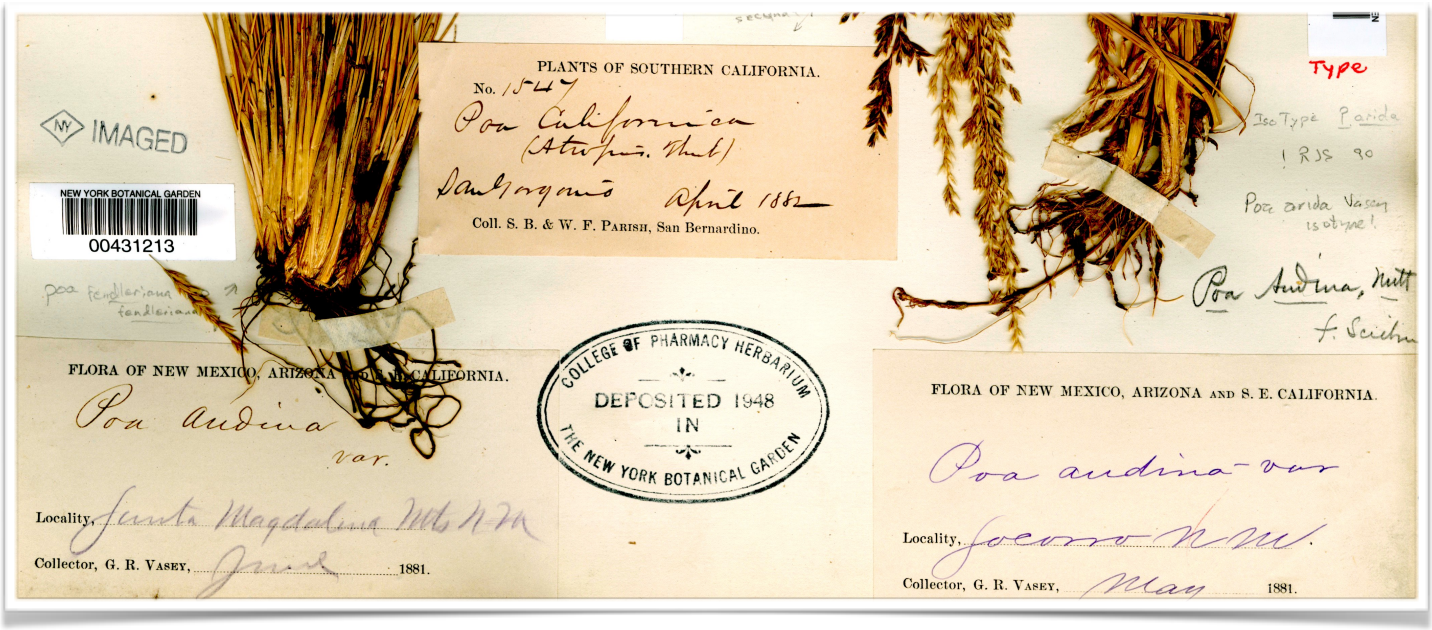
Unfortunately, the collector cards on the specimen sheets do not distinguish between Sr. and Jr. Given, however, that G. R. Vasey Sr. was actively corresponding from Washington, D.C., during June of 1881, it is probably safe to conclude that the specimens collected in New Mexico were collected by G. R. Vasey Jr. Indeed, the Harvard University Herbaria cross references the plants collected in the Santa Magdalena Mountains of New Mexico during the summer of 1881 with G. R. Vasey Jr.

That said, it does not get us much closer to the question about the provenance of the plant specimen in question.

George R. Vasey Jr. was also collecting in other New Mexico locales during 1881, from Santa Fe County to the Organ Mountains (Harvard Collection linked to above). During that period he collected several type specimens. Later in the year he was collecting in Texas (El Paso), Arizona, and California (Riverside and San Bernardino Counties).

Several of the specimen sheets from the 1881 collection trip are "complex collection objects", meaning that two items are presented on one specimen sheet. Some of the specimen sheets also have obvious geographical errors; several collected in Kingman, Arizona are listed as Kingman, New Mexico, for instance. (Note, however, that Kingman was part of the New Mexico Territory until 1863, when Arizona was split from the New Mexico Territory.)

A *Phlox* specimen is listed as being collected in the Santa Magdalena Mountains of New Mexico during June 1882, *Phlox nana*. This, however, appears to be a database entry error. The date on the specimen sheet appears to be a scribbled "1881", and Vasey is not known to have been in New Mexico during 1882. On a similar point, however, the Harvard collection includes a specimen of *Ipomopsis longiflora* (among others) with collection data indicating that it was collected in El Paso



County, Texas during 1880. (That species is not found in California according to BONAP.)

During 1880, George R. Vasey Jr. collected extensively in California (including Marin County), at one point forming a "collecting team" with Samuel Bonsall Parish. (See image above.)

Dr. Hubbard notes that the specimen in question (*P. spinulosus)* might be an individual introduced from California. The collection site for this specimen is not specific. *P. heterophyllus* is generally found at elevations between sea level and 7,000'. The town of Magdalena is located at an elevation of 6,572'. It is likely, therefore, that the specimen was collected in or near the town, rather than in the mountains (which range to 10,783' in elevation), if it was collected here. The town of Magdalena was an established entity during the referenced time. (By 1885 a railroad spur had been built to the town from Socorro to aid the cattle drives which came from the west.) So it is possible, but, I would argue, unlikely, that someone brought seeds or a specimen to Magdalena from California.

I am not qualified to opine on the question of whether or not this one specimen represented the one and only known individual from a relictual population.

My conclusions, after going down this botanical rabbit hole, are:

- **The subject specimen was collected by George R. Vasey Jr. during a collecting trip that included sites throughout New Mexico, the El Paso region of Texas, Arizona, and California.**
- **The subject specimen was collected somewhere within its native range in California, either in 1880 or 1881.**
- **Arguing for the 1880 date is the fact that Vasey Jr. collected extensively within the range of *P. heterophyllus* during that time, as well as the conclusion referenced in the notation of the subject specimen sheet that it was probably collected at the same locale as the specimen shown to the left.**
- **Arguing against the 1880 date is that most of those specimens would most likely have been distributed by 1881, the date on the subject sheet, and that mislabeling a sheet as to (a future) collection date is unlikely.**
- **Arguing for the 1881 date is the fact that Vasey Jr. collected in the species range during that year and it would have been easy to simply mislabel a specimen.**
- **Although it is not possible to know for sure, I surmise that *P. heterophyllus* (or *P. spinulosus*) should not be included in the flora of New Mexico - given the preponderance of evidence. That includes the fact that it is extremely unlikely, but not impossible, that the individual specimen was an introduced [singular] plant or the sole remaining survivor of a relictual population.**

USDA considers *Penstemon spinulosus* Wooton & Standl. to be a synonym of *Penstemon heterophyllus* Lindl. *ssp. purdyi* D.D. Keck, Purdy's Penstemon, which has a range limited to California. *P. heterophyllus* is known as Bunchleaf Penstemon.

George R. Vasey - Sr. & Jr.

Like many a significant contributor to our society, Vasey was an immigrant, being born in England during February 1822.

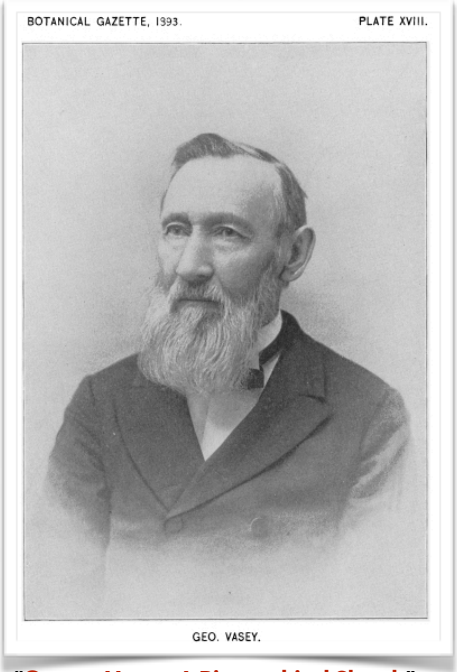
Early in his life he became well acquainted with John Torrey and Asa Gray - through luck, the kind of serendipity which all to often determines the course of our lives. In his mid teens he was clerking in a local store when the luck struck, his first meeting with a fellow botanist:

> **"I remember well that one day as I was standing in the doorway of the store, I saw a gentleman**

approaching who stooped down and plucked a flower from the sidewalk. Coming to where I stood he held up the plant and asked me if I knew the name of it. I replied, 'Yes, it is a buttercup.' 'Well,' said he, 'do you know its botanical name?' 'Yes,' I replied, 'it is *Ranunculus acris*.' This was probably more than he had expected. We entered the store and he talked with me to ascertain how much I knew of botany. This stranger was Dr. P. D. Knieskern, a German physician, a fine scholar, and one of the foremost botanists of that day."[1]

And the rest is history.

He became educated, was married, widowed, lived in the states of New York and Illinois. By the time he was 45 he was well established in the field, remarried, and friends with George Engelmann, John Wesley Powell, and others who are noteworthy.



"George Vasey: A Biographical Sketch", William M. Canby and J. N. Rose, The Botanical Gazette, May, 1883, pp. 170-183.

In 1868 he joined Powell's Colorado Expedition. A prominent feature in the Grand Canyon is named for him - Vasey's Paradise.

He was appointed Botanist to the U. S. Department of Agriculture and Curator of the U. S. National Herbarium, Smithsonian Institution, on April 1, 1872, and served in that capacity until his death in 1893. In this position, he was familiar with all of the major plant collectors in our area.

Later in his career he focused on the grasses and published many works on those plants. He was the driving force behind the establishment of the grass experimental stations in the west. He published extensively, including the seminal work "*Grasses of the Southwest*".

George R. Vasey Sr. had an illustrious career, and finding references to him is fairly straight forward. His son, George R. Vasey Jr., is another matter entirely. Other than his collecting activities (referenced in the preceding article), little appears to be known about his life. He owned a farm near Steptoe, Washington from about 1883 to about 1903. From there he lived in Cedonia, Washington, for a couple of years. He then emigrated to Alberta, Canada, where he died in Donalda on the 23rd of May 1921.

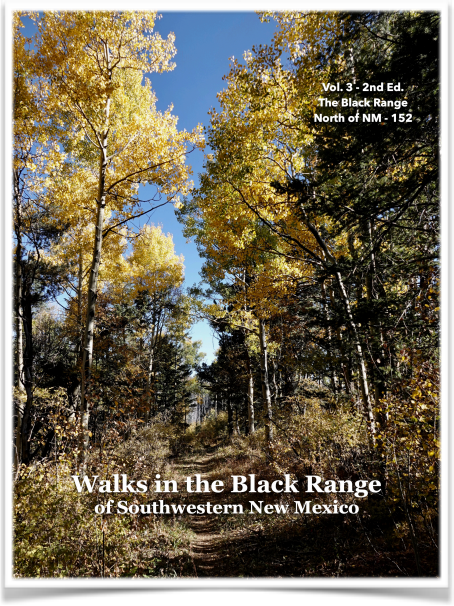
At various times, George Vasey Jr. collected with his father, with S. B. Parish, and with T. C. Porter. He collected extensively, and successfully, in many locales of the American Southwest.

1. "George Vasey: A Biographical Sketch", William M. Canby and J. N. Rose, *The Botanical Gazette*, May, 1883, p. 171.

New Offerings From The Black Range Website

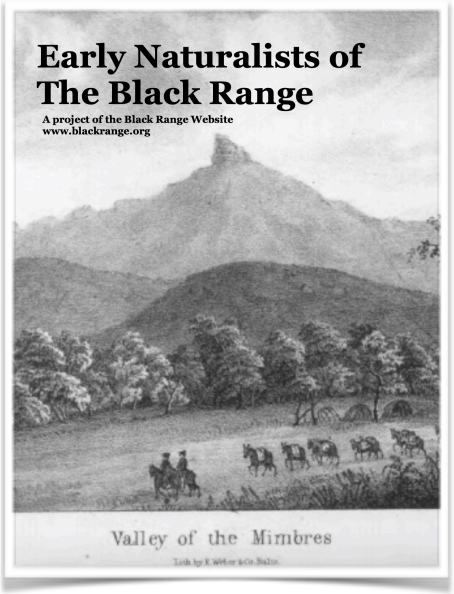
In February, Volume 3 of the second edition of *Walks in the Black Range* was issued. It describes hikes along the crest and western slopes of the Black Range, north of NM 152. Volume 4, which describes the walks south of NM 152, is in the works.

If you are interested in hiking the trails of the Black Range, the following websites may have information which will be beneficial to you:



- Gila Trails Info
- Gila Back Country Horsemen
- Southern New Mexico Explorer

In June, the website released *Early Naturalists of The Black Range*, a survey of the people who have increased our knowledge of the Black Range. This survey ends in 1930. There have been many people studying the natural history of the Black Range since that time.



Do You Hear What I Hear? - Red-backed Jumping Spider

The Red-backed Jumping Spider[1], *Phidippus johnsoni*, can probably hear you coming. So what?

First of all, a major disclaimer. The genus *Phidippus* includes 60 or more species. I infer that the findings for the species *P. audax* may hold true for *P. johnsoni*.

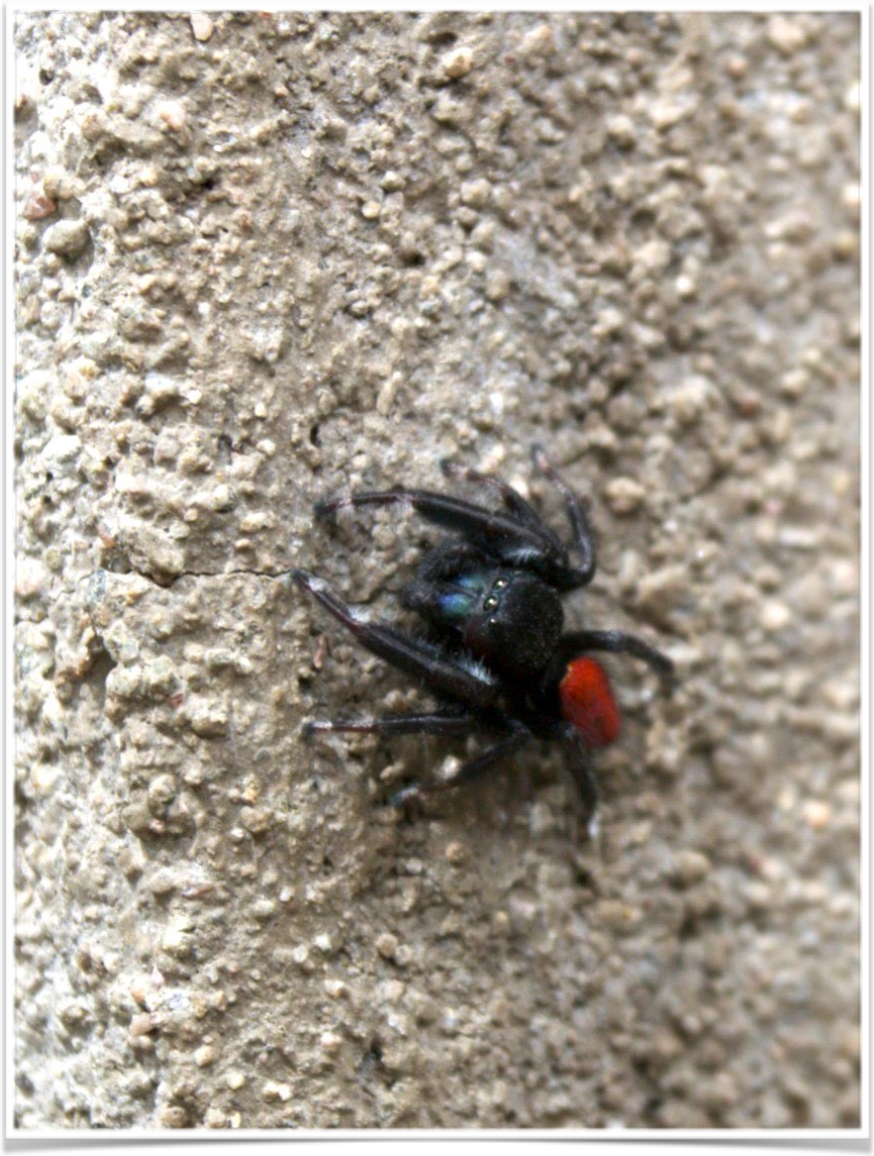
Spiders do not have ears (tympanic ears, i.e., with an eardrum). Creatures with ears "hear" sound by assessing pressure waves. It appears that the species *P. audax* can detect sound from 10 feet or more away, by detecting sound (airborne acoustic cues) through the hairs on its legs.[2]

(The effort that was used, in this study, to ensure there were no extraneous stimuli is impressive. The description of the study design used by Shamble et al. is reason enough to read the study.)

Understanding the sensing of airborne stimuli by hairs, as in this study, is not, in itself, great insight. Many species use sensory hairs to understand their environment. (It is the reason it can be so difficult to catch a cricket, for instance.)

Airborne sound is composed of two components, a pressure wave and particle velocity. While our eardrums perceive the pressure wave, the leg hairs of *P. audax* perceive the particle velocity. The physics of these two components differ and are influenced by a variety of factors, not all of which affect both the same. For reasons associated with the physics it has generally been assumed that species that perceive particle velocity are able to do so at shorter distances than those which used pressure gradients.

The frequencies which *P. audax* detect most effectively are those which correspond to the wing sound of wasps which prey on the spiders. The study found that when this frequency of sound is detected, the spiders freeze. It has been posited that the sensitivity of the leg hairs may also play a role in the courtship dance of the species. (See below.)



***Phidippus johnsoni,* photographed in Hillsboro, New Mexico.**

It is asserted that this species is a mimic of mutillid wasps (*Dasymutilla*) which have a very painful sting. A photograph of a *Dasymutilla* is shown on the following page. I suspect that this assertion is a reach.

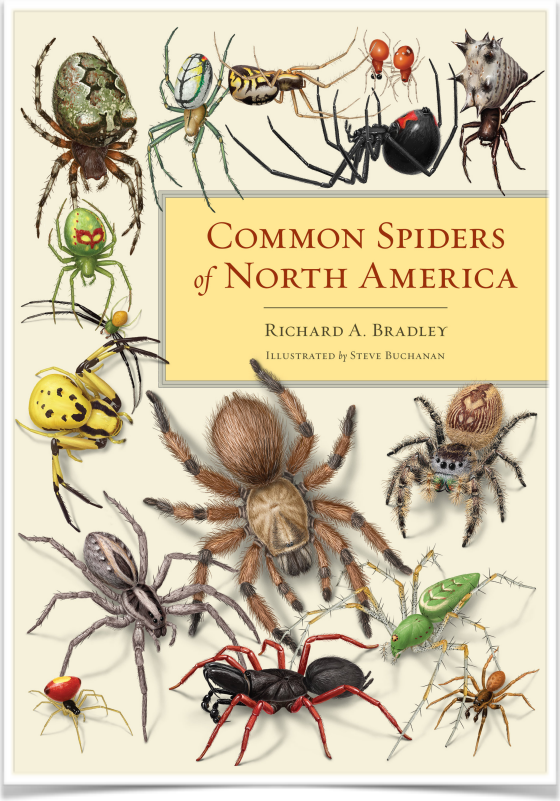
The Internet Archive Wayback Machine has an interesting series of photographs of a male and female *P. johnsoni* "dancing".

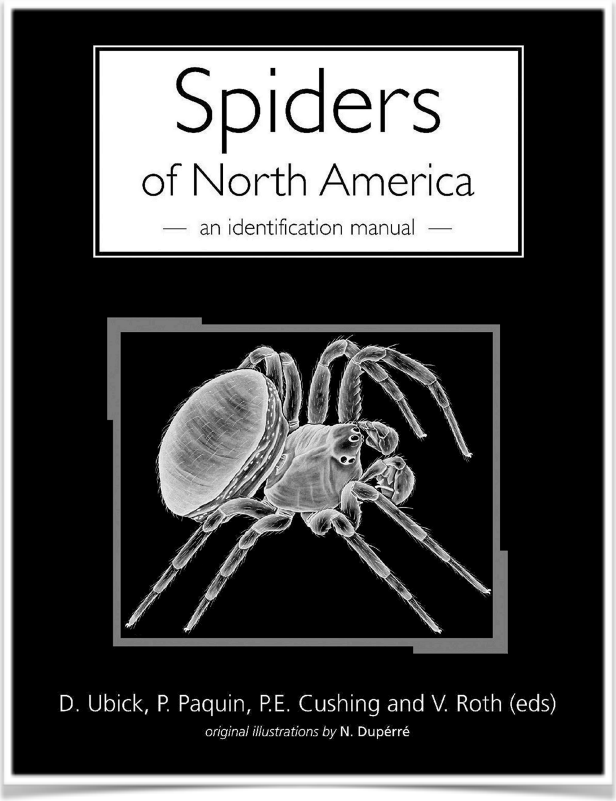
Statstrom, Hoy et al, in "Ogre-Faced, Net-Casting Spiders Use Auditory Cues to Detect Airborne Prey", *Current Biology*, October 29, 2020, explored the auditory sensory capabilities of another species of spider, finding an integrated sensory system which uses multiple inputs to make decisions.

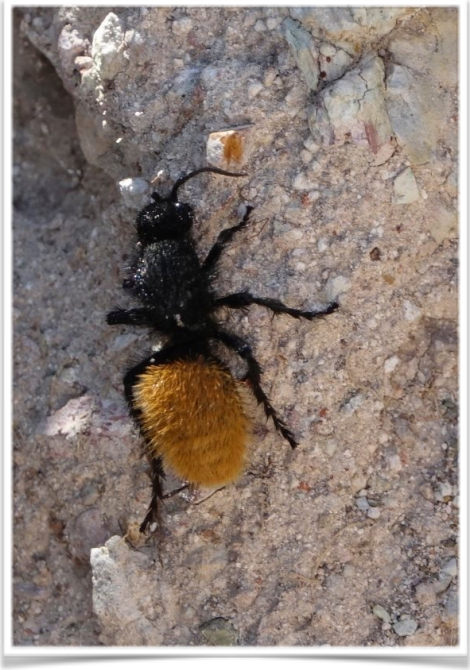
And it is this, the differences in life forms and capabilities which makes the natural world such a joy to behold. All too often, people take a human-centric view of the world. They seem to think that life is a pyramid and they sit on top of it. But life is a spiderweb. Creatures hear with eardrums and with hairs on their legs. Neither is necessarily better than the other; it is all a matter of definition. It is all a value judgement. A value judgement does not a fact make.

1. **"Life History of Phidippus johnsoni" by Robert R. Jackson, *The Journal of Arachnology* 6:1-29**

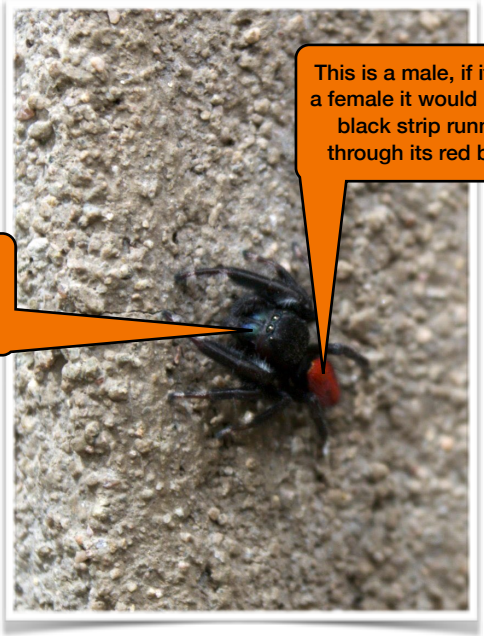
2. **"Airborne Acoustic Perception by a Jumping Spider", Shamble, Menda Golden, Hoy et al., *Current Biology*, November 7, 2016.**

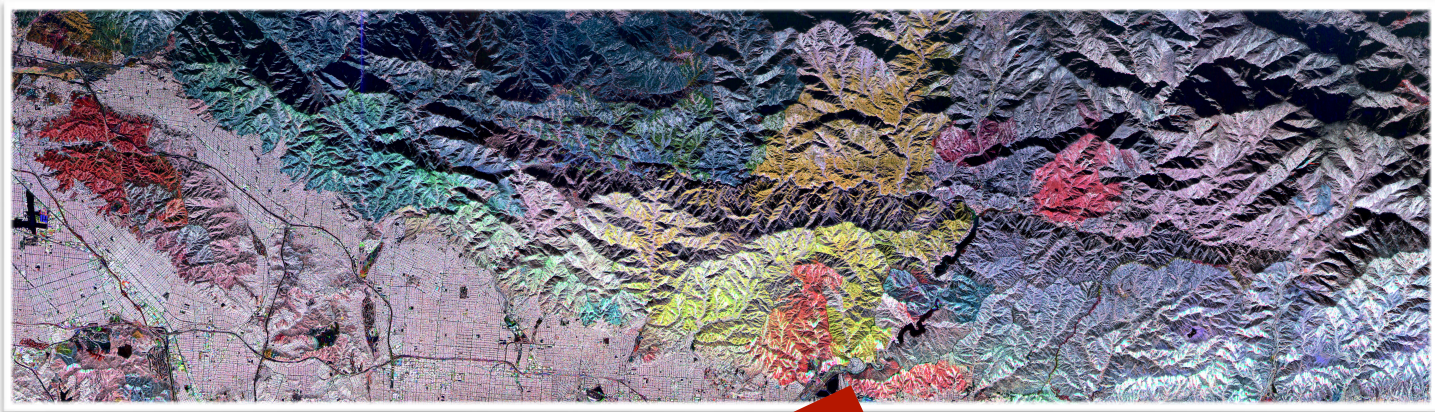






A Velvet Ant of the genus Dasymutilla (possibly D. magnifica or D. klugii) photographed in Ready Pay Gulch east of Hillsboro, New Mexico. Females of the genus are wingless; it is the wingbeat of the male wasp that the spider hears.





Vegetation Regeneration After Fire

Fire and the change which occurs after fire is of particular interest to us in the Black Range. Many of us have had the experience of watching the changes which have occurred following forest fires while walking the trails of the Black Range. Those changes have not only been of interest from a natural history perspective but they have also affected our "natural history experience": "Let's not walk the Sawyer's Peak Trail today because the wind will be high and there are still a lot of standing snags." (They are prone to fall in high wind.)

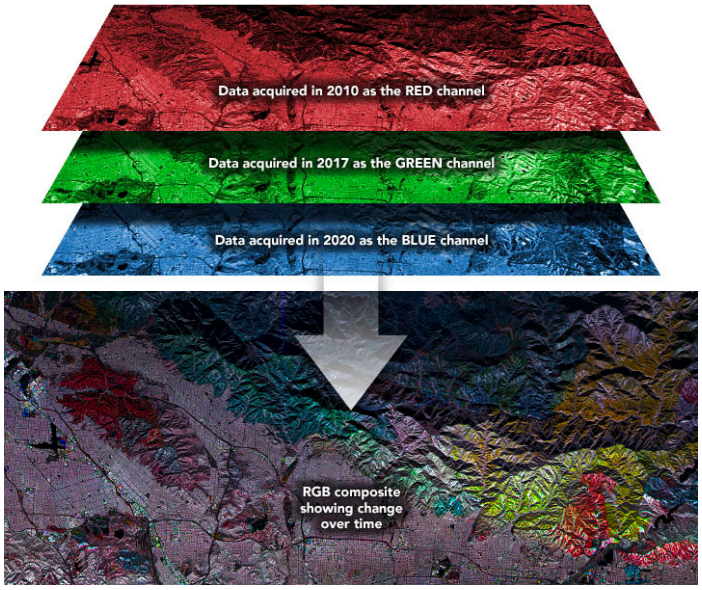
The Black Range is a geographically complex area. At many a vantage point it is possible to look out over a series of ridges - ridges with different exposures (north, west, south, east); different relief profiles (steep, very steep); and different vegetation patterns. It is easy to imagine what effect all of that had during a fire, causing it to rage in one spot and go more slowly in another. (An issue of profound importance to firefighters.) Those differences mean that a fire will be much hotter, and have a greater effect on vegetation and animals, in some places than others. The changes caused by the Silver Fire varied significantly in the Black Range. We have been able to watch the regeneration of vegetation with great interest. Regeneration has not all been the same - or at least, has not occurred at the same rate - because it began from very different base points. Our perception of that change has been limited by the amount of time we have been able to spend in the mountains and our relative skill at discerning that change.

An interesting tool has been, and is being, developed/deployed by NASA and JPL (National Air and Space Administration/Jet Propulsion Laboratory) in Southern California. The technique could be utilized anywhere, of course. The NASA Earth Observatory has made overflights in the area north of Pasadena since 2009. The flights have been equipped with SAR (a technology which is several decades old now).

> "Synthetic aperture radar (SAR) instruments send out pulses of microwaves that bounce off of Earth's surfaces. The reflected waves are detected and recorded by the instrument and can help map the shape of the land surface (topography) and the land cover–from cities to ice to forests. By comparing changes in the signals between two separate satellite or airplane overpasses, scientists can observe surface changes like land deformation after earthquakes, the extent of flooding, or the exposure of denuded or bare ground after large fires." (Quotation and images were downloaded from link above on 2/21/2021.)

Bear with me here. At this point understanding what the tool shows becomes a bit more complicated. It shows change, not the status at a particular period of time per se.

The data images shown above are the composite of recordings made in 2010, 2017, and 2020. The data from each of the years were exported to the matrix in a different color for purposes of this analysis (red for 2010, green for 2017, and blue for 2020). What you see in the graphics above is the result of layering data (different "color channels") from the different years. It is like using a color chart which shows what new color you get when you mix other colors. The layers of data, represented by different colors, are shown graphically at the top of the next page.



"For instance, areas with more red had more vegetation in 2010 than they do now. Areas with more blue and green shading had more vegetation (regrowth) in recent years. Yellow indicates areas burned in 2020 that had a higher volume of vegetation in 2010 and 2017 (red+green) but lower volume in 2020 (blue)." (From the cited link.)

Synthetic Aperture Radar systems are different from "traditional imaging" systems in that they can determine "surface characteristics like structure and moisture". "Synthetic" is a term which is increasingly prevalent in systems which utilize large amounts of data. It refers to the combining of data from a variety of sources, sometimes similar sources, sometimes not. In this case,

> **"the synthetic aperture . . . (is) a sequence of acquisitions from a shorter antenna (which) are combined to simulate a much larger antenna, thus providing higher resolution data." (Quotations here and below, and chart below, downloaded from link directly above on 2/21/2012.)**

> **"Wavelength is an important feature to consider when working with SAR, as it determines how the radar signal interacts with the surface and how far a signal can penetrate into a medium. For example, an X-band radar, which operates at a wavelength of about 3 cm, has very little capability to penetrate into broadleaf forest, and thus mostly interacts with leaves at the top of the tree canopy. An L-band signal, on the other hand, has a wavelength of about 23 cm, achieving greater penetration into a forest and allowing for more interaction between the radar signal and large branches and tree trunks. Wavelength doesn't just impact the penetration depth into forests, but also into other land cover types such as soil and ice."**

Data links for current applications of SAR systems are listed at the page linked to above. The quotation above may cause some to ask "is this LIDAR", the technology being used for archaeology and all sorts of other things. LIDAR (light detection and ranging) systems use a different technology, but SAR and LIDAR systems are compatible, and the fusion of these technologies is promising for a variety of remote sensing applications.

The SAR system application described here holds great promise for the study of change in vegetation, following fires and other events. For instance, in places like the Black Range and the Gila, characterized by large areas and rugged terrain, such an application could be used to study the effects of long-term climate change (temperature, moisture, variability, and intensity of variability).

Band	Frequency	Wavelength	Typical Application
Ka	27 – 40 GHz	1.1 – 0.8 cm	Rarely used for SAR (airport surveillance)
K	18 – 27 GHz	1.7 – 1.1 cm	rarely used (H_2O absorption)
Ku	12 – 18 GHz	2.4 – 1.7 cm	rarely used for SAR (satellite altimetry)
X	8 – 12 GHz	3.8 – 2.4 cm	High resolution SAR (urban monitoring,; ice and snow, little penetration into vegetation cover; fast coherence decay in vegetated areas)
C	4 – 8 GHz	7.5 – 3.8 cm	SAR Workhorse (global mapping; change detection; monitoring of areas with low to moderate penetration; higher coherence); ice, ocean maritime navigation
S	2 – 4 GHz	15 – 7.5 cm	Little but increasing use for SAR-based Earth observation; agriculture monitoring (NISAR will carry an S-band channel; expends C-band applications to higher vegetation density)
L	1 – 2 GHz	30 – 15 cm	Medium resolution SAR (geophysical monitoring; biomass and vegetation mapping; high penetration, InSAR)
P	0.3 – 1 GHz	100 – 30 cm	Biomass. First p-band spaceborne SAR will be launched ~2020; vegetation mapping and assessment. Experimental SAR.

Ponderosa Pine Forests

The Ponderosa Pine, *Pinus ponderosa*, is the most widely distributed pine species in North America. As is often the case with widely distributed species, there are a number of recognized subspecies. (See map and listing below.) Synonyms for *P. ponderosa* include *P. brachyptera* (Englemann). Note, however, that the taxonomy of this species is not fully resolved. [1]

Ponderosa Pine was first recognized by David Douglas in 1829 from a specimen collected near Spokane, Washington. It was first described by Charles Lawson in 1836.

This species usually grows in mountainous terrain and is found throughout the Black Range at higher elevations (5,500' - 8,500') where it is the most common pine.[1] Across its range, this species will grow from sea level to 10,000'.[2] The upland vegetation of the Gila National Forest is described by 13 Ecological Response Units (ERU) by the USDA-Forest Service. The Ponderosa Pine Forest ERU makes up 19% of the upland vegetation in the Gila National Forest, and the Ponderosa Pine/ Evergreen Oak ERU makes up 12%.[3]

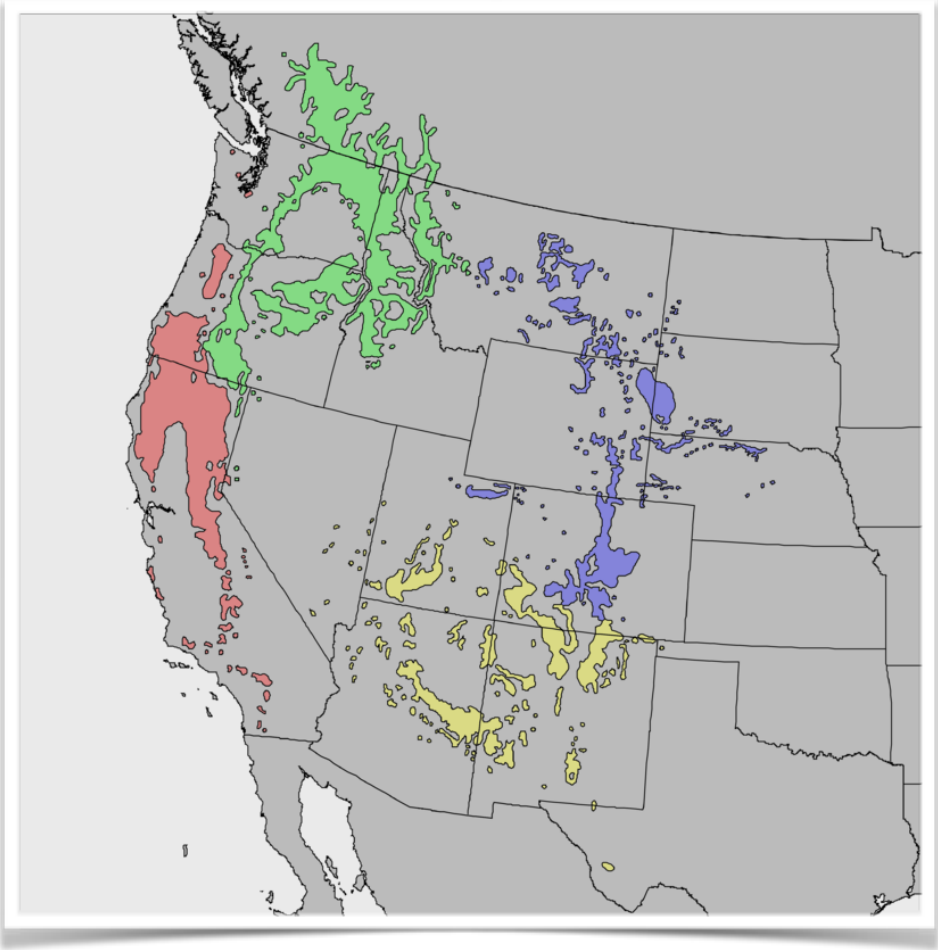
Ponderosa Pine is generally drought tolerant and grows well in both dry and moist forests. The plant communities associated with the Ponderosa in these two types of forest differ significantly. Here we deal only with the dry forest populations. The amount of moisture in the soil during the summer is often the restriction which determines whether or not a Ponderosa will grow at a specific location. The composition of the soil it is growing in does not appear to be a limiting factor. This species will grow in soils which were igneous, sedimentary, or metamorphic in origin. What seems to be more important is how loose and deep the soil is. Since Ponderosas often grow in dry areas, it is important that the soil be loose enough to retain and release moisture.

Ponderosa Pine does not need as much phosphorus or nitrogen to grow its needles as many other species do. It, therefore, will grow in soils which are not fertile enough to support other pine species.

One reason that Ponderosas are able to grow in mountainous areas with relatively shallow soil systems is that their root system is quite extensive (6' deep and laterally from the trunk 150'+). When they are growing in dense stands each root system will generally be only as wide as the crown of the tree. Young plants can grow root systems of 20" or more during the first two months of growth. Even so, young plants can be easily stressed by the lack of moisture.

Young Ponderosas can withstand higher temperatures than many other evergreens (Douglas Fir and Sugar Pine in our area, for instance). However, other species are able to withstand lower temperatures. Young plants can be damaged by temperatures as high as 23° F.

At lower elevations, Ponderosa Pine stands are bordered by, and intergrade with, grasslands, piñyon-juniper woodlands, Oaks (Emory, Gray, Arizona White), and/or chaparral. Stands of Ponderosa at intermediate elevations tend to grow in "purer" stands, while



Subspecies [4]

Green: *Pinus ponderosa ssp. ponderosa*

Red: *Pinus ponderosa ssp. benthamiana*

Blue: *Pinus ponderosa ssp. scopulorum*

Yellow: *Pinus ponderosa ssp. brachyptera* (Southwestern Ponderosa Pine)

Not shown: *Pinus ponderosa ssp. critchfieldiana* [NW coast]; *Pinus ponderosa var. pacifica* [NW coast mountains]; *Pinus ponderosa ssp. readiana* [central high plains]; *Pinus ponderosa var. washoensis* [NE Calif. and adjacent Nevada & Oregon]

Pinus arizonica considered by some to be a subspecies of *Pinus ponderosa*.

Distribution map courtesy of USDA.

Pinus ponderosa ssp. brachyptera

Found in areas with hot summers, mild winters, bimodal monsoon, wet winters & summers (monsoon) vs. dry spring and fall. Gila and Black Range have large stands.

Seeds are eaten by small mammals (Abert's Squirrels, chipmunks, mice), insects, and birds.

Other interdependencies: Abert's Squirrels are prey for larger hawks, but they are not a major food source for mammal predators.

Abert's Squirrel (a.k.a. Tassel-eared Squirrel), *Sciurus aberti chuscensis*, photographed in Railroad Canyon of the Black Range on 7/23/2017. There are currently nine recognized subspecies. This subspecies is found in SE Arizona/western New Mexico. They are associated with Ponderosa Pine, using the needles for nesting material and eating the seeds. The range of an individual varies by season and location but is generally between 10 and 30 acres, though it can be as high as 60. Although Abert's Squirrels may nest in Ponderosas, they do so on the branches since these pines seldom have cavities large enough for a nest. Gambel Oaks - sometimes cottonwoods - are more typically used for nesting. Abert's are omnivores, but feed on Ponderosa Pines throughout the year (seeds, inner bark, buds, and young cones).[5]

those at higher elevations are more often found in stands of mixed conifers. The ecotones between these zones vary in "width" depending on local conditions. Ponderosa Pines may be the dominant species in a tree and shrub community which includes Douglas-fir, juniper, Southwest White Pine, manzanita, Chokecherry, etc.

Ponderosa Pine likes the sun. Its growth rate can be cut in half by partial (50%) shade. Because of this, Ponderosas can often be found in stands where the trees are of the same age. These factors, the quality of the wood, and its growth habit (tall straight and of significant girth) make this tree a favorite of loggers.

The cones of the Ponderosa Pine take 2 years to mature. Flowering occurs during the first year (April to June). The cone reaches maturity during the second year and disperses seeds during August and September. Seeds are small and seldom fall farther than 100 feet from the parent tree. It may take up to 23,000 seeds to weigh a pound, although as few as 7,000 may weigh that much.

Every 8 years or so Ponderosas will produce an especially heavy seed crop. In about a quarter of the years, very few cones are produced. Each cone contains about 70 seeds. By age 7, this species can produce cones and may continue to do so for more than 350 years.

Pinyon Jays and Clark's Nutcrackers are among the bird species which cache Ponderosa Pine seeds, and to the degree that they forget the cache, they disseminate seeds away from the parent trees.

Abert's Squirrels will begin the season by eating immature seeds in May, and by the peak of the "harvest" they may consume the seeds of 75 cones a day. They will continue to eat seeds as long as they are available. They also eat the inner bark of twigs year round, but especially in winter (November to April). Besides the seeds, they will eat new cones in their entirety, only the pollen is eaten from dried cones.

Ponderosa Pine seedlings are food sources (and are otherwise damaged by) rabbits, pocket gophers, squirrels, and deer. Cattle and sheep also destroy them.

Following the excessively intense grazing which characterized the Southwest until the first quarter of the 1900's, Ponderosa seedlings developed into dense stands, facing no competition for nutrients or sun. These large stands of single-age Ponderosas were a fertile food source for a variety of insects, including:[2, 6]

- Western Pine Beetle (*Dendroctonus brevicomis*), which can kill older trees and young healthy trees during eruption. A study in Northern Arizona found this to be the most common *Dendroctonus* species at elevations around 7,000 feet[7];
- Roundheaded Pine Beetle (*Dendroctonus adjunctus*) is often associated with the Western Pine Beetle;[8A]

Although Ponderosas in the Black Range can grow to heights well over 100', they don't get as tall or have a girth as great as shown to the right.

Pinus ponderosa ssp. brachyptera (description) Wikipedia, Pinus Ponderosa	
Height	Tallest measured at 268'
Circumference	Largest measured at 8.5'
Years needles remain green	4.3 ± 0.18, N=24
Foliage length on branch (cm)	21.8 ± 2.7, N=24
Needle length	14.7 cm ± 0.45 / 5" - 10"
Needles per fascicle	3.0 ± 0.03, N=24
Needle thickness	44.8 ± 0.87, N=24
Branches per whorl	3.4 ± 0.25, N=23
Branch angle (° from vertical)	48 ± 3.1, N=24
Seed cones length	74.9 mm ± 2.51 / 3" - 6"
Seed cones width	62.6 mm ± 1.77 / 2" - 4"
Seed cone form W/L	0.86 ± 0.02, N=20
Seed length (mm)	6.4 ± 0.18, N=16
Seed width (mm)	4.3 ± 0.09, N=16
Seed + wing length (mm)	23.3 ± 0.68, N=15
Bark (Young Trees)	Dark brown, rough in texture
Bark (Old Trees)	Orange-brown, large plates

Arceuthobium vaginatum subsp. *cryptopodum* (Southwestern Dwarf Mistletoe) grows on the Ponderosas of this area. It is yellow green in the summer and turns to orange in the fall. These plants feed on Ponderosas by "sinking" their roots (modified as haustoria) into their host. Although the haustoria grow just underneath the bark, they also penetrate deep into the host, causing considerable damage.[2] Ponderosa pine is the principal host for this subspecies, and this mistletoe is found wherever the host grows. These plants can grow quite large, and the degree to which they infest a branch and host can be substantial. Ironically the additional structure of the mistletoe can diminish the likelihood that the branches they are growing on will self-prune.[7]

The seeds of *Arceuthobium* are spread primarily by Mountain Chickadee and Pygmy Nuthatch. This is not done by ingestion: They do eat the seeds, but ingested seeds are generally not viable. Instead, the seeds stick to the feathers of the birds while they feed and are spread to other trees - think pollen. The populations of these species will fluctuate somewhat with the degree of "infestation" by this mistletoe species. Infestation, in this case, is far from universally negative.

- Ponderosa Pine Cone Beetle (*Conophthorus ponderosae*), which eats seeds;
- Pine Tip Moth *(Rhyacionia busnelli),* which deforms buds;
- Pine Butterfly (*Neophasia menapia*), which is a defoliator; and
- *Enoclerus* (Checkered Beetle) numbers increase with elevation; and
- *Temnoscheila* (Bark-gnawing Beetle) which is found at lower to mid-elevations.[7]

As with most living things on Earth, Ponderosas suffer from a variety of diseases, including:[6]

- Black Stain Root (*Leptographium wageneri),* which kills roots of all ages;
- Needle Cast (*Elytroderma deformans*), which infects twigs, slows growth, and kills trees;
- Blister Rust (*Cronartuim comandrae*), which kills the tree;
- Heart Rot (*Phellinus pini*);
- and many others.

Many of these diseases will significantly weaken Ponderosas, if they do not kill them outright. Weakened trees are more easily damaged by insect infestation.

Flora of North America has a more complete description of Ponderosa Pine than that found above.

Fire plays a major role in the life cycle of Ponderosa Pines. Prior to years of fire suppression, fires in Ponderosa forests tended to be less intense and burn cooler. Although seedlings might be killed by such fires, saplings and large trees stood a much better chance of survival. They are, for instance, more fire resistant than is the Douglas Fir. Ponderosa Pines tend to have more open crowns (a feature enhanced by their tendency to self-prune limbs), making them less susceptible to flash-overs. Even when half of the crown catches fire, a Ponderosa can survive. Fire suppression endangers Ponderosas in three major ways: it allows the build up of heavy fuel loads on the floor of the forest, causing much hotter fires; more undergrowth is allowed to flourish, creating more fuel load; and other trees (like Southwest White Pine) are allowed to form forest crowns. They tend to burn hotter and are less open than Ponderosas.[6]

The Draft EIS for the Gila National Forest Plan notes that "the variability in fire regime characteristics are specific and are synchronized with climatic fluctuations."[3 (Vol. 1, p. 48)] Historically, non-lethal fires were associated with relatively dense masses of needles and bark on the ground around Ponderosas. This "fuel mass" generally produced smoldering fires which did not erupt into the canopy.[2 - p. 13] The relationship between fire, in all of its variability, and the Ponderosa is nuanced. For instance, it "regenerates readily on both mineral and burned over seed beds, however, it does not establish well on unburned organic surfaces."[2 - p. 4] Graham and Jain were reporting on research of Haig and others from 1941.

Following an especially severe fire in a Ponderosa Pine plant community, the full community may reestablish in less than 350 years (as opposed to more than 1,000 in some other communities, like coastal Douglas Fir).[2 - p. 5] Vegetative succession following a major disruptive event is generally predictable. It is, however, important to remember that for any given plot there may have been more than one major disruptive event. Although there are single-aged stands of climax Ponderosa Pine, there are also stands of mixed age with several different succession processes underway. In addition, the characteristics of a site; the mineral content of soil, depth of soil, aspect, and slope, among other things, will influence the rate and type of succession which occurs. In the Black Range, early succession often includes Quaking Aspen, Gambel Oak, and New Mexico Locust, with the locust being especially vigorous. Southwestern White Pine is often found in association with Ponderosa in mature stands in the Black Range.

Significant fires do not generally kill adult birds immediately. However, if the fire occurs during the breeding/nesting season, it will significantly affect the size of the next generation, since nestlings experience exceedingly high levels of mortality. The changes in food resource and shelter which follow a fire can have a significantly harmful effect on adult birds which are foliage-gleaning insectivores, while providing enhanced food resources for woodpeckers and others because of increased insect infestation - in the wood - following a fire.

As with most areas in the West, the fire history of the Black Range, both in spatial extent and in fire severity, is varied. See Larry Cosper's "Fire History of the Black Range" in the January 2019 (Vol. 2, No. 1) issue of this publication.

In the Black Range, weather can have a significant effect on the life cycle of Ponderosas. Following the Silver Fire, for instance, many weakened - but live - trees succumbed to washouts, high winds, and snow (both accumulation and concentrations falling from higher limbs).

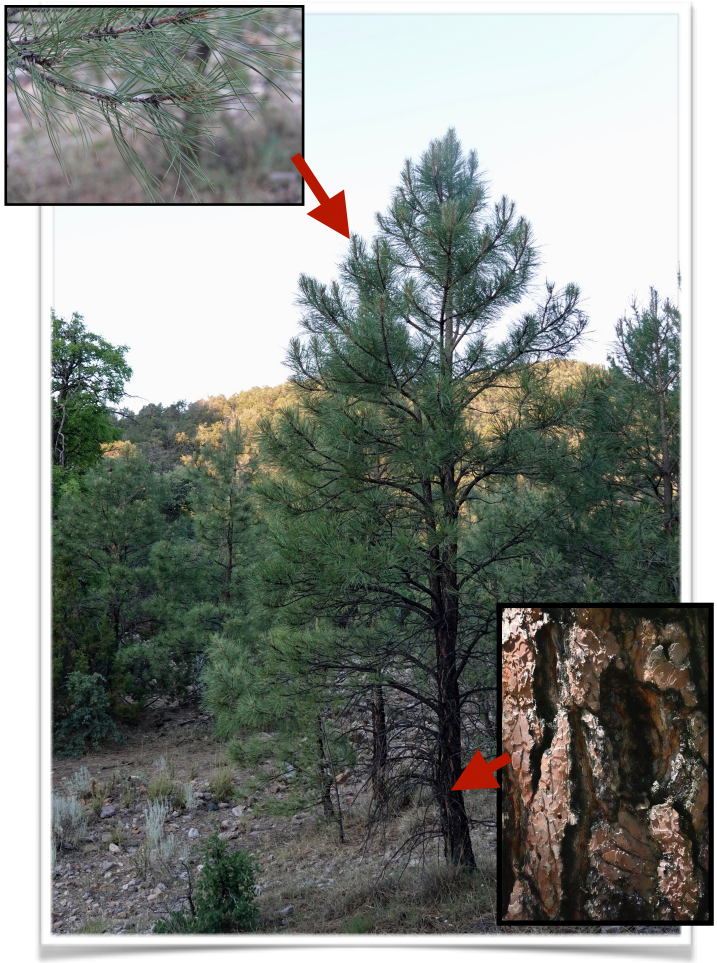
"When combining forest succession, potential vegetation, disturbance, weather, and physical setting, it becomes obvious that ponderosa pine forests can be very complex. Depending on the combination of these components, multiple tree species can occur within stands and across landscapes, as can multiple shrub and forb species. This vegetation varies in arrangement, amounts, and juxtapositions that are continually changing, in response to the occurrence, extent, and severity of both natural and human caused disturbances."[2 - p. 9]

Changes in the forest, created by fire suppression, grazing, and climate cycles are not limited to the type of climax tree. The plant community associated with Ponderosas is different from that of Douglas Fir, for instance. The change occurs at all levels in the forest, from the crown of the trees to the composition of the soil and the microbial base associated with it. The complexity of this shift is significant. For instance, "There is a gradual shift in the proportion of soil nitrogen reserves and organic matter from mineral layers in pine forests to surface organic layers in fir forests."[2 - p. 16] And, of course, that is just the start of it.

There is an ongoing effort to restore Ponderosa Pine forests to "enhance the resilience and sustainability of the ecosystem to a state that is within an historic range of conditions, known as the 'natural state of variability'. . . Variability in structure and process means that patterns of stand density, species composition, and disturbance regimes differ significantly across landscapes and throughout the region. Ponderosa pine grows across a 1500-m elevational gradient in many mountain ranges . . .with at least 21 different ponderosa pine 'habitat types' recognized across diverse landscape conditions in the Southwest."[12 - p. 1421] Although much has been written about this effort, the intensity and effectiveness of implementation is affected significantly by human social, economic, and political systems. It is worth noting that the Black Range is a mosaic of "ecosystems" and as such is biologically diverse. The techniques used in the restoration process are not uniformly effective or appropriate across the full range of ecosystems.

A Ponderosa Pine Timeline[8A - p. 3]

- 600,000 years BP, Ponderosa Pine fossils found in west central Nevada
- 10,400 - 43,000 years BP, packrat middens in New Mexico and Texas indicate that Ponderosa Pine was absent from the area, this roughly equates to the Wisconsin Period (the most recent period of glaciation) - vegetative zones in what is now the United States moved southward or northward with the ebb and flow of the glaciation
- 4,000 - 6,000 years BP, Ponderosa Pine began to colonize higher elevations as the environment warmed



Birds

There is a reasonable set of data about the abundance of various bird species in the Ponderosa Pine forests of New Mexico during the last century. The tables found below and on the following page are from Chapter 3 of *Songbird Ecology in Southwestern Ponderosa Pine Forests*[8]. They draw on data sets completed by Fannie Ford in 1911, Florence Merriam Bailey in 1928, and J. Stokely Ligon in 1961. Care should be used in analyzing the data, because the three compilers used different techniques and databases in assembling their material. Ford, for instance,

Table 8. Recorded abundances of ponderosa pine avifauna in New Mexico. A = abundant; C = common; *U* = uncommon; ***R*** = rare; E = extinct.

Common name	Source			Population Increase (I) Decrease (D) Stable (S)
	Ford 1911	Bailey 1928	Ligon 1961	
Blue grouse	C	Locally U	Locally U	D
Merriam's turkey	C	Locally U	U	D
Band-tailed pigeon	C	R to U	Locally C to U	D
Mourning dove	A	C	A	S
Thick-billed parrot	a	Locally R	E	D
Greater roadrunner	a		U	I
Common nighthawk	C		C	S
Poor-will	U	C to U	U to C	I
Common poor-will	U	C to U	U to C	I
Whip-poor-will	U	R	U	S
White-throated swift	C	Locally C	C	S
Calliope hummingbird	C	C	U	D
Broad-tailed hummingbird	C	C	C	S
Rufous hummingbird	C	C	C to A	I
Lewis' woodpecker	L y U	Locally U to C	Locally U to C	S
Acorn woodpecker	C	C to U	C	S
Williamson's sapsucker	C	U to C	U	D
Yellow-bellied sapsucker	C	C	C	S
Downy woodpecker	U	Locally U	U	S
Hairy woodpecker	C	Fairly U to C	C	S
Three-toed woodpecker	U	Locally U	U to R	S
Northern flicker	C	C	C	S
Olive-sided flycatcher	C	Locally C	U	D
Western wood pewee	C	Locally C	U to C	S
Dusky flycatcher	a	a	C	S
Say's phoebe	C	C	C	S
Cordilleran (western) flycatcher	U	U to C	U to C	I
Ash-throated flycatcher	C	Locally R	C	S
Cassin's kingbird	C		I	D
Purple martin	U	Fairly C	U	S
Tree swallow	a	U	U	S
Violet-green swallow	A	C	C	D
Black-billed magpie	C	Locally U	C	S
Steller's jay	C	C	C	S
Pinyon jay	C	U	U	D
Gray jay	C	R	U	D
Clark's nutcra		Locally R	U	D
American cro	A	U to A	U	D
Common raven	C	Locally U	U	D
Black-capped chickadee	A	C	C	D
Mountain chickadee	A	A	C	D
Golden-crowned kinglet	C	R	U	D
Ruby-crowned kinglet	C	U	C	D
Red-breasted nuthatch	R	U to R	U	I
White-breasted nuthatch	C	C	C	S
Pygmy nuthatch	A	A	C	D
Brown creeper	U	U to C	C	I
Winter wren	a	R	R	S
Rock wren	C	C	C	S
Canyon wren	Locally C	R	Locally C	S

traveled about the state but also relied heavily on specimens maintained at NMSU.

These data sets have been generally corroborated by independent studies. The drastic decline in game birds, to include the Band-tailed Pigeon, for instance, has been dramatic. In the case of those species, the declines have not been caused by a change in the Ponderosa Pine ecosystem but rather by human hunting/disturbance. The decline in other species, like the Olive-sided Flycatcher, is due, primarily, to changes in the ecosystem. As a counterpoint to these declines, the occurrence of woodpecker species (the Williamson's Sapsucker being an exception) have remained relatively stable. Some species will change in abundance following fires. This change is not always negative (reduced numbers). Woodpecker populations will often increase following fires because insect infestation will increase (or at least be easier to access).

In the Black Range, the Hairy Woodpecker is often the most abundant, and the Northern Flicker is often the most apparent, woodpecker.

Common name	Source			Population Increase (I) Decrease (D) Stable (S)
	Ford 1911	Bailey 1928	Ligon 1961	
House wren	C	U to C	U	D
Western bluebird	C	Locally C	A	I
Mountain bluebird	C	C	C	S
Townsend's solitaire	C	U	U	D
American robin	C	C	C	S
Hermit thrush	C	U to C	C	S
Northern mockingbird	R	R	R	S
Loggerhead shrike	[a]	R	U	I
Solitary vireo	C	Locally C	U	D
Warbling vireo	C	U to C	C	S
Yellow-rumped warbler	A	C to locally A	C	D
Black-throated gray warbler	U	U	U	S
Virginia's warbler	U	U to locally C	U	S
Townsend's warbler	U	U	U	S
Orange-crowned warbler	R	U	U	I
Grace's warbler	R	U	C	I
MacGillivray's warbler	C	U	U	D
Red-faced warbler	R	Locally U	Locally U	S
Painted redstart	[a]	Locally U	Locally U	S
Hepatic tanager	R	U	U	I
Western tanager	C	C	C	S
Black-headed grosbeak	C	C	U	D
Spotted towhee	C	C	U	D
Cañon towhee	C	U to R	C	S
Green-tailed towhee	U	Locally U to C	U	S
Dark-eyed junco	C	A	A	I
Yellow-eyed junco	[a]	Locally C	Locally A	I
Brewer's blackbird	C	Locally U to C	Locally U	D
Brown-headed cowbird	[a]	Locally R	U	I
Pine grosbeak	[a]	U	U	S
Cassin's finch	R	U to C	U	I
Rosy finch	R	[a]	R	S
Red crossbill	[a]	R	U	I
Pine siskin	C	U	C	S
Lesser goldfinch	[a]	U	U	S
American goldfinch	U	R	R	D
Evening grosbeak	C	R	U	D
Baird's sparrow	R	C	C	I
Vesper sparrow	C	C	U to C	S
Savannah sparrow	R	[a]	U	I
Song sparrow	C	U	U	D
Lark sparrow	[a]	U	U	S
Chipping sparrow	A	C	C	D
Brewer's sparrow	[a]	C	C	S
White-crowned sparrow	C	C	U	D
Lincoln's sparrow	C	U	U	D

[a] Data not recorded.

Table 3. Increasing and decreasing bird species on managed ponderosa ***pine*** Breeding Bird Survey routes in Arizona and New Mexico, for species with ≥***5*** routes and 20.5 birds per route (modified from Miller 1992). These lists include both songbirds and non -songbirds. Hall. Morrison Block. p 74

Decreasing	Increasing
Mallard	Turkey vulture
Killdeer	Red-tailed hawk
Band-tailed pigeon	American kestrel
Mourning dove	Northern flicker
Hairy woodpecker	Cassin's kingbird
Acorn woodpecker	Cordilleran flycatcher
Common nighthawk	Steller's jay
Broad-tailed hummingbird	European starling
Western Kingbird	Brown-headed cowbird
Ash-throated flycatcher	Vesper sparrow
Say's phoebe	Spotted towhee
Western wood-pewee	Green-tailed towhee
Gray flycatcher	Blue grosbeak
Horned lark	Western tanager
Western scrub jay	Hepatic tanager
Common raven	Purple martin
American crow	Barn swallow
Clark's nutcracker	Rough-winged swallow
Pinyon jay	Bewick's wren
Red-winged blackbird	House wren
Eastern meadowlark	Red-breasted nuthatch
Western meadowlark	Townsend's solitaire
Brewer's blackbird	Hermit thrush
House finch	American robin
Red crossbill	Western bluebird
Lesser goldfinch	
Pine siskin	
Lark sparrow	
Chipping sparrow	
Canyon towhee	
Black-headed grosbeak	
Cliff swallow	
Violet-green swallow	
Loggerhead shrike	
Warbling vireo	
Solitary vireo	
Virginia's warbler	
Yellow-rumped warbler	
Grace's warbler	
Black-throated gray warbler	
House sparrow	
Northern mockingbird	
Rock wren	
White-breasted nuthatch	
Pygmy nuthatch	
Plain titmouse	
Mountain chickadee	
Common bushtit	
Ruby-crowned kinglet	
Mountain bluebird	

In 1992, R. Miller (*Preliminary results from breeding bird survey data estimates of trends in bird populations in or near managed ponderosa pine in the Southwest.* Unpublished Report, Arizona Department of Game and Fish, Flagstaff, Arizona) found that the population of 46 out of 61 bird species surveyed in New Mexico had declined and that "many of these were birds that nested in open cups and species that tended to be year-round residents".[8C - p 72]

Hermit Thrush, Pygmy Nuthatch, and Cordilleran Flycatcher are generally associated with old-growth stands of Ponderosa Pine. These species are replaced with Yellow-rumped Warbler, Rock Wren, and Western Wood-pewee

Guild	New Mexico
Woodland nesting	11 of 13 (85%)
Coniferous nesting	8 of 8 (100%)
Primary cavity nesting	1 of 2 (50%)
Secondary cavity nesting	9 of 12 (75%)
Open cup nesting	23 of 26 (88%)
Permanent resident	11 of 11 (100%)
Short distance migrant	15 of 25 (60%)
Neotropical migrant	10 of 13 (77%)
All birds	46 of 61 (77%)

Proportion of bird species declining 1968 to 1990 along managed ponderosa pine breeding bird survey routes, for species with 25 routes counted, and an average of 20.5 birds per route (modified from Miller 1992). [8C - p 73]

when the forest undergoes a significant disturbance. Arguing that this makes the Hermit Thrush, and others, an indicator species for old-growth may be true but not terribly useful.

In the Black Range, Pygmy Nuthatch is strongly associated with the mature Ponderosa Pine forests found along the crest trail.

"In Southwestern Ponderosa Pine forests . . . at least 49 species of birds, 10 species of mammals, and numerous species of insects and herpetofauna used tree cavities (and) . . . that 63 percent of the birds and 75 percent of the mammals that are snag dependent in Southwestern forests are insectivorous."[8C - p 75] **Cavity nesters may be either primary (they excavate the cavity) or secondary (they use existing cavities) nesters.**

The biodiversity of the Black Range is substantial. The Ponderosa Pine forests of this area are just one example of that.

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4. **Wikipedia, Pinus Ponderosa, website accessed November 28, 2020**
5. **Wikipedia, Abert's Squirrel, website accessed November 29, 2020**
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7. ***Ecology, Management, and Restoration of Piñon-Juniper and Ponderosa Pine Ecosystems*, USDA, Forest Service, Rocky Mountain Research Station, RMRS-P-51, 2008. ("Influence of Elevation on Bark Beetle Community Structure in Ponderosa Pine Stands of Northern Arizona", Miller et al. p 181)**
8. ***Songbird Ecology in Southwestern Ponderosa Pine Forests*, 1997, USDA-Forest Service-Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-292, William M. Block and Deborah M. Finch, Editors**
   A. **"Ecology of Southwestern Ponderosa Pine Forests", Moir et al. pp 3-27**
   B. **"A Historical Review", Scurlock and Finch, pp. 43-68**
   C. **"Songbird Status and Roles", Hall, Morrison, & Block, p. 69**
9. **Vascular Plants of the Gila Wilderness, website accessed November 28, 2020.**
10. **Flora of North America , website accessed November 28, 2020.**
11. **Flora of North America, website accessed November 28, 2020.**
12. **"Ecological Restoration of Southwestern Ponderosa Pine Ecosystems: A Broad Perspective", Allen et al, *Ecological Applications*, 12(5), 2002, pp. 1418–1433, 2012**

Black Range Surface and Groundwater

The drought continues, and the possibility that it is a megadrought (lasting two decades or more) is increasingly heard.

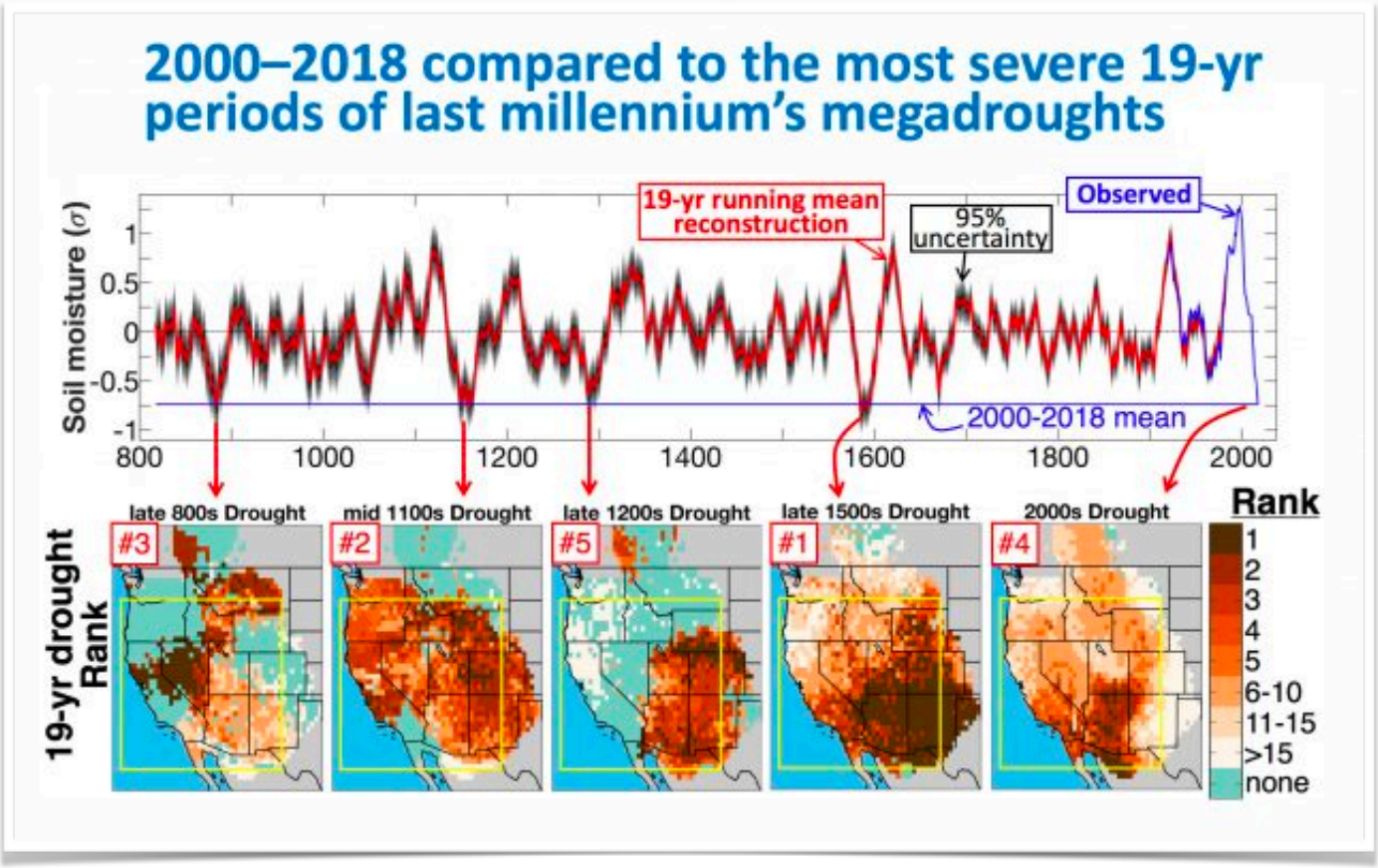
As individuals, there is woefully little that we can do; in aggregate there is much we can do, and when our society decides to address the issue, the prospects become reasonably manageable. But from the individual, to the aggregate, to society as a whole is a long march. We can begin the march, one that is in everyone's long-term interest, by learning all we can about the current situation. Despite all of the hype, we know surprisingly little.

In this article we assess the danger (very briefly - much has been written elsewhere), discuss some of the things we know and those that we do not, how we go about knowing, and our financial-political response to the situation.

The chart shown below describes the current drought (as of 2018) in terms of historical records, in this case, about the last 1,500 years of history. This information has been ferreted out using a number of techniques, including the assessment of data from the study of tree rings, dendrochronology. When John Wesley Powell travelled through the west, he was struck with the mismatch between the water resource and the desires of eastern farmers and ranchers to go on doing what they had always done - only in the west. In general, his arguments (including the one that the geographic shape of political entities should be based on watersheds) were ignored, and continue to be ignored.

The West has experienced drought on a regular basis and with alarming frequency. A number of our droughts have been megadroughts, which changed the human culture of the area significantly. The five most severe megadroughts since the 800's are identified below, our current experience being one of the five. The areas most severely affected and the variation in soil moisture from the 800's to present are also identified. Several things are readily apparent from the chart below: 1) there is a lot of red on the maps, and a lot of it is in the area we live in; 2) there is a lot of variation in the amount of soil moisture, and that variation appears to be generally cyclic; and 3) we are in a bad way.

It is this last point that needs some explanation, because the graph above the maps is a bit confusing. The graphical information for the first four maps (from the left) is pretty clear. Significant periods of very low soil moisture occur with regularity. Soil moisture was at a high point at the beginning of this century and has since plummeted (the sharp drop at the very end of the chart). The average (mean) soil moisture level, since the beginning of the century, is shown as a line (labeled 2000-2018 mean) which runs along the bottom of the graph. It is that point that should make our hair stand on end. "Along the bottom of the graph" means equivalent to the worst droughts since the 800's. Our drought has continued since 2018, so it is really even worse!



The top graph shows a reconstruction of soil moisture over the past 1200 years, based on tree ring data. The plummeting blue line on the right indicates the current drought. Below: maps show the distribution of dry conditions for the five worst megadroughts in this region's history. Image: Park Williams, Columbia Climate School, Sarah Fecht, December 13, 2018

The amount of soil moisture is only one indicator of the crisis we face. The state of our surface water and associated riparian zones is another.

There are a number of factors which affect the flow of water above ground level and through the strata below. The interplay between the amount and timing of water intake (snow melt and rainfall), the topography of the surface the precipitation falls on and flows over, the type and amount of vegetative cover, the physical and chemical characteristics of the ground the precipitation falls on, air and ground temperature, and the physical and chemical characteristics of the underlying strata are a few of the factors which determine the amount of surface water which is present at any particular site.

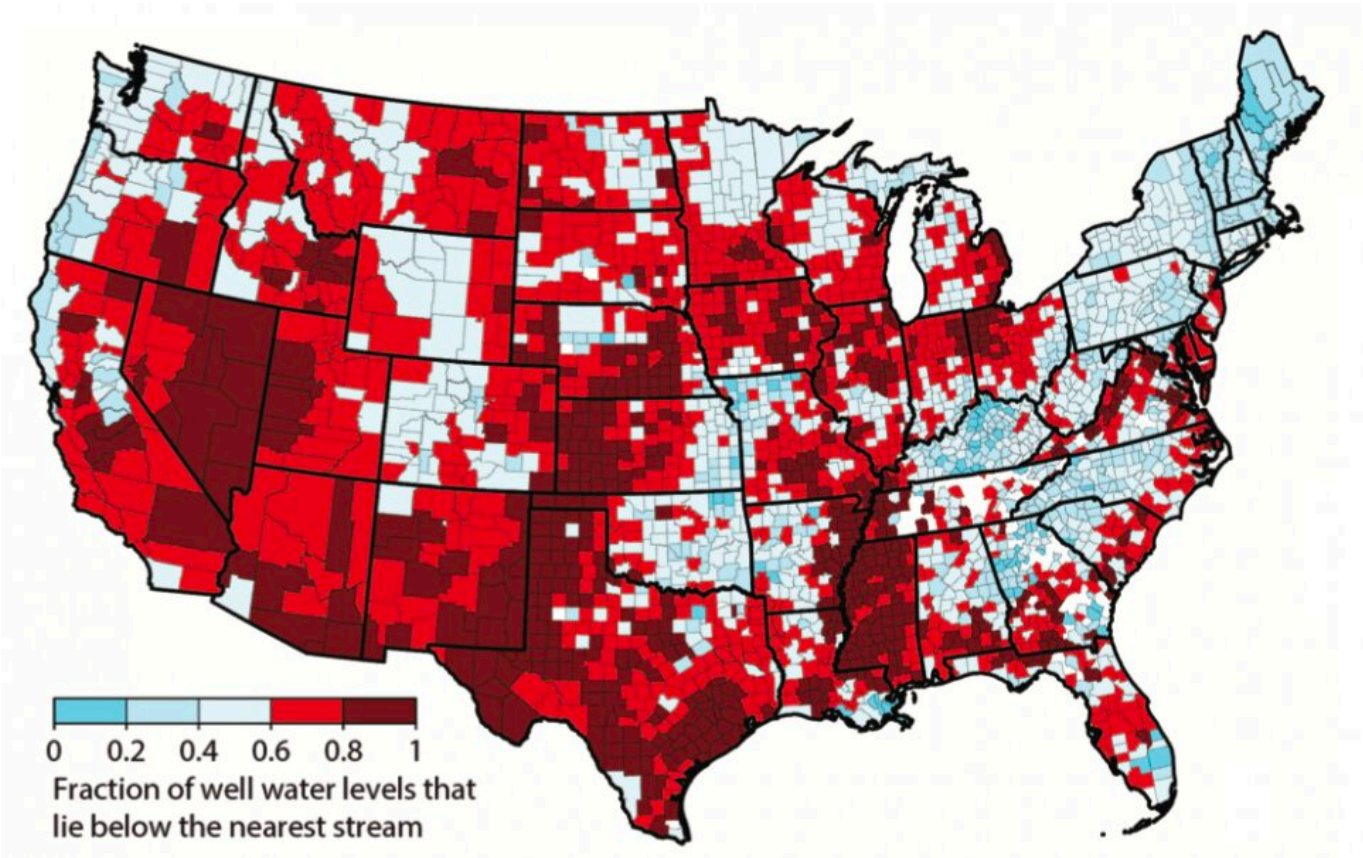
In "Widespread potential loss of streamflow into underlying aquifers across the USA" (Jasechko, Seybold, Perrone, Fan, and Kirchner; *Nature*; Vol. 591, 18 March 2021; pp 391-395), the authors surveyed the likelihood of, and the amount of, surface water percolating downward to underlying aquifers throughout the United States.

There are two "common sense" principles which most would immediately recognize: there is a tendency of water to soak into the ground, and the nature of the ground is a determining factor in the rate and amount of absorption. Add to these two the importance of the amount and level of water in the strata below ground. Our understanding of how this water exchange works is bifurcated between broad brush studies of large geographic areas and very specific studies of very narrowly defined geographic areas. Both extremes suffer from deficiencies in data. Our lack of understanding about what is happening in more narrowly defined areas (e.g. watersheds in the case of small site studies) and our lack of understanding at larger scales (in the case of regional and national studies) is often unappreciated. This study adds information to our understanding of everything in between - albeit an incomplete understanding, but a start.

Watercourses which lose water to underlying aquifers are referred to as losing streams, those that gain water from aquifers are called gaining streams in the study. Our area is characterized by losing streams. To determine if streams were likely to be gaining or losing, the authors compiled and analyzed data from millions of wells located in proximity to watercourses. If the static level of water in the well was higher than the elevation of the stream, the stream was likely to be "gaining"; if lower, the stream was likely to be "losing". A simple and effective model but one which is affected by the nature of rock formations which exist between stream level and the static level of the wells.

Among their findings, "losing rivers are common near wells" (p. 393). Roughly 2/3 of the wells they surveyed (or 4.2 million of 6.3 million wells) were found in areas where the static level of the water in a well was below the elevation of the nearest stream, "implying a hydraulic gradient that will drive seepage from the channel into the underlying aquifer." (Ibid.)

The amount of loss a steam may experience is affected by the amount of water pumping which is occurring from adjacent aquifers. "Near-stream groundwater pumping can deplete streamflow by either (1) withdrawing groundwater that would otherwise seep into the stream, or (2) lowering the hydraulic head below the stream surface, creating the potential for the stream itself to drain into the underlying aquifer . . . . Whereas recent model simulations have projected that losing streams may become more common in future decades, our data demonstrate that they are already prevalent here and now." (Ibid., p. 394). See map below.



The Source of the material on this page.

The need for people to remain socially distanced has created a recent upsurge in live interactive presentations, using tools like Zoom and Webex. This trend has created a level of accessibility which has not existed before.

On April 9, 2021, for instance, we were able to "attend" a presentation by George Veni. Veni is the Executive Director of the National Cave and Karst Research Institute. Information about karsts on this page is taken from his presentation. Any errors are solely the responsibility of the editor.

His presentation was part of the Southern Wetlands Roundtable presented under the auspices of the New Mexico Department of Environment. Maryann McGraw and team have been putting these presentations on for years, one in the spring and one in the fall. Each season there are two roundtables, one in Santa Fe and one in Las Cruces. (Contact her directly to receive advance agendas and access information for the presentations.) We have attended live sessions in Las Cruces prior to this, but missed many because of the three additional hours of travel time that would require. We wish to express our appreciation of the efforts of NMENV, and of Maryann McGraw and team in particular. And we appreciate the time George Veni took to share his knowledge with us on April 9.

Karsts

As just noted, the nature of the strata which water flows over and through determines the distribution of surface and sub-surface water and the amount of contamination which is in the water.

Karst features form when carbonate rock (limestone, dolomite, marble) or evaporate rock (gypsum, halite) is dissolved by water. These two factors, type of rock and dissolution, typify karst strata. Karsts are not features created by erosion; they are formed by dissolution. As noted on the following pages, there is a fair amount of carbonate rock at or near the surface in the Black Range, and there is sufficient water available to form karst features (caves, sinkholes, underground streams, and large springs).

There are few reported karst features from the Black Range. Given the amount of mining which has occurred, it is likely that some features would have been encountered if many of them exist.

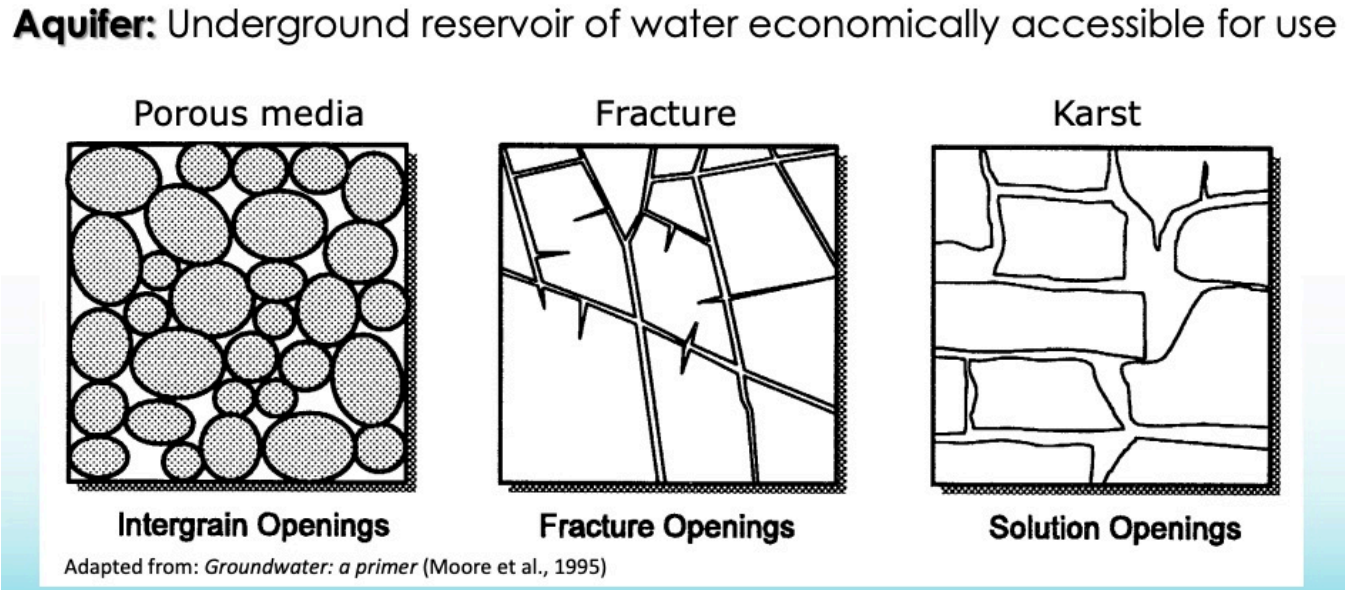
Rock ranges from impermeable to highly permeable. The permeability of rock is a function of its chemical and physical structure. In the Black Range we have rock strata at both extremes, making for some interesting water-flow questions.

The structure of karst strata (solution openings, below - from *Groundwater, a Primer*, John E. Moore, American Geologic Institute,1995) allows for the free unfiltered flow of water. Note, "unfiltered" karst water can be easily contaminated. The (relatively) free flow of water which karst rock allows also means that water tends to follow the strata. Surface drainage topography is not always a significant factor for water-flow through karst strata. That is, if a carbonate stratum, for instance, is found below an area which has several ridges at the surface (each ridge demarking a separate "watershed") water will flow freely under the ridges, through the carbonate layer, and can easily flow from one watershed to another.

There are many sources of information about karst systems, including www.karstportal.org and the USGS site on karsts in the United States.

The International Year of Caves and Karst -2021 has been extended to 2022 because of the COVID-19 pandemic. The opening video on the home page (link above) is worth the time to watch. This site provides many links to information about cave and karst geology and information about upcoming online events.

It is unlikely that we will ever find cave formations, like the above, in the Black Range. But the complexity of the geology here leads easily to many (as of yet, unanswered) questions about the water we access via wells and the ground water which sometimes runs in our streams. There is a lot more to



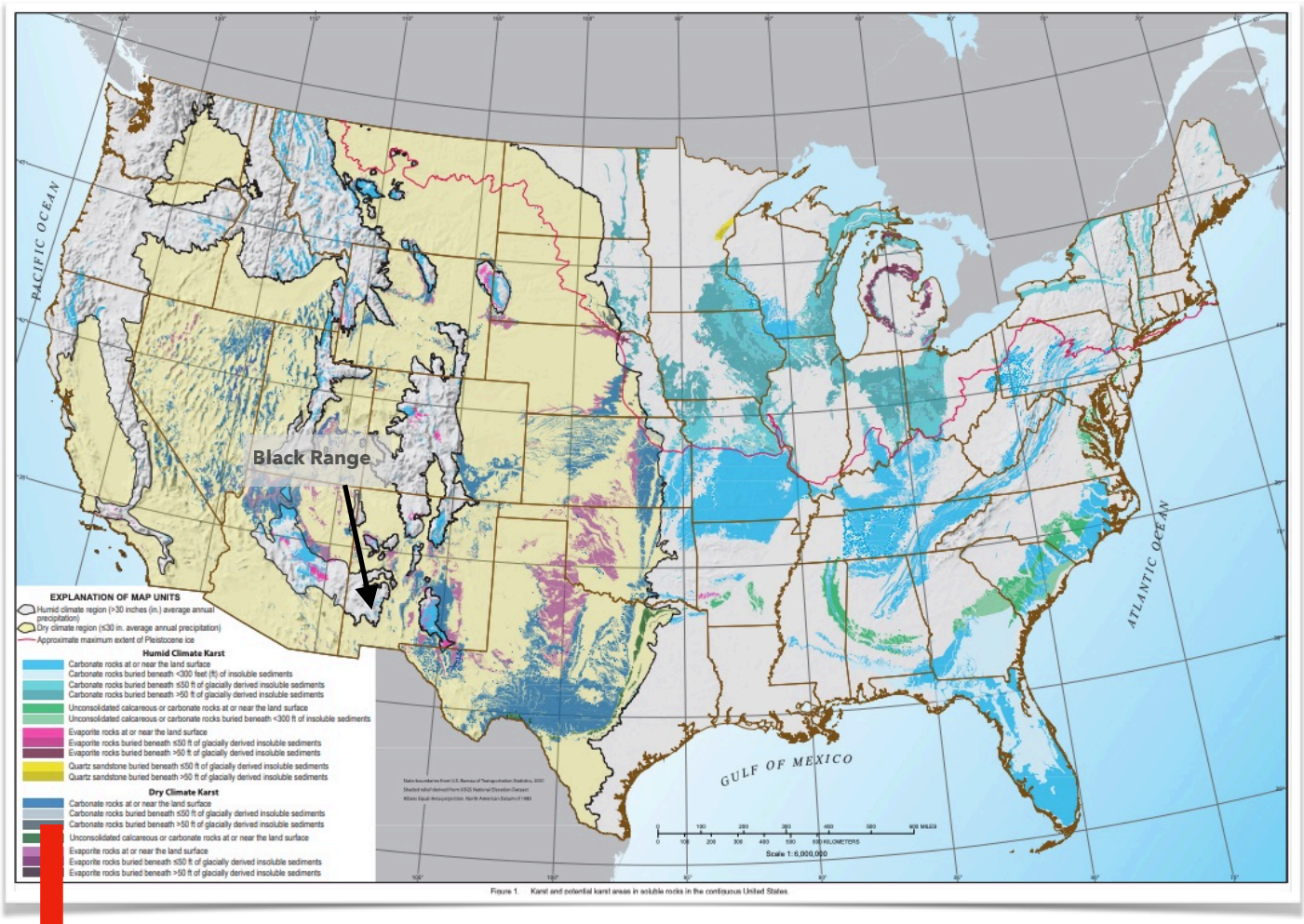
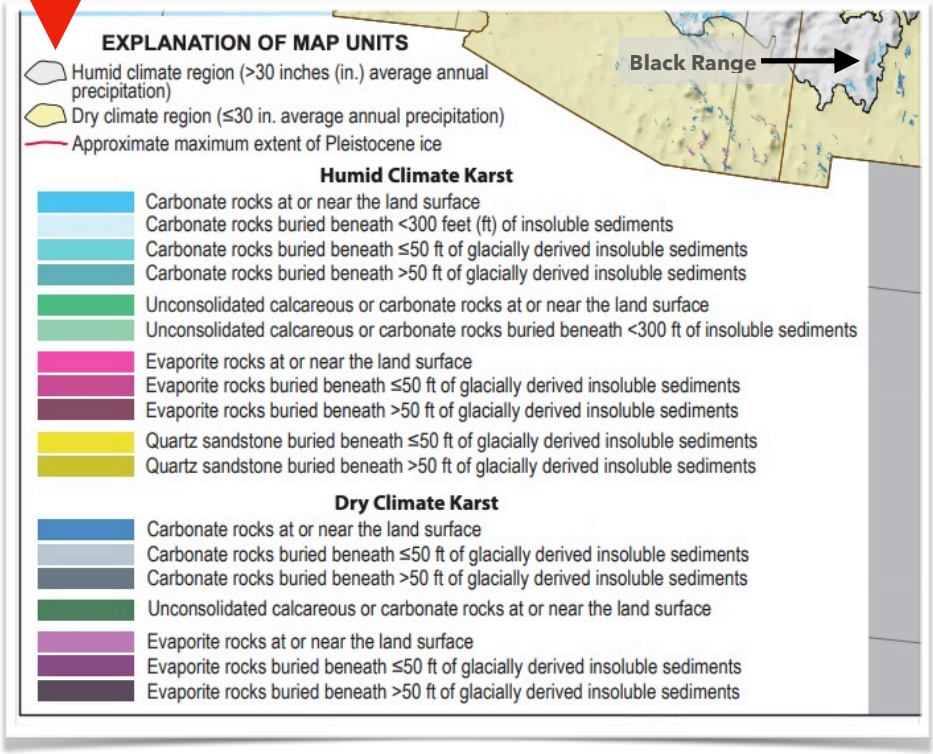


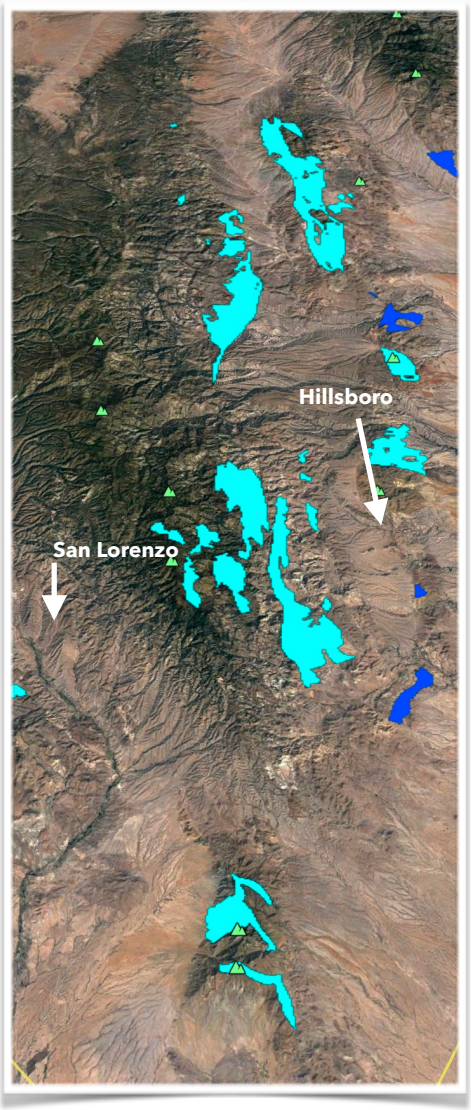
Figure 1. Karst and potential karst areas in soluble rocks in the contiguous United States.

Figure 1 from Karst in the United States: A Digital Map Compilation and Database, Weary and Doctor, USGS, Open-File Report 2014- 1156, 2014, p. 5



The Google Earth image shown on the following page has a .kmz layer superimposed on the Black Range. Light and dark blue colors indicate carbonate rock at or near the land surface. These strata have the potential for "karst or pseudokarst" development. The .kmz file is available at this link should you wish to download it. The file will be in a folder titled KML_USKarstMap and is entitled "Southwest kmz". When you click on this file it will open in Google Earth as a layer.

The interplay of volcanic and carbonate rock in this area may be important. At page 2 of the report by Weary and Doctor (link above), it is noted that "large integrated groundwater flow systems, some of which resurface at large springs, occur in some areas of layered volcanic rocks in the western United States."



streamflow in the Black Range than "There is water running in that wash, it's just running below the sand; when the bedrock comes to the surface it will force the water to the surface as well" or "This spring has been active for decades, never changes".

The geology of the Black Range is terribly convoluted, complicated by the significant volcanic activity which has occurred here. Volcanic strata play a major role in groundwater flow. That said, Weary and Doctor note, "Even very sparse karst features evident at the land surface can indicate important groundwater flow processes that are characteristic of karst in the broader subsurface." (Ibid., p.2)

Humid vs Dry Climate Karst

Seemingly, in all things, the Black Range is at the boundary. For instance, there are various ways that ecosystems are defined, and those definitions are used to map geographic areas which match those definitions. As you would expect, since each map is depicting a "different definition of the world", the boundaries of the geographic areas rarely match. Except, when you look at the Black Range. Then all of those maps depict one thing clearly: The Black Range is on the edge of whatever they are defining. It is our place at the margin which makes this area so incredibly diverse. It is a place to relish, not to try to put into a box.

If you happen to drive through this area, or look out your front door, you might say "This is dry". The map on the previous page distinguishes between humid climate karst zones and dry climate karst zones. Guess what, the Black Range is in the humid climate karst zone (defined as greater than 30 inches of average annual precipitation). Two things here: One is a knee-jerk reaction of "that does not pass the laugh test" and the second is that we are on the boundary between the two climate karst zones.

The Black Range (and west through central Arizona) is considered a humid climate karst zone because of the monsoonal precipitation pattern. When talking about karst zones, we are talking about the solubility of (in our case) the carbonate rock. Geology is geology, it does not always follow annual totals. Basically the effect on solubility, during the monsoons, is equivalent to that which you might find in the Southeastern United States, for instance. Thus, we are in a humid climate karst zone because the effect of the monsoonal phenomena would not be recognized otherwise.

Does this mean that the geology of the Black Range includes karst and karst-like features? Maybe. Does it mean that a more thorough understanding of the area's geology would be useful in predicting the underground accumulation and flow of water in our area? Probably.

The complexity of the geology of this area affects the plants and animals which live in the Black Range. There is a tendency of one of the animal species (*Homo sapiens*) to overstate its understanding of the world and its ability to comprehend such complexities. That can create problems. Simple answers are sometimes right, but rarely.

Flooded mines, like that shown above, sometimes high on hillsides - high above the "water-table", are common in the Black Range and were sometimes used as the source of water by local communities.

How and why these mines came to be flooded may be explained by the presence of carbonate strata, or not. The flooding may also be explained by the presence of many fissures in the area, or not. And that is the point: "or not" is an indication of our lack of knowledge. That lack of knowledge had significant economic impact in our past and will have an even greater impact in the future.

The Black Range Website maintains several videos about the mines of this

area. The frame grab below is from Mines of the Hillsboro Mining District - Vol. 1 (at 35:43). Early mining operations were continually involved in "dewatering" and reframing. Every time a mine changed ownership, which was frequently, the new owners would raise capital to "dewater" the mine, bringing in the latest pumps to get the water out so the mines could be worked. Water seepage was generally more of a problem than the supply of clean air. Clean air was only an issue if you could get the water out. Flooded mines also tended to rot the timbers that framed shafts and adits, thus the continual reframing. And reframing was not a trivial matter. In most of the mine shafts which dot the hills the framing has been removed, but at some, like the Bigelow, shown below, the framing is still intact.

This is an image, from Vol. 2 of the mine series, looking downward, at about seventy feet down the shaft.

The image shown below was taken less than a hundred feet away from the one showing the framing above. The two shafts begin at the same elevation and the frame grabs are from the same depth in the shaft. In the shot below the camera is approaching the flooded part of the shaft; a moment later it drops below the water level for some underwater exploration. (See Mines of the Hillsboro Mining District - Vol. 3 at 7:13.)

These examples of mine flooding are not the exception, they are the norm, and they have been the norm since the inception of mining in the Black Range.

The mines in the mining districts on the east side of the Black Range are in, or are dug through, strata which are permeable to water. The degree of permeability is not well documented.

In these examples, the shafts and adits are in the Animas Hills beside the Copper Flat Mining Facility. The mine operators and the Bureau of Land Management estimate that the pit at that mine site holds from 20-28 million gallons of water and that the water in the pit is replenished at the rate of 24 gallons per minute, seeping in from "larger fractures" (BLM - Copper Flat Copper Mine, Final Environmental Impact Statement, April 2019, p. 2-32). That report notes that pumping would be required throughout the life of the mining operation. The pit is in the middle of a formation called the Animas Uplift which is claimed to be impervious to the flow of water. The hydrogeology of the area is reported in Section 3.6 of the Final EIS. Data and analysis contained in this report require independent verification of veracity and scientific credibility.

As noted above, the flooded shafts and adits shown here are within the area described as the Animas Uplift, in an area which has, historically, been rather notorious for the dewatering of mines which had to occur. The water in these mining features does not flow in from the surface, and the flooded areas are above groundwater level in the surrounding area.

The current characterization of the Animas Uplift does not appear to be correct, or at the very least comprehensive. But that is not unusual. How the geology of the area is characterized, generally, has significant gaps, and those gaps will continue to influence future decisions which will profoundly affect all of us.

Chelifer canroides, Pseudoscorpion

This pseudoscorpion was photographed in Hillsboro on May 21, 2017. The body length is roughly 2 mm.

—

The line above is 2 mm long. Macro photography has many advantages. Such a magnificent creature as this would generally never be seen by most people. But it also has its disadvantages, as in, people don't read the fine print. The creature pictured below looks like an interesting bug, in the way that scorpion types are interesting. But the image is misleading. Take another look at the line above and feel a bit of awe.

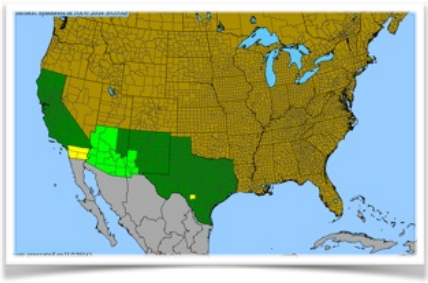
There are about 420 described species of pseudoscorpion in the United States and something in the range of 3,530 worldwide. This individual is probably in the species *Chelifer canroides*, the House Pseudoscorpion, which is cosmopolitan - but in truth that is little more than an educated guess.

Although this species, and others of this ilk, have poison glands in their pincers, they are not dangerous for humans, simply because they are too small to bite the surface of our skin. For the very small prey that they eat, however, these creatures are formidable hunters. They are said to "hitch" rides on larger animals but are not parasitic. They are extremely agile and can easily run backwards.

To reinforce the fact that this species is small, consider that the male establishes a mating territory of two square centimeters or less. Equally amazing is that the adult form can live from three to four years.

Calliandra eriophylla - Fairy Duster

According to various sources, Fairy Duster, *Calliandra eriophylla*, is not found in Sierra County, although some specimens are known from Luna and Grant counties. The specimen photograph shown here is from the



northern part of Luna County, on the south slope of the Mimbres Mountains.

The BONAP map below shows the range of this species within the United States. Its range extends south to the southern part of Mexico. It is likely that the spot where this photo was taken is one of a very few where this species appears in the Black Range, as it appears to prefer elevations of less than 5,000 feet. The light green color on the map indicates that the species is native to, and not rare within, the county indicated.

Scientific synonyms for *Calliandra eriophylla* include two varietal names, *Anneslia eriophylla*, and *Feuileea eriophylla*. It was first described by George Bentham in 1844. Other English Common names include Fairyduster, Pink Fairyduster, Mesquitilla, Baja Fairy Duster, and Mock Mesquite.

The Native American Ethnobotany Data Base indicates that the Yavapai used a decoction of leaves and stems from this species as a gynecological aid following childbirth.

Although earlier specimen sheets are available, the one shown below is of a plant collected by Dr. E. A. Mearns in Grant County on April 30, 1892. It was collected as part of his efforts in support of the United States National Herbarium Mexican Boundary Survey of that year.

Andrew Lincourt, of Kingston, (left) and Megan Perry (below) could not resist the photo op and bonding experience. "Who wants to hold a pup?" Ask the question and get out of the way.

This event was one of the few interactions these pups will have with humans during their life. Three weeks later they were given more shots, and the process continues on through a program to familiarize the wolves with the natural world. And then, off to Chihuahua to be introduced into the wild. It will be a hard life, full of human induced danger and the normal travails of survival.

Bound for Mexico

The Mexican Gray Wolf (*Canis lupus baileyi*) has been forced to the edge of extinction by our direct and indirect actions. Some ranch operations have joined the efforts of Mexican and American agencies and various non-governmental organizations to keep the Mexican Gray Wolf from going the way of so many subspecies/species we have destroyed.

Adult Mexican Gray Wolves are somewhat smaller than domesticated German Shepherds. The pups of the species are cute, cuddly, and remarkably calm when receiving their first shots.

On May 25 of this year, five pups at a captive breeding facility in the Black Range received their first shots. At six weeks of age, even with virtually no human contact during their life, they remained placid while being handled for the first time in their life. They had RFID (radio frequency identification) tags implanted, their blood was drawn, they were physically inspected for parasites and to assess general health, and they were given those shots.

The RIFD tag enables researchers to access historical and identification information about the subject (in this case a wolf) without encumbering it with weighty tracking equipment. The medical assessment ensures the wolf will not introduce disease into the wild population and will help maximize the success of the reintroduction effort.

What Does Your Gut Tell You?

What is the nature of your gut? What is the biological history of the microbiome of your gut?

Over the last decade, the general public has discovered that everyone is an ark. We all harbor billions of critters, of thousands of species, in our bodies. In fact, many argue that it is not possible to separate "humans" from the rest of the "human colony". The relationships between "human" and the millions of microbes which inhabit our gut is so profound that it may not be possible to separate the two. That we harbor such a biomass is commonly known, that the relationship between "human" and that biomass is deeply symbiotic is known to fewer perhaps, and even fewer yet have wondered about what we do and have done to that biomass.

Wibowo, Yang, et al. published "Reconstruction of ancient microbial genomes from the human gut" in the May 12, 2021 issue of *Nature*. They report on the findings of their study of human palaeofaeces from the southwestern United States and Mexico, dating from up to 2,000 years ago. These samples allowed them to examine the gut biome of people of that time and compare it with the gut biome of modern peoples, both those of industrialized and non-industrialized societies.

Because of the sample size used in the study it may be inappropriate to generalize the findings to the world.

They found that 39% of the genome sequences from the samples were from "previously undescribed species-level genome bins." The fact that more than a third of the species found in the ancient feces are not known from the present raises a multitude of questions. They found that the biome present in the ancient feces is more similar to that found in samples from non-industrial societies than to those from industrialized societies. The authors note that "None of the phyla is significantly different between the palaeofaeces and the non-industrial samples."

In the words of the study: "Previous studies have shown that industrial lifestyles are correlated with both a lower diversity in the gut microbiome and increased incidence of chronic diseases, such as obesity and autoimmune diseases."

Wrens of the Black Range - Our Covers

In addition to the Canyon Wren (*Catherpes mexicanus* - Photo Gallery), which graces our front cover, and the Rock Wren (*Salpinctes obsoletus* - Photo Gallery), which graces the back cover, there are five other wren species which can be seen, more or less regularly, in the Black Range. Three are shown here. We also have Pacific Wren and Marsh Wren.

The Pacific Wren, *Troglodytes pacificus*, was once lumped with what is now *T. hiemalis* (now called Winter Wren) of the eastern United States/Canada, and *T. troglodytes* (now called the Eurasian Wren) of Eurasia and northern Africa in a species called Winter Wren, *T. troglodytes*. It is currently believed that *T. pacificus* and *T. troglodytes* last shared a common ancestor about 4.3 million years ago. The two North American species overlap in range, with the Rio Grande posited as the "dividing" line between the two ranges in our area. Both species are rare here. The two were established as full species following a 2008 study (Toews and Irwin) which found strong evidence of reproductive isolation in the area where the ranges of the two species overlap. (The study area was in British Colombia.) In their study, Toews and Irwin stated that "We located the first known area in which both forms can be found, often inhabiting neighboring territories. Each male wren in this area sings either western or eastern song, and the differences in song

Bewick's Wren - Thryomanes bewickii - Hillsboro, New Mexico

Northern House Wren - Troglodytes aedon
Railroad Canyon, Black Range, New Mexico

are as distinct in the contact zone as they are in allopatry. The two singing types differ distinctly in mitochondrial DNA sequences and amplified fragment length polymorphism profiles. These results indicate that the two forms are reproductively isolated to a high degree where they co–occur and are therefore separate species." ("Cryptic speciation in a Holarctic passerine revealed by genetic and bioacoustic analyses", David Toews and Darren E. Irwin, *Molecular Ecology*, June 2008, Vol 17, Issue 11, pp. 2691-2705.)

The best way to tell the two species apart is by song. The sonograms shown below are from the referenced study. Compare them with the YouTube video of a Pacific Wren and that of a Winter Wren (sorry about the ads).

The Marsh Wren, *Cistothorus palustris*, is also found in the Black Range. Although we are in the winter range of the species, they seem to be most common in passage - perhaps because we have so little "marsh". They are found in relatively thick low undergrowth, such as reed beds.

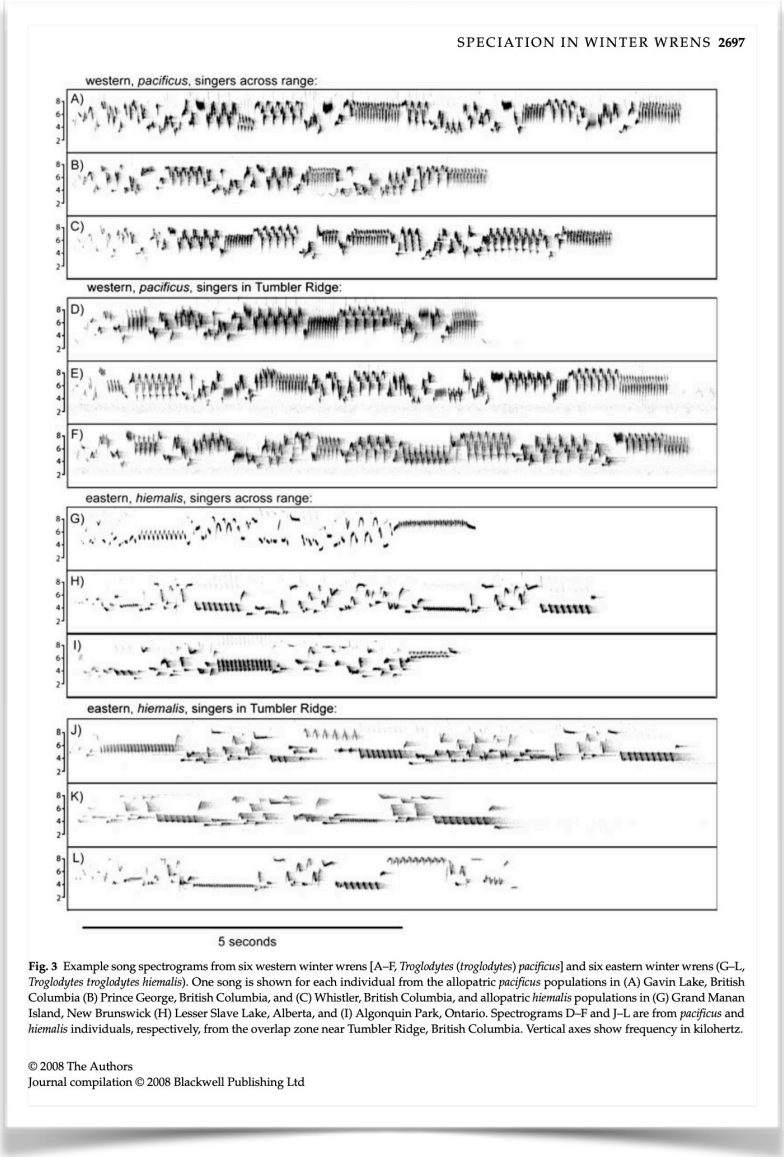
The Bewick's Wren, *Thryomanes bewickii*, is found, primarily, in the western United States and Mexico. Pronounce this species name like "Buick". Photo Gallery. Video from Oregon and Hillsboro, New Mexico.

The Cactus Wren, *Campylorhynchus brunneicapillus,* is often found nesting in or near washes, generally in cholla or "thorny" plants. Photo Gallery. Video from Arizona.

The Northern House Wren, *Troglodytes a. aedon*, is the species/subspecies which we have in this area. On occasion a bird which looks like the Brown-throated Wren, *T. a. brunneicollis*, of northern Mexico and Arizona will show up. The main species/subspecies of South America is the Southern House Wren, *T. (aedon) musculus*. Although some "authorities" continue to assert (as do we) that the Southern House Wren, *T. musculus* is a species, the South American Classification Committee of the American Ornithologists' Society now considers it a subspecies of the House Wren, *T. aedon*. Photo Gallery. Video from Wyoming. Video of Southern House Wren from Tobago for comparison (including song).

Of these species, the Canyon and Rock Wrens can be remarkably indifferent to nearby human activity. In Hillsboro, we sometimes encounter Canyon Wrens wandering about the yard, far from any cliffs, looking in cracks and nooks for a bit to eat. They note your presence and go about their business. The song of the Canyon Wren is one of the most beautiful bird songs which I have heard.

Wren, Cactus - Campylorhynchus brunneicapillus - Hillsboro, New Mexico



SPECIATION IN WINTER WRENS 2697

western, *pacificus*, singers across range:

A)

B)

C)

western, *pacificus*, singers in Tumbler Ridge:

D)

E)

F)

eastern, *hiemalis*, singers across range:

G)

H)

I)

eastern, *hiemalis*, singers in Tumbler Ridge:

J)

K)

L)

5 seconds

Fig. 3 Example song spectrograms from six western winter wrens [A–F, *Troglodytes* (*troglodytes*) *pacificus*] and six eastern winter wrens (G–L, *Troglodytes troglodytes hiemalis*). One song is shown for each individual from the allopatric *pacificus* populations in (A) Gavin Lake, British Columbia (B) Prince George, British Columbia, and (C) Whistler, British Columbia, and allopatric *hiemalis* populations in (G) Grand Manan Island, New Brunswick (H) Lesser Slave Lake, Alberta, and (I) Algonquin Park, Ontario. Spectrograms D–F and J–L are from *pacificus* and *hiemalis* individuals, respectively, from the overlap zone near Tumbler Ridge, British Columbia. Vertical axes show frequency in kilohertz.

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