

The Black Range Naturalist

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Front Cover: *Solanum rostratum*, Buffalo Bur
Back Cover: *Penstemon metcalfei*, Metcalfe's Penstemon

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Six Years And Counting

When we began the experiment which is the *Black Range Naturalist* we were not sure that it would succeed, by any definition, not sure at all. After all, the concept of a community sharing its knowledge is noble but may not be practical. With the last issue we completed the sixth year of publication. The success we have had is due to the contributions, advice, and encouragement of many of you. In particular it is appropriate to recognize the following, who have contributed material and information to the journal:

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"We have become isolated from nature and as a result may apply technology where it isn't needed, habitually relying instead on expensive tools where simple and low-cost observation might suffice." – Harley Shaw

Natural History - Tools of the Trade - Part 1 - Sign

Harley Shaw's essay in ***Shadow Cat: Encountering the American Mountain Lion*** (Susan Ewing and Elizabeth Grossman, 1999) provides an excellent perspective about the ways we know Cougars. It was titled, "Sign". The quote above is from that essay.

In the essay, Harley describes the training of a researcher from the east, a researcher who badly wanted to learn Mountain Lion tracks. He summed up his experience with Cougars in this way. "In Arizona, we know we have lions. I had just finished eight years of research, capturing mountain lions with the help of hounds, fitting them with radio collars, and following them to the prey they killed. With three other trackers, I had been working to estimate the density of lions in various Arizona habitats and to evaluate the track count as a method for monitoring lion populations . . . but in an entire week, searching good tracking surfaces in the best of lion country, we found no lion sign. Sometimes it happens that way." In a subsequent visit they had more success. "As I continued my own surveys, lion sign took on a different significance. I realized that studying lion sign was a special opportunity, for without knowing lion sign, you can't know lion . . . "

And, as Harley notes "the key to seeing natural sign involves focusing on appropriate search images. During my research, I developed a search image for lion tracks, and I am still jerked out of my reveries by anything on the ground that resembles that form."

SIGN
by Harley G. Shaw

Left by no apparition
This is real
Impressed by mass and motion
Clean, clear, crisp
Species certain, for we know they are here.
Not a surprise, not proof
Affirmation.

But for one who has searched for years, it is more.
Reality.
A lesson in odds.
A seed of doubt.

She has searched where the species is gone
Only its body in headlights at night
Or trailside silently staring
Accusing.

Making fools of those who see.
No track; no carcass,
Ghosts? How?
We die and leave.
Is a species resilient,
It is vacuum a phantom
To remind us?

I'll hold out for tracks.

Practitioners of non-institutional science, citizen science, community science - whatever you wish to call it - have a huge store of knowledge. There are, however, several issues with that reservoir. Quality is always an issue as is the dismissal of quality observations and analysis by gate-keepers. Even when valuable knowledge is articulated, finding a medium through which it can be heard can be difficult. Many natural history sites (BugGuide, iNaturalist, eBird, etc.) have sprung up to address this particular issue. Often, however, their focus is on simple observation and offer no, or a limited, platform for the analysis which may have occurred.

These issues can be successfully addressed, and we can all reap the benefits of that success.

In "Sign", Shaw noted the need. "I believe that this is where well-trained amateurs could play a role in resource management. With agency biologists forced to manage an increasing variety of species and habitats, and with the documentation and constraints demanded by the National Environmental Policy Act, the Endangered Species Act, and other legislation, fewer and fewer professionals are leaving their desks and going into the woods. They are unable to dig themselves out from under the volume of environmental assessments, environmental impact statements, and other forms of project document-ation. Periodic, long-term monitoring of common species seldom occurs. Well-trained lay naturalists with specific skills could do much to lighten this load." Added to the issues described above, the use of budget, by politicians, to control scientific findings - either by preventing the studies from happening or by diminishing their quality - is a well known tactic of those who find the truth bothersome.

Shaw notes that "we have forgotten that the founders of our environmental knowledge, such as Darwin, Mendel, and Thoreau, were amateurs in the truest sense of the word. They had no biological degrees, no agency titles, no government grants, no official authorization to do research. But they did have excellent eyes, ears, and brains. And they understood the labor of love."

Added to the wealth of motivated and qualified, but perhaps uncreden-tialed, observers here in the Black Range, we increasingly have individuals who have spent their careers in natural history research and now relish the opportunity to pursue their love without organizational constraint.





Mountain Lion Prints
Directly above: East of Hillsboro, January 26, 2017
Left and Below: Hillsboro Peak Trail, March 4, 2013



Regardless of their background and/or experience the non-institutional observer/ researcher is unlikely to have the latest gadgets at their disposal.

There are alternatives to all that tech, however. In this issue we explore some of the techniques and resources that are available to all of us. This material includes access to some sophisticated and comprehensive databases, the use of sign to understand what is going on in the world, and intriguing techniques which can be used to assess and analyze the natural world.

The development of expertise in the use of this material requires some effort, but it is effort which can be expended in the field, in the midst of the Black Range.

The most obvious low-tech assessment technique is one we encounter on almost any outing in the Black Range. An animal track. What made the track and what was it doing? These are questions which immediately come to mind.

One of the more fabled tracks in our area is that made by the Mountain Lion. It is with that track that we begin our discussion.

Harley Shaw provided the images to the right. The top photo is a Mountain Lion print, the middle is an image of the type of foot that made it, and the bottom is one of those high-tech methods of assessment we are talking about.

Many of us document tracks with photographs. As shown in the photographs on this and the preceding page, it is always good to have something to provide scale. Even if you are more inclined toward the "art" side of documentation, it is not difficult to provide scale. On the preceding page a few needles in the track provide a sense of size, perhaps not the most definitive sense, but a good sense. In the photo to the right (of a Mountain Lion's front foot), the hand is an integral part of the photograph, and it provides scale. Items of known size are useful if you are focusing on "documentation" rather than "art". But the instrument of measurement does not have to be a ruler; that helps, but it does not have to be metal or plastic with calibrated markings. It can be whatever is in your pocket. A set of keys (which can be measured later to establish a precise assessment) will work.

In the bottom photo a clear piece of plastic is placed over a track. Note that it is placed on small stones so that it remains above the track and does not alter it. A marker is then used to outline the track on the glass. A photograph of the outline, with a handy-dandy ruler, provides excellent documentation.

There is more to making such an outline than may first appear. As artists and photographers know, focusing on an object highlights elements which may have been missed in a casual observation. Outlining a track brings the track into sharp focus.







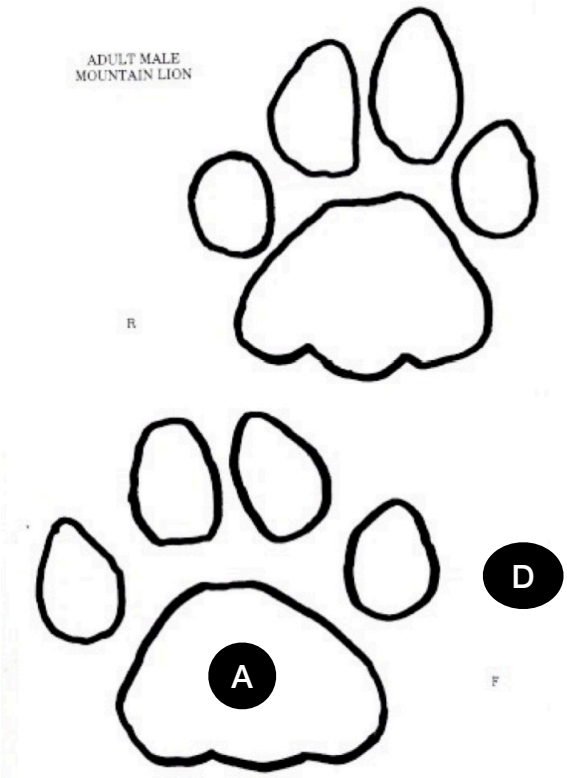
Simple outlines of prints can be very useful, not only in documentation, but during instruction as well. On this page we highlight some of the parts of a track to focus on when you are trying to determine the species which made it.

Feline vs. Canine: Note the large hind pad of the print. In cat species the pad is large compared to the toe imprints and the pad is more rounded toward the front ('A") than is the case in canine prints ("B"). Although the claws of the Coyote prints shown here are apparent, that is not always the case. Claws can be a good affirmation of species, but if you don't see any indication of claws that does not mean that it is not a canine ("C").

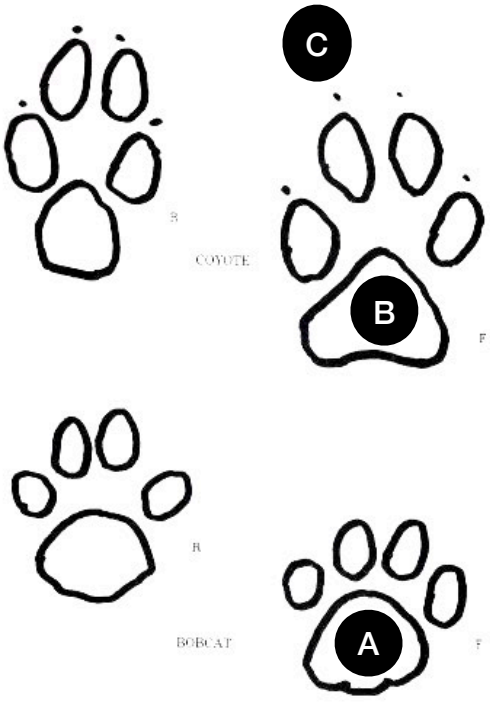
A Mountain Lion's front track will normally be larger and rounder than the rear track. But Mountain Lions have significant control of their toes and thus how they appear in a track. An individual track, therefore, may be deceiving if you consider only the size and relative shape of the entire track. The metacarpals (back pad) of cats make up more of the total surface area of a print than is the case with canines ("D"). The size of the metacarpal pad is often used to distinguish between Mountain Lions (1.5" to almost 3") and large Bobcats (1" to 1.5").

If you encounter a set of Mountain Lion tracks which are more or less in a straight line, it is traveling from one site to another. If the line of tracks wanders about, the Mountain Lion is probably hunting.

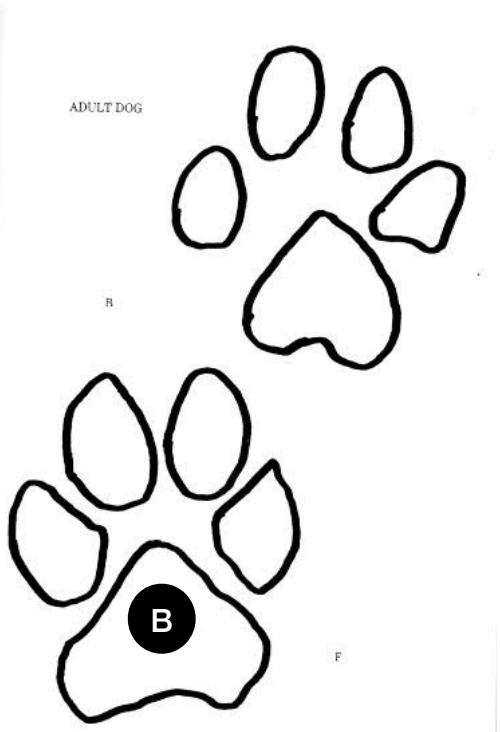
The tracks shown here are from a publication by Harley Shaw and are referenced in the following article.



Tracks of adult male Mountain Lion, rear foot at the top and front foot at the bottom



Coyote (top) and Bobcat (bottom)



Adult domestic Dog

Weight Load and Flotation in Wildlife Feet - by Harley Shaw

Some 30 years ago, I accompanied a group of ecologically minded citizens to New Brunswick to attempt to document the presence of pumas. We arrived in mid-March. Snow depth throughout the province was between two and three feet. Although most of my career had been in Arizona, where we tracked mountain lions on bare, dry ground or in snow that was usually less than a foot deep, I was no stranger to deeper snows. I did my master's theses in northern Idaho, where we often used snow shoes to get around, and I also lived in Flagstaff and, later, on the North Kaibab during years of record snowfall. Based upon my observations on the Kaibab, especially, I had concluded that pumas headed downhill in a hurry, when snow got deep on the summer range. It made sense. They struggled to negotiate deep snow, as did deer, their primary prey. Such vertical movements to less severe conditions, following their food, is a common phenomenon in the mountainous western U.S., Mexico, and Canada. Ergo, the pumas in the west have evolved to move, if not migrate, in response to weather, and the terrain makes it possible for them to do so.

In New Brunswick, one of my first impressions was that wildlife, including pumas and deer, would not be able to get away from the deep snow. The terrain was relatively level, and snow was ubiquitous. Deer, all whitetails, followed the classical NE tradition of "yarding." That is they spent the worst months near a river, concentrated in areas where woody shrubs and some tree species provided a modicum of feed. They stayed in these areas, beating the snow down and packing it. Within the yards, they could move more easily and find food, as long as the food held out. Under such conditions, by late winter, things were getting tough.

I don't know what the average number of deer per "yard" might be under normal conditions, but I suspect that distribution was fairly sparse. Coyotes, wolves, and lynx exist in the province; deer die through the winter from starvation and disease; a puma would have to be able to move between several yards to survive, all the while competing with other pumas and other predators. Persistence under the conditions I was seeing seemed unlikely.

Out of curiosity, I explored the potential effects of deep snow upon the movements of pumas. During our cursory survey in New Brunswick, we had spent at least one day on snowshoes doing track counts in Fundy National Park. We found no puma tracks, and, even though I had some experience on snow shoes, I floundered a lot in the deep snow, breaking through often and having to extricate myself from waist deep holes, often with help from the park naturalist who was conducting the survey. At that time, I weighed about 160 pounds – close to the weight you might expect for a mature male puma in that northern part of their range. The snow shoes I was using obviously provided much better flotation than the surface area of a puma's four feet combined. And in actuality, the only time an animal would have weight distributed across all four feet would be when it was standing still. I concluded that a puma could not negotiate the kind of snow that existed under New Brunswick's average winter conditions. And they would have to travel hundreds of miles south to escape such conditions. To me, winter snows alone were enough to assure that any transient puma wandering this far north would be unlikely to stay. If it did, it probably wouldn't survive.

To pursue my hypothesis a bit further, I calculated my own flotation in booted feet without snow shoes. Even though I was bipedal, my two size 12s provided me more surface area per pound than the four feet of an equally heavy puma would have. Female pumas, while lighter, also had smaller feet. It seemed to me that they simply would not get around.

Over the past 30 years, I've thought about the importance of "floatation" in animal travel and survival but not taken time to explore the concept further. The nearest I came to considering effects of weight on the feet of animals involved horses – a species known for common foot issues resulting from heavy weight of horse plus rider or load upon the relatively small surface area of the hoof on the ground. Their weight bearing is tremendous.

The concept of floatation based upon an animal standing still on four feet is oversimplified insofar as foot surface area affects animal movement and strain. At some point in nearly all locomotion, depending upon pace, an animal may have weight on only one or two feet. This was demonstrated clearly by Eadweard Muybridge as early as 1887.[1] Little work beyond his monumental set of photographs has been done since, although a few efforts at assessing the mechanics of animal movement using tools of physics, engineering, and mathematics have been published.[2] These demonstrate clearly that the process is complex, but do not address the evolutionary adaptations of foot morphology in terms of weight loading and its effect on habitat substrate selection, or risk of injury.

Perhaps the group that has given most attention to foot/substrate relationships is trackers, and their understanding is mostly intuitive and unwritten. Their interest lies mostly in identifying tracks and detecting faint traces of animal movement through a landscape. Weight loading almost certainly affects the choice of terrain and surfaces over which an animal moves, and accomplished trackers know intuitively what surfaces are or are not worth searching for sign. I've seen no discussion of how land surfaces might affect choice of route by an animal.

As a meager beginning of assessing weight loading, I have carried out the following exercise to evaluate differences in species for which I can easily acquire measurements of foot area and weight loading of standing animals. The approach used here is crude and, if pursued seriously, will require better tools of measurement, more accurate animal weights, and more attention given to the complicated traits of moving animals such as those analyzed in Lee et al., mentioned above. Because of my earlier work on pumas, using tracking dogs, I have published tracings of

tracks of a male mountain lion, a scent hound, a coyote, and a bobcat. (See page 5.) These are actual size*, so depict the actual surface of the tracks contacting the ground. I do not have weights for any of these animals, so initial weight loading will have to be based upon expected weights provided in the literature or from my own experience. An ideal to carry such a study of this further would involve access to actual weights of animals and imprints of their tracks in substrate that holds them clearly. The odds of building a sample of such measurements is almost nil, but a beginning can here be attempted using track tracings and measurements, track pictures and measurements from tracking guides, and modal weights provided by research on the various species of interest. Only after some careful experimenting with such study and reflection on the significance of the findings, can I decide if more intensive study might be worthwhile.

1. Muybridge, Eadweard 1887. *Animal Locomotion*. University of Pennsylvania.
2. David V. Lee, Eric F. Stakebake, Rebecca M. Walter, and David R. Carrier. 2004. "Effects of mass distribution on the mechanics of level trotting in dogs." *The Journal of Experimental Biology* 207:1715-1728.

* Oh the joys of electronic media. The prints referenced above were drawn to actual size and printed (in a book, on paper) so there was no question about how the reader would experience them - they were actual size. With electronic media it is not that straight forward, what a reader sees on their screen varies with numerous settings - so the image may not be "actual size". Here we have settled for "relative size", all the prints are proportional to each other.

Addendum

For the present, I have the pleasure of tinkering with what appears to be a little-explored subject simply because I'm interested.

First efforts:

Tools to measure the area of an irregularly shaped object like an animal foot (or track traced from the ground), using modern computer technology, are relatively expensive, although one online app looks tempting, but is not free (https://www.sketchandcalc.com). For the present, I will discuss my low-tech approach that doesn't require a computer. I will initially compare areas and estimated foot loadings of a male mountain lion and a male scent hound. Starting with 100 percent scale tracings of a front and a hind foot on a single sheet of paper for each species, I created a 5cm X 5cm (25 square cm) square on the same paper sheet. I cut this sheet of paper out and also cut out the tracings of the track segments, keeping hind and fore feet toes and heel separated by species. I then carefully weighed the 25 square cm piece of paper and each of the foot cutouts in grains (1 gram [g.] = .0648 grains [gr.]) on a reloading scale. Calculating of surface area in grams used the simple ratio: Weight of 25 square cm slip/25 = Weight of track cutout/area of track. For the dog hind foot, this became 3.1 gr./25 = 4.0/x. Cross multiplying and solving for x yielded hind and fore dog feet areas of 32 square cm (4.96 square inches) and 40 square cm (6.2 square inches) respectively. The same approach yielded a hind foot area for the lion of 7.50 square inches (48.4 square cm); front foot of 56.5 square cm (8.75 square inches) for puma. For each species standing on all fours: Using a male puma weight of 63.5 kg (140 pounds), resulted in a standing load of .302 kg /square cm. (4.28 pounds/square inch) spread unevenly over four feet. Using a hound weight of 29.5 kg (65 pounds), resulted in a loading of .204 kg /square cm. (2.89 pounds/square inch) spread unevenly over 4 feet. Standing still on all fours is only one of many conditions, perhaps one of the least likely an animal assumes for any length of time. It would be interesting to calculate weight loading of other large mammals, especially where actual weights might be obtained.

Sign (con't)

Harley Shaw's discussion of the surface an animal is crossing and how that affects the look of the print and the behavior of that animal is instructive on several fronts.

The appearance of animal tracks is dependent on many factors, and because of that a clear, pristine, easily identified print can be hard to find. With experience it becomes easier to identify partial or degraded prints. Knowing the morphology of an animal's foot (feet) can be very enlightening, as can knowledge about the way an animal moves. Indeed, animals move in a variety of manners. Gaits may meander, bound, or run. All will leave different types of prints.

Prints left in mud will look different from those left in sand. And one substrate is not inherently better at capturing a print than the other. Generally mud is good, but mud is often associated with water, and water can cause the sides of a print to collapse or the structure of the print to degrade as it fills in with sediment. On the other hand, moist compact sand can be an excellent medium to capture tracks, but when it begins to dry, the sides collapse and the structure of the print degrades as loose sand fills the print. The effect of water is completely opposite in these examples. One thing should be remembered, however - time. In all cases a track degrades in quality over time; the amount of degradation and exactly how it happens may vary but it always degrades. Information lost you say? No, understanding the rate of degradation can tell you about the timing of a creature's passing.

Sometimes a poor print will be created when a creature is moving quickly, especially if the substrate is loose. Sometimes speed equates to weight and a print will be deeper and more exact.

The lesson? An animal track is a sign left in substrate. To fully understand the track you must also understand what has happened to the substrate over time and you must understand how the substrate captures a track under different conditions. When you know those things you can look at a track and know a story.

Black Bear tracks are often found in the Black Range, as are Black Bears (see photo right). The Mimbres people often depicted their tracks in petroglyphs and on pottery. The two track images on this page show the difference that substrate can make, in this case mostly due to the amount of moisture in the sand. Black Bear, like other animals, leave a variety of sign, including good old-fashioned poo. Scat is not just about voiding the system. Sometimes a Black Bear will lay down scat as a territorial marker. Sometimes scat is deposited as a marker of low-level aggression. As when it is deposited on the track you left as you walked down a wash.

As shown on the following page, Black Bear scat has its own tales to tell. For







Black Bear print. Above: Ready Pay Gulch, east of Hillsboro, NM. November 2022 - Below: August 26, 2013 Middle Percha west of Kingston





Above: Black Bear hind foot print. Palomas Creek, East slope of the Black Range, June 7, 2018.
Below: Black Bear scat, Sep. 4, 2018, Percha Box (Top); Nov. 13, 2020 from Middle Percha (Left); and May 30, 2016 from McKnight Mountain (Right)



For starters, it does not always look the same, and that is a clue. That difference can inform you about the bear's activities. General health and the recent diet of a bear can be discerned from its scat. (As we will see later, this is true of most other animals as well.)

In the center photograph on the preceding page the bear has been eating berries, in the photograph at the bottom right it has been eating something with hair. Bears are opportunistic omnivores and will have a preference for one source or another depending on the time of year (what is fruiting, for instance, or how much weight needs to be put on for the winter). See the Black Range Naturalist Vol. 6, No. 1 for a description of the bears in the Black Range.

Coyotes are also opportunistic omnivores, eating a variety of fruit/berries and meat. Although they may track down a live rabbit or two, the larger sources of meat are usually



carrion. Scattered bones are often a sign that a Coyote has had a feast. On page 14, Coyote scat tells a story of hard times. The Coyote which left this scat was down to the hide of a dead cow. If scat like this is greater than ¾ of an inch in diameter, you can safely rule out fox. Coyotes will often leave scat along a trail and especially at trail junctions where quite a bit can accumulate.

Whether the Mimbres petroglyph to the right depicts a wolf or a Coyote track is open for conjecture. Black Bear can be ruled out because there are four, rather than five, toes.

The Mimbres, as well as other indigenous peoples, were keen observers of the natural world. For all of their artistic flair, the petroglyphs and images on pottery which they left behind can often be identified very precisely and the image can be identified to species. Sometimes the art is overwhelming and pierces the heart. The tracks on the following page climb up the side of a large boulder in Frying Pan Canyon at the south end of the Black range. When you come upon them it is startling. A track in the sand can be very informative; a thousand-year-old track on a rock wall can evoke an entire set of feelings which are humbling.

There are many reasons that people want to understand the natural world. One is that they want to understand how they, as individuals, and we, as a species, fit into the scheme. Were the Mimbres trying to do the same? Or were they just doing art? Maybe that is all part of the same process.



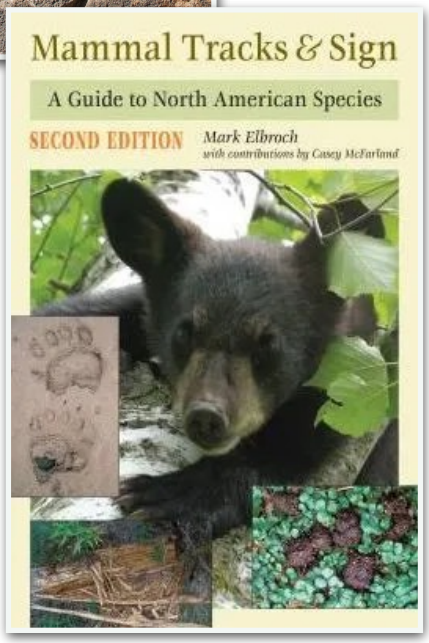
A track can very significantly, even when made only feet apart, depending on the substrate.







Frying Pan Canyon
2/30/2013









Above: Wild Turkey Track, Middle Percha west of Kingston. August 26, 2013.
Right: McKnight Cabin, April 23, 2015
Below: Percha Creek, December 3, 2014







Quail and turkey tracks look very similar. Quail tracks are smaller and generally in much larger concentrations. Bird tracks, generally, are difficult, and (unfortunately) the best way to identify them to species is to see the bird make them. At least that is my (uneducated) take on the topic. Others disagree.

The naturetracking.com website has an extensive photo guide to tracks, including bird tracks, and other sign.





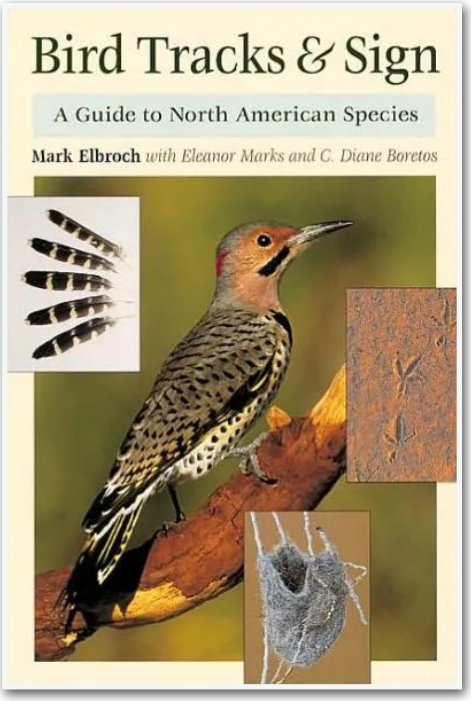
Puerco Black-and-White
1030-1200 CE
Pueblo I - Pueblo II Periods

Elbroch has published a variety of tracking books with various authors. The link at the lower right of the book will take you to Barnes & Noble. - there are many other sellers.





Wild Turkey were domesticated by the indigenous peoples of the Americas. The pottery to the left is a depiction of a Wild Turkey from southern Mexico.







Coyote scat. The Coyote was probably feasting on an old cow hide. The hair is coarse and there is no sign of "meat" in the scat. Coyote scat is often found in connected segments. March 2023.



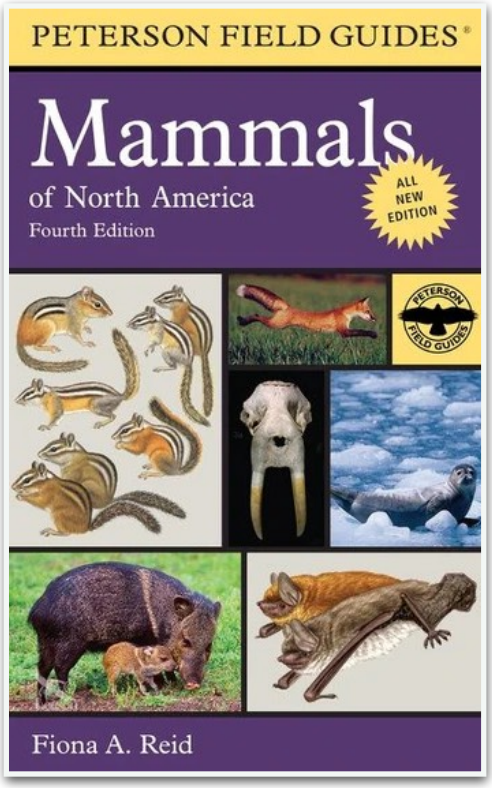


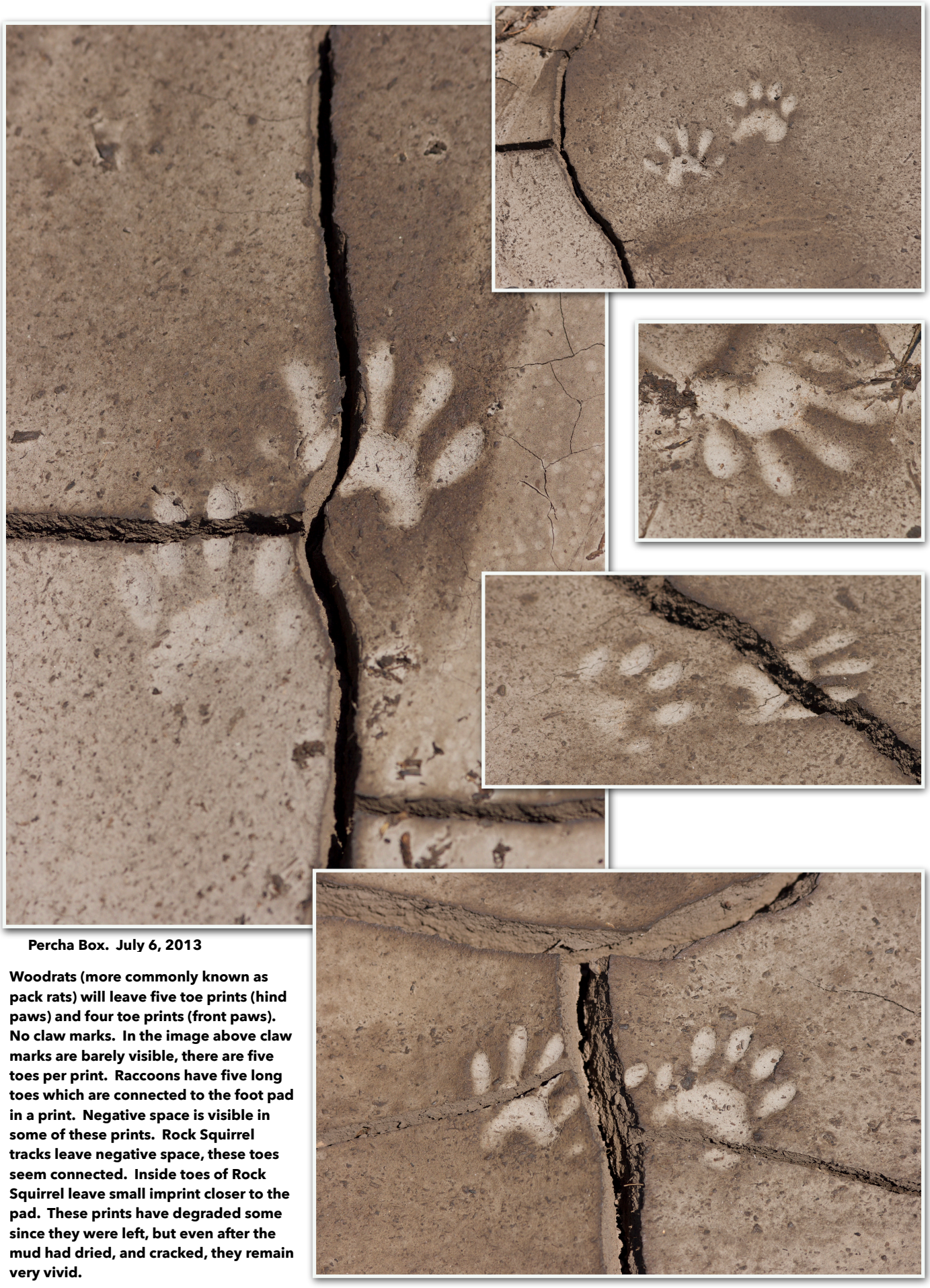


Probably the most common bat found in Hillsboro, New Mexico is the Pallid Bat, *Antrozous pallidus* (photo above). Telling the scat of a Pallid Bat (right image) from that of another bat species is almost impossible without some sophisticated analysis or lucky field observation. When fresh, this scat will be black, very dark, and very obvious. Although bats will defecate just about anywhere, the place they do it most often is below their roosts. If you find such an accumulation, there is a reasonable chance that you will be able to find the bats above the scat site at some point.

As with many sign, scat can tell you part of a story - not all of it, but a significant part. It can be a clue to the identity of the species which left it. The Coyote scat on the preceding page is clearly just that. We know the scat above right is from a Pallid Bat, not because of the scat, but because we saw the bat. In this case, the scat can get us into the right league, not the right ball park (probably a bat, but perhaps some type of small rodent). Scat can be useful in determining what a creature is eating; seed and hair residue often pass through the digestive system without huge transformation. With experience and a bit of natural history knowledge (in this case how particular food sources are digested and what that looks like on the ground) it is possible to determine not only what the animal is eating but perhaps its state of health.

Although with experience it is often possible to identify the species which left scat in your part of the world, this is not always the case.





Percha Box. July 6, 2013

Woodrats (more commonly known as pack rats) will leave five toe prints (hind paws) and four toe prints (front paws). No claw marks. In the image above claw marks are barely visible, there are five toes per print. Raccoons have five long toes which are connected to the foot pad in a print. Negative space is visible in some of these prints. Rock Squirrel tracks leave negative space, these toes seem connected. Inside toes of Rock Squirrel leave small imprint closer to the pad. These prints have degraded some since they were left, but even after the mud had dried, and cracked, they remain very vivid.



Wood Rat (?) or Rock Squirrel (?) tracks, Percha Box, July 6, 2013

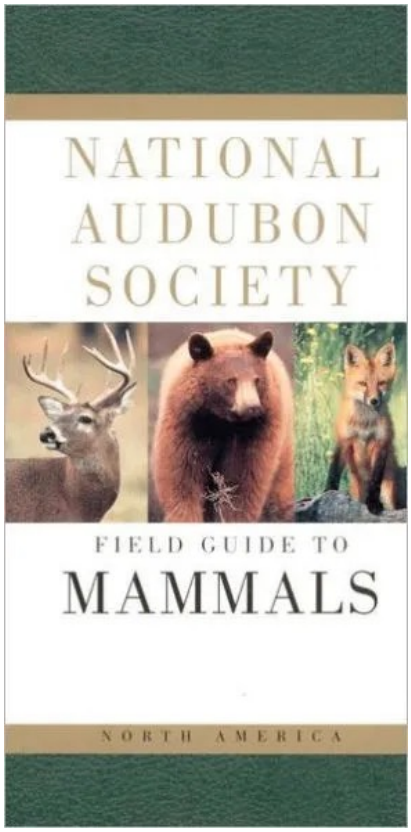


The White-throated Wood Rat, *Neotoma albigula*, shown here was captured during a bio blitz conducted by NMSU at Broad Canyon near Rincon, NM, on May 15, 2011. Note that the nails are at the upper part of the toe and would normally not print, even in soft mud.



The various field guides have different strengths and weaknesses, and you will probably find that you would like to have more than one on hand.

The National Audubon guide has a nice set of outlines for everything from species shapes to skull images and track outlines - as well as a nice set of species accounts.





The prints in the photograph above were probably left by a skunk. Note the five toes (those on the outside quite distinct from the three in the middle) and the pad lobes. The two photographs to the right were taken on the same day at the same location. All three show definite claw marks, all three show a complex pad with several areas which make a more significant imprint than the rest, and all three show rather distinct toes. It is possible, however, that the prints in the photographs to the right were made by a *Spermophilus variegatus*, Rock Squirrel - there are apparently only four toes.

The photographs of the wood rat prints (pp. 16-17) and the prints shown on this page suffer from a common lack of information. There is no apparent scale, you can guess from the matrix, but that is all it is. Regardless of the beauty of the lower left print in the bottom photograph, it is left as one likely made by a Rock Squirrel.

Sets of prints like these can tell you the stride of the animal and, therefore, its probable state of mind. Was it ambling and undisturbed, was it running straight and fast (fright or chase?), was it running every way but straight (being chased, giving chase)? Identification of the print to type of animal and careful observation of its stride can tell you a great deal about what happened at your feet sometime in the past. Mark Elbroch's book (see earlier) includes an extended discussion on how to read a set of tracks.



Percha Box. July 6, 2013



There will always be tracks which leave you with an feeling of "oh, well". The number of tracks which leave you with this feeling will diminish with experience but there will always be some.

The tracks on the following page fall within this category for the editor.



Percha Creek east of Hillsboro - Aug, 9, 2013



Ready Pay Gulch, October 13, 2022. Among the possibilities - a walking stick.



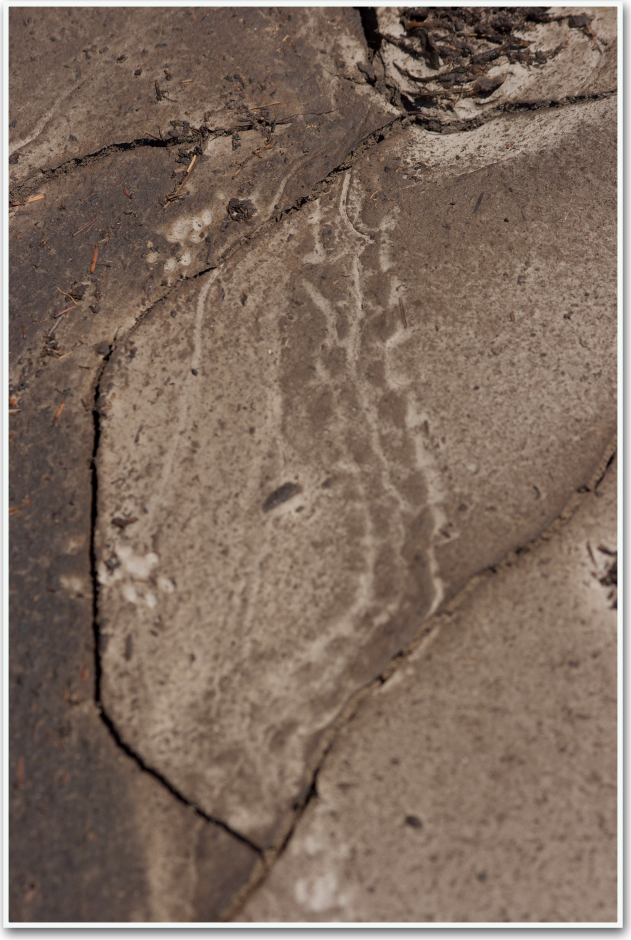


White-nosed Coati tracks, Southwest Canyon, east slope of the Black Range, March 7, 2021

After a White-nosed Coati, *Nasua narica*, was observed along NM-152 west of Kingston and above Southwest Canyon, a trip into the canyon was made, revealing this set of tracks in the melting snow. Again there is no scale and the melting snow has made the tracks less than distinct. The loping stride is apparent, however, and the tracks are unfamiliar - leading to the identification of these tracks as probable White-nosed Coati.







Above: Berrenda Wash, August 2023
Right: Percha Box, July 6, 2013

Go to any wash in the Black Range and you will see marks in the sand, usually indistinct. Long furrows, often disjointed. Generally these are the tracks left by the tails of lizards - and given the dry sand and rock substrate, footprints are rarely present. Or, they may be the trails left by snakes. In both instances, the more compact the substrate the less likely it is that there will be tracks and, if present, that they will be recognizable. This type of track is less common during the winter when the reptiles are hibernating.

The ability of a creature to leave a mark in substrate can be very deceiving, however. The image at the upper right is most likely a (insert answer), in soft mud. At first glance it is the type of track left by beetles. But look at its size. Look at the paw prints on the left. If it was a beetle, it might be undescribed.







If the substrate is not likely to provide you with the tracks that you wish and you don't want to leave things to chance, you may wish to try this simple and inexpensive tool. Find a length of conduit, something with a flat bottom and you may need to use some of that duct tape you have lying around to tape several sections together - see above. In the bottom of the conduit, place paper and ink pads as shown to the left, as many or as few as you wish. Creatures running through the conduit will leave nice prints for you to study.

Sign like eskers (trail castings) are those tunnels made by voles, pocket gophers, etc., above the ground. The individual which made the tunnel was traveling beneath the snow, and above the ground. As the creature excavates its underground tunnels it has to place the excavated dirt (the casting) somewhere. What better use of this material than to use it to line the tunnels they make beneath the snow. When the snow melts the tunnel infrastructure remains, providing a fascinating glimpse into the winter lifestyle of the individuals who made them. The size of the eskers and the entrance to any tunnels that you encounter are good indicators of the size of the animal involved, and depending on the species distribution in your area may allow you to make a species specific identification.

Sign does not always rise to the level of recognition in our minds. Take spider webs, for instance. Find a spider web, find a spider, and from the web it is possible to discern much about the lifestyle of the creature that made it. There are spiders that live in burrows, there are spiders that build loose webs, there are spiders that build elaborate webs. Each species' web is a key to the natural history of the species which made it. See Volume 5, Number 4 (October 2022) of this Journal for an article about some of the spiders found in the Black Range.





Using Cameras to Document Natural History

Cameras have increasingly become a basic tool in the study of natural history. Take a look through any issue of The *Black Range Naturalist* for affirmation of that fact. In Volume 4, Number 4 (Oct. 2021) of this journal we explored some of the history of





Vole eskers after melting snow, Hillsboro Peak Trail, Black Range, March 13, 2017

the use of this tool (see "The Camera and Natural History - William L. Finley", for instance). In that same issue, as well as in several others, we discussed how use of the trailcam has become standard technology in the study of natural history. See "Trailcam Photography", "The A-Spear Trailcams", "Trailcam Case Study", and "Trailcam Skunks". The last article was a survey of the skunk species in the Black Range; the images in that article were drawn almost exclusively from the photo library of Travis Perry's research in the Black Range. In the April 2020 (Volume 3, Number 2) issue of this journal, Harley Shaw reported on the use of a trailcam to survey the activity at a kangaroo rat mound. The photograph to the right, of a Bobcat at the site, was taken from that study.

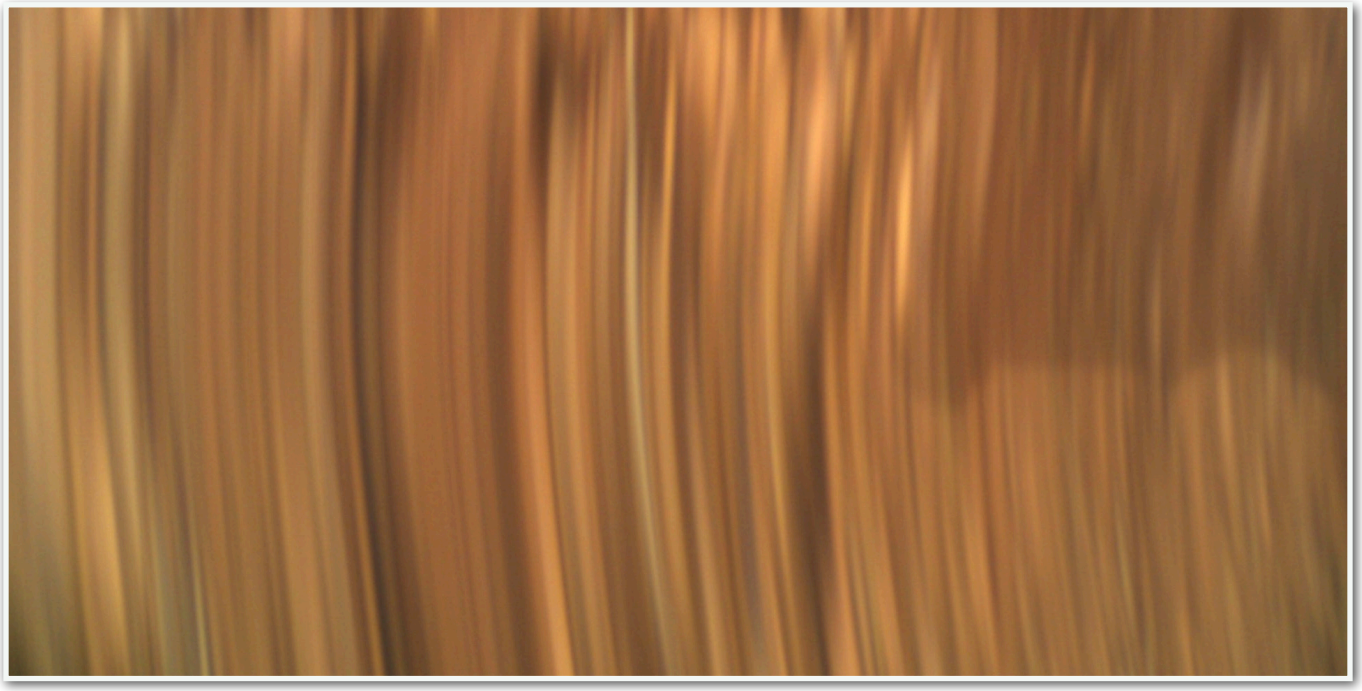


The middle photograph at the right is an image from Travis Perry's research trailcam array. You might think that it illustrates predator/prey, natural history of the two species, animal movement at specific hours and at various times of year. Sure, it illustrates all of that, but it is included here because it illustrates the fact that you never know what is going to show up in the photographs and video taken by a trailcam. The role of serendipity in science should never be discounted.

Elsewhere in this issue we discuss the interplay of art and science. Be open to the fact that your trailcam is going to get messed with by the subjects you are studying. Step back when that happens and just consider it art. (See below for an image from a trailcam "documenting" the activity of a Black Bear.)

Unlike many other camera systems, decent trailcams can be purchased for less than $100 US.





Increasingly, drones are being used in natural history research and in the presentation of the results of that research. The drone to the right was used in the production of *Trailing With Toasty*, a production about Harley Shaw's survey of the natural history of the Black Range, with his beagle Toasty.

And of course cell phones and cameras of various types can be used for art and documentation. On a regular basis the occasional photograph on an outing becomes part of the documentation of some study. Not that anyone will really doubt a Mountain Bluebird on the Hillsboro Christmas Bird Count, but photographs of ladybird beetles on Sawyer's Peak always make a nice addition to citizen science sites like iNaturalist.















Volume 4, Number 2 (April 2021) of this journal featured a cover photograph from a series on "shrike caches". Loggerhead Shrikes (*Lanius ludovicianus*) hunt and feast in the Black Range. This species gets one of its common names, Butcherbird, from its caching behavior. It hunts many small creatures: insects, birds, mammals, amphibians, and reptiles. It will often cache the corpses of its prey on something with sharp spines. That might be a barbed wire fence, a mesquite, anything which has lots of spikes to empale its prey on. Coming across a cache of this sort tells a story about the natural history of the area. In the case of the image to the right, a Loggerhead Shrike has hunted (and eaten) *Phrynosoma modestum*, the Roundtail Horned Lizard (see the following page and the Black Range Naturalist Volume 6, Number 1).

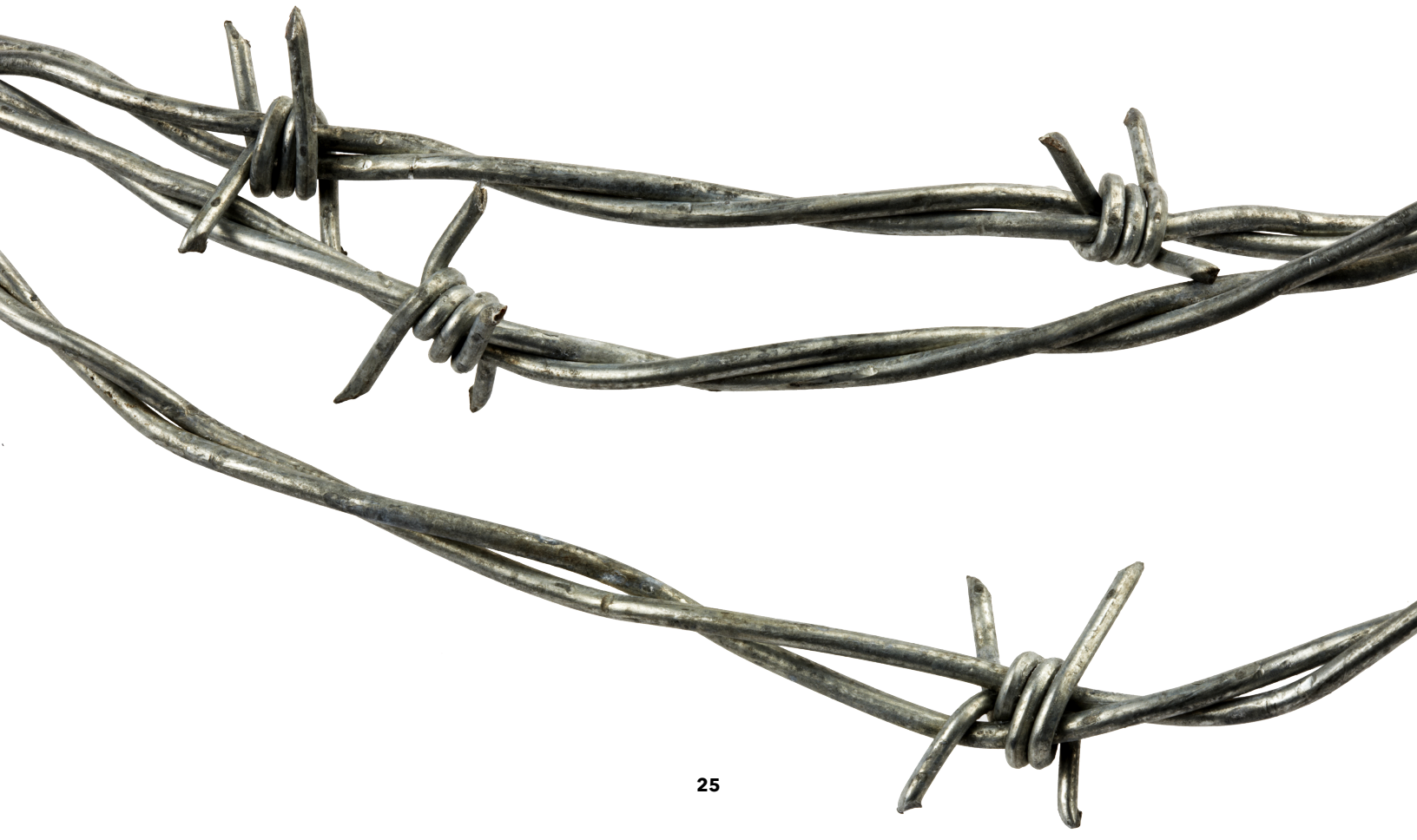


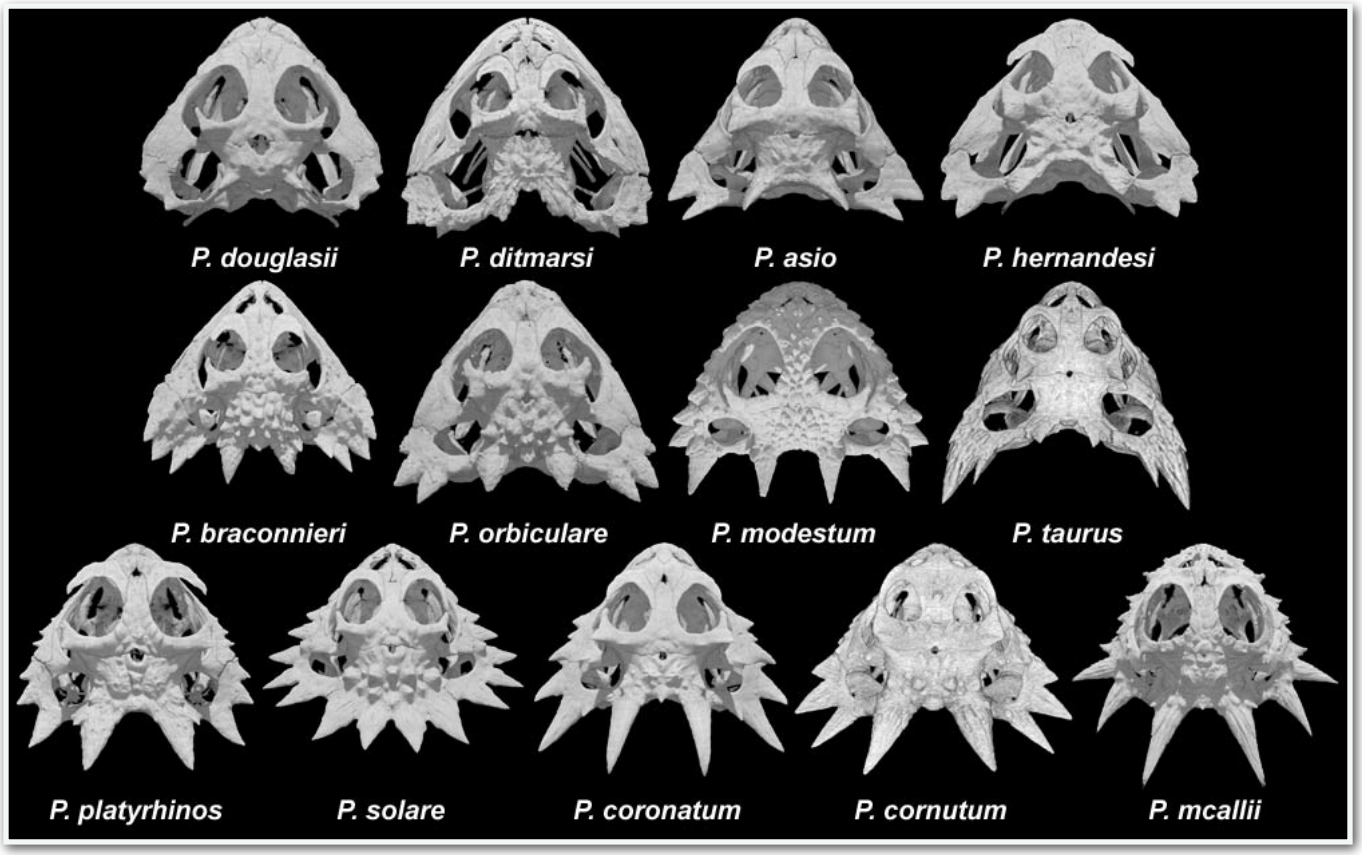
It is obvious that bones, including little lizard skulls, are signs of animal activity. They are useful in the identification of the species involved (see paragraph above) and they can tell a story - perhaps. How did the creature die? How long ago did the creature die (here we are not discussing carbon-14 dating but rather how much the flesh has decayed)? If the creature was killed, how did that happen and by what? A careful examination of the bones may leave you stupefied or with a bit of poignant history.

Barbed wire fences have ruined many a pair of jeans, are loathsomely absent on the free range, kill many a bird, and injure many a mammal. They are also a great place to look for sign. The most common sign to appear on a barbed wire fence is fur (attribution for image below). The remnants of a mammal's encounter with the human world. Fur can be difficult to identify to species: for proof of this statement, take the quiz at The Trapper magazine. For that reason, if you find a bit of fur caught on a barb, look for tracks and other sign to aid in identification.

Fur can present sign of a different type. In the bottom image on the following page the head and neck of a deer show teeth marks on the throat. Harley Shaw, who provided the image, noted, "I think that this was a deer killed by a young lion, hence the rather messy job of killing the deer."

On occasion observers will note a patch of missing feathers on a bird they are watching. At times it is obvious that they are not missing because of molt. In most cases, the bird has escaped a predator. Sit back for a moment and imagine the sequence of events. That can be a humbling experience. Looking for sign is more than looking for tracks, it is immersive.

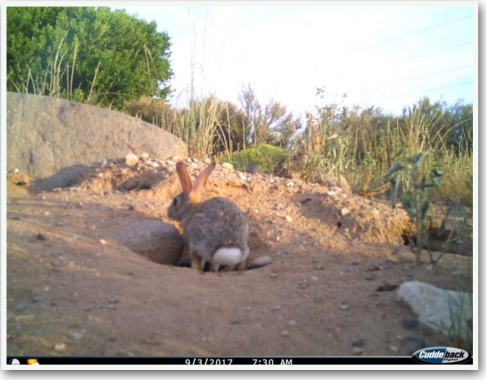




Attribution. The National Science Foundation Digital Library at the University of Texas at Austin.



The places that animals lie down to rest or sleep are often obvious. In "On the Shape of a Form" (Black Range Naturalist, Volume 3, Number 2, April 2020) Harley Shaw used trailcam images (right) and the Black-tailed Jackrabbit photo below to describe the "forms" which rabbits and hares use when resting and sleeping. He also did a bit of etymological research as well to ferret out how the term came to be used, sorting out views of natural history along the way.



However, care should be taken in assuming that such depictions are natural history, or even solely artistic, illustrations. For example, the rabbit shown below on a Mimbres bowl may be a reflection of religious beliefs. The rabbit in the moon is an integral part of the belief system of indigenous peoples from throughout the Americas (as well as in Japan, China, and Southeast Asia). Apparently this particular set of beliefs is very old.



Earlier we included images of pottery and petroglyphs from the Mimbres culture to illustrate how people in earlier times viewed the natural world. Such artifacts are important resources in understanding natural history. By seeing how other peoples viewed the natural history (of their world) we can learn more about ours.













When using ancient human materials, extra care is also necessary not to assume that you and the makers of the material share a common understanding of what the world is like. Shifting baselines are often overlooked when doing temporal comparisons of material. For instance, humans have a history of driving other species to extinction or of extirpating them from particular areas. In our area, for example, the indigenous peoples of the Pleistocene played a major role, perhaps the major role, in driving much of the megafauna of the Americas to extinction. (See "Pre-Younger Dryas megafunal extinction at Rancho La Brea linked to fire-driven state shift", *Science*, Vol. 381, issue 6659, 18 August 2023, p. 746.) Later the call was taken up by the Europeans. In the *Black Range Naturalist* of January 2023, Volume 6, Number 1, we discussed the role of Europeans in extirpating the Grizzly Bear from the Black Range. In our next issue we consider how close they came to doing the same to the American Beaver. It is not clear which group was responsible for extirpating the California Condor (below) from this area.



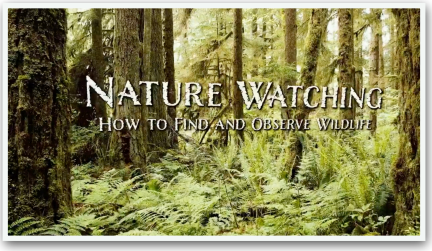


When using this type of information to discern the natural history of the past, care should be taken not to introduce cultural bias. Fish illustrate this well. The thinking about the fish depicted on Mimbres pottery and in their petroglyphs has been "inconsistent". Everything from "they don't know what they are drawing" to "the area rivers must have had much larger flows in the past - to accommodate larger fish". However, recently many of these depictions have been identified to species, species from the Gulf of California. They are evidence of long range trade.

See the various articles in the *Black Range Naturalist*, Volume 3, Number 1, January 2020, for a more detailed discussion of the issues noted above. In the next issue of this journal we continue the exploration of "tools of the trade".

Other Resources

A few resources are referenced below; in some cases they have been cited earlier. We have no commercial interests in any of them.



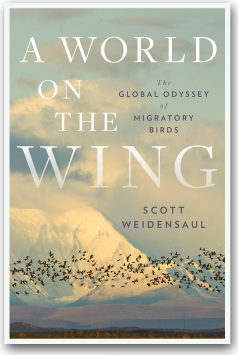
Wondrium Course: This 24-lecture series presented on Wondrium by Casey McFarland receives the personal endorsement of our editor. Bio from course: "Casey McFarland is a Senior Tracker and Evaluator for CyberTracker Conservation, a nonprofit organization that educates and certifies professional wildlife guides and amateur naturalists around the world." He is also a wildlife guide and naturalist. He coauthored the Peterson Field Guide to *North American Bird Nests and Bird Feathers: A Guide to North American Species*, and he contributed to Mark Elbroch's *Mammal Tracks & Sign: A Guide to North American Species*. McFarland's website also has a lot of information about how to develop tracking skills - https://www.caseymcfarland.net.

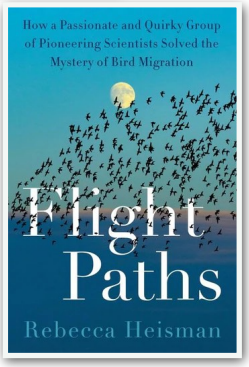


And, of course, there is YouTube for those of you who want to watch ads. Jonah Evans video (above) is excellent.

Bird Migration Must Reads

If you have an interest in bird migration, there are two books which will awe you, dumfound you, and generate immense feelings of respect and appreciation. Scott Weidensaul's *A World on the Wing* explores the mechanics of bird migration with a heavy emphasis on the physiological changes which birds go through in their lives. Having body parts shrink by 90% in preparation for a trip makes TSA hassles seem trivial, for instance. Rebecca Heisman's *Flight Paths* explores the topic from a different perspective. How is it that we know what we know today? She explores the history of research in bird migration. It is a wonderful tale of cross-disciplinary collaboration, a bit of serendipity, and grueling hours of tedious hard work.



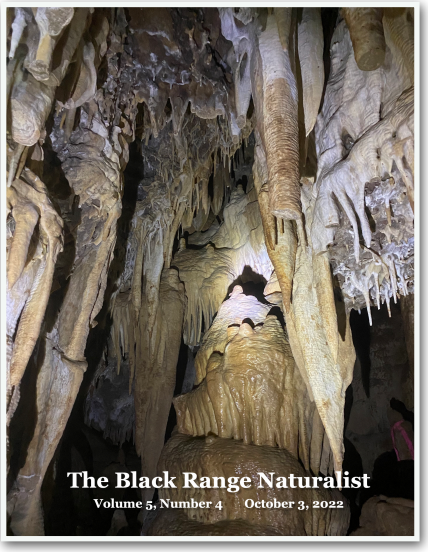


Robinson's Cave
by Bob Barnes

On September 20, 2023, Steve Morgan and I ventured into Robinson's Cave on the north slope of the North Percha Creek canyon. The cave entrance is at the bottom of a large limestone formation. The trail follows the base of the cliff for a while and then a scramble up a short pitch (photo top right) brings you to the entrance to the cave. The cave is a walk-in (middle right), and much of the cave is characterized by fairly large open areas. Of course, a bit of crawling, sliding, groaning, and cursing is called for along the way. There are persistent reports of javelina using the cave. We saw tracks and scat but nothing with tusks. Most reports on this cave will mention little mud sculptures made by earlier visitors - we did not bother to look.



In our October 2022 issue (Volume 5, Number 4) we described Coffee Cave, which is approximately two miles to the southwest of Robinson's Cave.



Follow the link to read a discussion of what is a different caving experience. Both caves are in the same geologic strata, both are situated at the base of a large limestone deposit, both have dry and wet areas. Coffee Cave is gated, the key is available at the Black Range Forest Service District Office in Truth or Consequences. Robinson's Cave is not gated but has javelina. Please do not dismiss an encounter with a group of javelina in a cramped narrow passage as insignificant. It could be quite exciting - in a bad way.

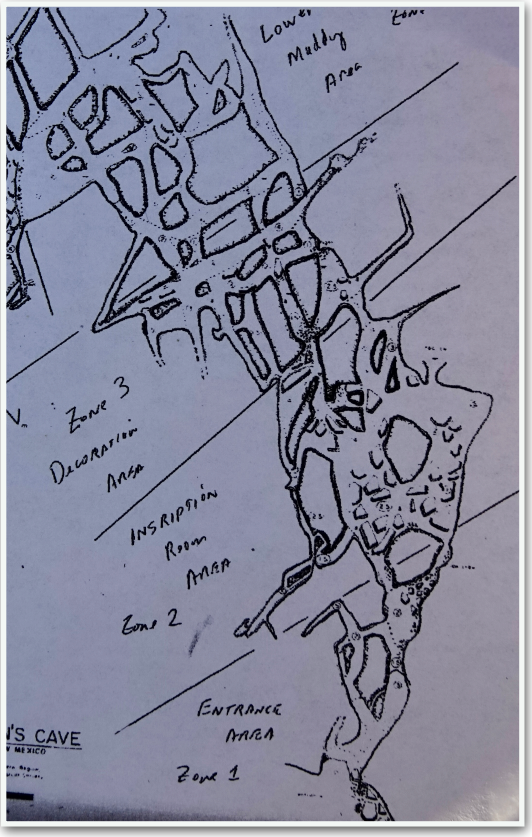






Coffee Cave is more strenuous than is Robinson's Cave, but there is a longer and more vigorous walk to get to Robinson's than to Coffee. Given the presence of these caves, there is no reason to doubt the presence of others in this formation.

Although a good deal of the substrate is rocky and dusty in Robinson's Cave, there are some fairly large areas where it is muddy, wet, and slippery. There are occasional pools and speleothems (all those mineral deposits forming into stalagmites, stalactites, columns, etc.) which are both actively forming and those which have gone "dormant". This cave is characterized by a great deal of breakdown (rock which has fallen from the roof or sides of a cave), most of substantial size. The limestone is heavily layered in this stratum and it may be that an earthquake resulted in a catastrophic breakdown event a few million years ago. In any case, recent evidence of small collapses is present. Most of this is probably the result of moisture seeping through the rock, especially along the seams.





This is a nice-sized cave for the Black Range but quite small by world standards. The map shown above (a portion of what is available from the USDA Forest Service, Black Range District office) shows the confusion which can result from a cave where there is a lot of breakdown. Especially on the ground (literally) it can be difficult to determine your exact location. Someone has painted arrows to lead the way in and out. Be sure to bring lots of light and backup light.



The Glossary of Cave and Karst Terminology refers to the speleothem shown at the upper right as a "straw" and notes that it is a thin-walled tubular stalactite. More commonly it is called a "soda straw" (a.k.a. "tubular stalactite"). Soda straws are hollow tubes of calcium carbonate (in this case) or

calcium sulfate. As each drop of water seeps through the rock above, it dissolves calcium carbonate; this solution seeps down the straw and deposits a bit of calcium carbonate at the edges of the straw. This is a slow process. A straw like that shown on the preceding page can take a very long time to form. (This one may be about 100 years old - estimated length 3" - growing at less than 2 mm a year.) This straw is very even in diameter throughout its length. However, variation in water flow can make a soda straw uneven in diameter along its length. Soda straws are very fragile and can break under the weight of their own structure. If a clueless caver or javelina touches it, it will shatter. If the end of the tube becomes blocked, water will seep down the outside of the soda straw and the structure will become a more traditional stalactite.



Below this particular soda straw, a stalagmite (showing a slight greenish hue in the photograph at the bottom right on the preceding page) was formed as each drop of water fell a couple of feet from the straw above.

Elsewhere in the cave, drops of calcium carbonate-laden water were dropping from stalactites. Note the sheen of water on the outside of the formation (upper right).



A (rather poor) video of water dropping from stalactites and some flow material may be seen on the Vimeo hosting portfolio for this journal. Additional photos from this outing may be viewed on the Black Range website.

In some locations there was enough water that it pooled. In nearly all cases, there were small sections of flowstone (bottom right) above and/or below the pool. Flowstone, like most other cave features, can be easily damaged. Touching an area

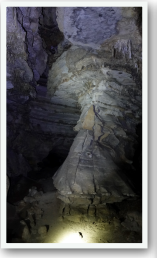




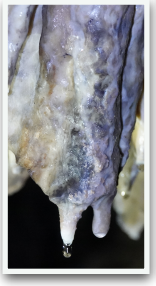
of flowstone can leave a bit of oil from your hands. Water will flow around this bit of oil, and that section of flowstone will dry out. There are many ways to damage a cave. Not all are obvious.

Soda straws are tiny. At the other end of the spectrum some of the stalagmites in the cave are fairly large.







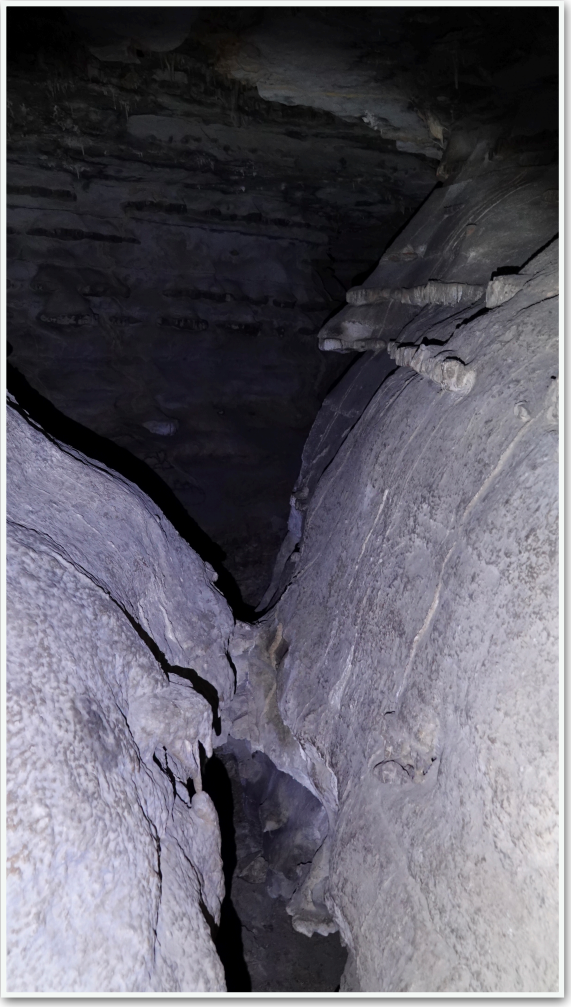








The section of rock shown above will soon become part of the breakdown on the floor.













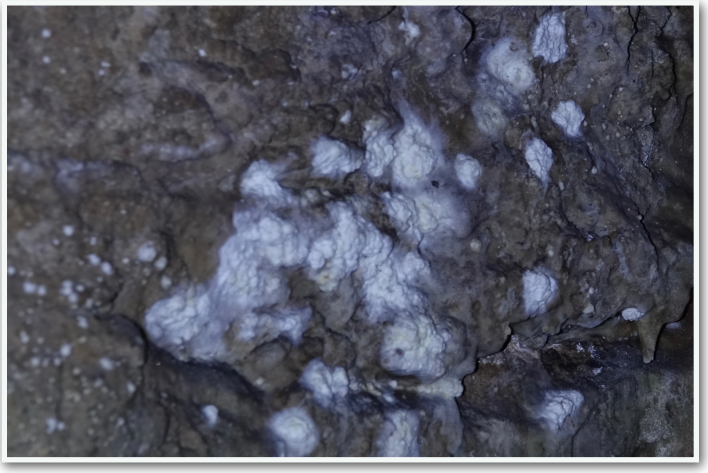


Much of what you see in a cave can be gray, or brown, or if there is no light - black. Add a little light, however, and the rock can come alive with soft hues. No need for artificial colors here. At the right, Steve Morgan works at lighting an object. Most of the photographs in this article were made with a standard camera, some were made with the camera on cell phones.



In a portion of the cave we found what I took to be undifferentiated calcium carbonate (below right). The stars of the cave, including helictites, are shown below and on the next two pages.

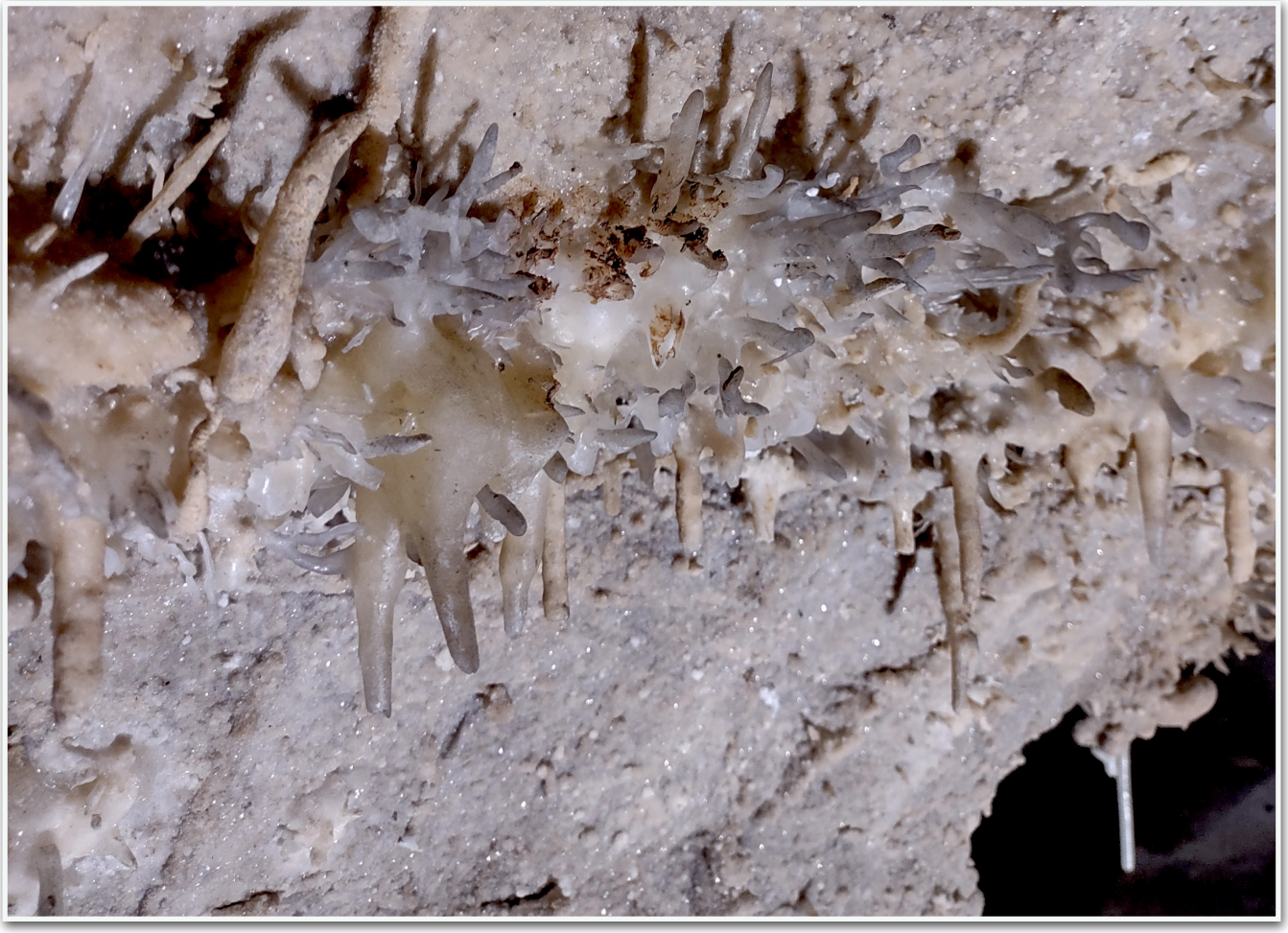








Helictites are speleothems which do not form vertically. They seem to go this way and that. Some have suggested that capillary forces acting on the water droplets are stronger than the force of gravity at this scale. Perhaps. Some authorities assert that these are the most fragile of all cave formations. Lucky are we to have them in the Black Range.











The Problem With Popular Field Guides

These photographs from James Von Loh, of Strawberry Cactus, *Echinocereus stramineus*, were taken on Tortugas Mountain on the eastern outskirts of Las Cruces in April and May of 2019. That is not quite in the Black Range but they illustrate an issue which is prevalent in most popular field guides - plant, mammal, bird. A species is the name we give to a population of something. We deem all of the individuals in the population to be the same species. But all of the individuals in that population are not the same, they will have a range of attributes. That range may be recognized by the establishment of subspecies, varieties, groups, or some other designation, or it may not be formally recognized. Field guides often provide only the "type", the normative value for the species, and fail to provide information about the outliers. Even very technical papers can fall prey to this disorder. With study and careful observation, the individual naturalist can become comfortable with the range of variability which he/she encounters. Sometimes we have enough knowledge to say "I don't know". Jim attributed the green growth to a viral or fungal infection. He noted that none of the flowers produced viable seeds, the flowers just withered and died. A field guide can get you just so far; a history of observation is definitely additive.







Dragonflies: The Clubtails of the Black Range

In this issue James Von Loh continues his series on the dragonflies of our area, reporting on the sightings he has made in Doña Ana County. Here he focuses on the Hanging Clubtails - *Stylurus plagiatus* (Selys, 1854), the Russet-tipped Clubtail, and *Stylurus intricatus* (Hagen in Selys, 1858), the Brimstone Clubtail.

He follows with a discussion of the Ringtails - *Erpetogomphus designatus* (Hagen in Selys, 1858), the Eastern Ringtail, and *Erpetogomphus compositus* (Hagen in Selys, 1858) the White-belted Ringtail.

Although there are several Clubtail genera, here we address only the two genera discussed in the following article. In the genus *Stylurus* (the Hanging Clubtails), only the Russet-tipped has been reported in Sierra County, near Elephant Butte Lake Dam and at Caballo Lake State Park. This species has also been reported from Broad Canyon in northern Doña Ana County. It has been found farther north along the Rio Grande. The Brimstone Clubtail has been reported from Bosque del Apache and farther south along the Rio Grande.

Other sightings of the Ringtail species covered in the following article include an Eastern Ringtail from Percha Dam State Park and near Elephant Butte Dam and a White-belted Ringtail at Broad Canyon in northern Doña Ana County.

In addition to the two Ringtail species reported on by Jim, other species have been reported from our area: **Serpent Ringtail**, ***Erpetogomphus lampropeltis*** from San Lorenzo (Grant County) and at the River Ranch Wildlife Management Area south of Faywood along the Mimbres; and a **Dashed Ringtail**, ***Erpetogomphus heterodon***, at the Royal John Road crossing along the Mimbres, at the River Ranch Wildlife Management Area south of Faywood along the Mimbres, at the Alamosa Warm Springs (Socorro County), and near Grapevine Campground along NM-15 on the west side of the Black Range.

These reported sightings are tantalizing and are reason for naturalists in the Black Range to closely monitor dragonfly populations for these species.

Other species in these genera

(From BugGuide)

Genus *Stylurus* (Hanging Clubtails)

S. amnicola - Riverine Clubtail
S. intricatus - Brimstone Clubtail
S. ivae - Shining Clubtail
S. laurae - Laura's Clubtail
S. notatus - Elusive Clubtail
S. olivaceus - Olive Clubtail
S. plagiatus - Russet-tipped Clubtail
S. scudderi - Zebra Clubtail
S. spiniceps - Arrow Clubtail
S. townesi - Townes' Clubtail

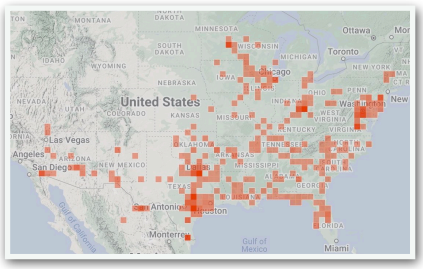
Genus *Erpetogomphus* (Ringtails)

E. compositus - White-belted Ringtail
E. designatus - Eastern Ringtail
E. elaps - Straight-tipped Ringtail
E. eutainia - Blue-faced Ringtail
E. lampropeltis - Serpent Ringtail
E. crotalinus - Yellow-legged Ringtail

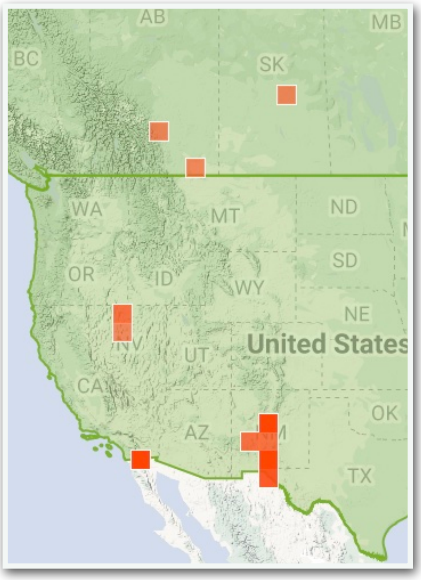
Gomphidae (Clubtails)

(This family includes the following genera in addition to the two listed above.)

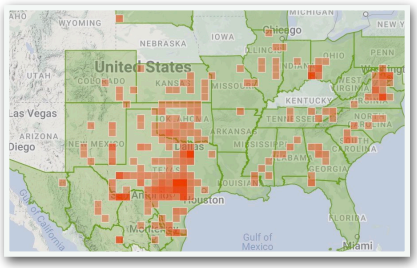
Aphylla - Forceptails
Arigomphus - Pond Clubtails
Dromogomphus - Spinylegs
Gomphurus
Hagenius
Hylogomphus
Lanthus - Pygmy Clubtails
Octogomphus
Ophiogomphus - Snaketails
Phanogomphus
Phyllocycla
Phyllogomphoides - Leaftails
Progomphus - Sanddragons
Stenogomphurus
Stylogomphus



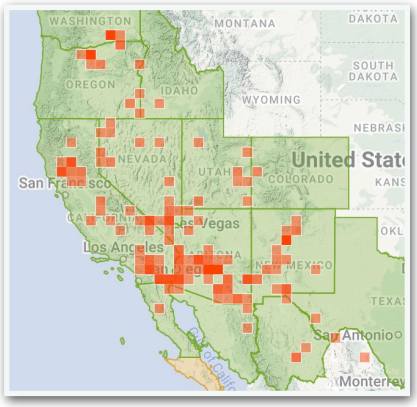
Plot of Russet-tipped Clubtail sightings from iNatualist.



Plot of Brimstone Clubtail sightings from iNatualist.



Plot of Eastern Ringtail sightings from iNatualist.



Plot of White-belted Ringtail sightings from iNatualist.

Dragonflies - The Clubtail Family - *Gomphidae*

by James Von Loh

Hanging Clubtails:
***Stylurus plagiatus* Selys, 1854**
(Russet-tipped Clubtail)
***Stylurus intricatus* Hagen in Selys, 1858 (Brimstone Clubtail)**

Ringtails:
***Erpetogomphus designatus** Hagen in Selys, 1858 (Eastern Ringtail)**
***Erpetogomphus compositus* Hagen in Selys, 1858 (White-belted Ringtail)**

The discussions of dragonflies as individual species and collectively as a taxonomic family, *Gomphidae* (the clubtails), within the order *Odonata* are presented herein. Illustrative images to support each species identification and their associated behavior(s) were collected entirely from Doña Ana County, NM (by the author unless otherwise credited) between 2019-2022.

Habitats particularly attractive to the clubtail family include the Rio Grande drainage along the western community boundaries of Las Cruces and Mesilla, south to Mesilla Valley Bosque State Park (MVB) and its associated irrigation and wastewater canals. Represented herein are adult individuals (clubtails and ringtails), behavior types as defined in *Dragonflies and Damselflies of the West* (Paulson, 2009), and when possible, instances of predation by these dragonflies. Because dragonfly species have an aquatic larval stage that rarely can be photographed in situ, each species presentation, by design, is incomplete (with a gap following egg laying/deposition behavior and before immature dragonfly presence).

Behaviors that may be illustrated within the clubtail family were presented and defined in Paulson (2009), as follows: perching; sleeping; flight; vision; feeding; predators and predator defense; sexual patrol; courtship and mating; egg laying and hatching; larval life history; and metamorphosis and emergence.

Clubtails (including ringtails) are considered the most exciting group of dragonflies by many enthusiasts,



Male Russet-tipped Clubtail (RtC) vertically perched on and hunting from a Johnsongrass, *Sorghum halepense* ([L] Pers.) leaf along the bank of the Rio Grande. Note his expanded S7-through-S10 segments which resemble a club.

because they are alert and fast-flying, and many are rare, local, and have brief flight seasons (Paulson 2009). Even though there is great diversity within the family, their behavior is poorly known; I have only photo-documented one mating pair encounter among otherwise perching, sleeping, and hunting behaviors.

Clubtail morphology and elusiveness present a challenge to photography, e.g., bringing into focus and photographing in crisp detail, due to length, width, depth, color, and behavioral elements. They tend to perch vertically, hanging in a large cross, sometimes horizontally across leaves or near the ground, or they obelisk, perching with their abdomen held nearly straight up. At times, their abdomen tip or club is also curled downward.

Locally, clubtails use the Rio Grande and associated riparian habitats, beginning when the river is flowing bank-to-bank providing irrigation water and delivering downstream water to deliver compact volumes (typically June-September). Construction of the levee and canal system occurred between 1938-1943 under the *Rio Grande Canalization Project,* authorized by congress in 1936 under the 1906 U.S./Mexico convention. The floodplain width (between levee banks) is ~2,100 feet, while the normal flow channel, locally, is ~500 feet wide; the channel capacity is 1,200 cubic feet per second locally with average water depth between 3' and 5'.

When release of water from upstream reservoirs ceases (typically during August-September), clubtails rely on a perennial, low-flow reach of the Rio Grande sustained for an approximately 3.0 km reach down-river from the outfall of the City of Las Cruces, *Jacob H. Hands Wastewater Treatment Facility* (JHH) lined canal. Discharge of treated, disinfected wastewater into the Rio Grande channel occurs ~150m north of Interstate Highway 10 and clear-water surface flow extends south under the Calle del Norte bridge to MVB.

Along this reach, four species of clubtail perched, hunted, sunned, and/or slept, and a pair of ringtails joined in a mating wheel. Common



Male RtC vertically perched on and sleeping on a twig in the shade of Coyote Willow, *Salix exigua* (Nutt.), tall shrubs along the bank of the Rio Grande. Note his widely separated, light blue eyes, white face, and thoracic striping pattern.

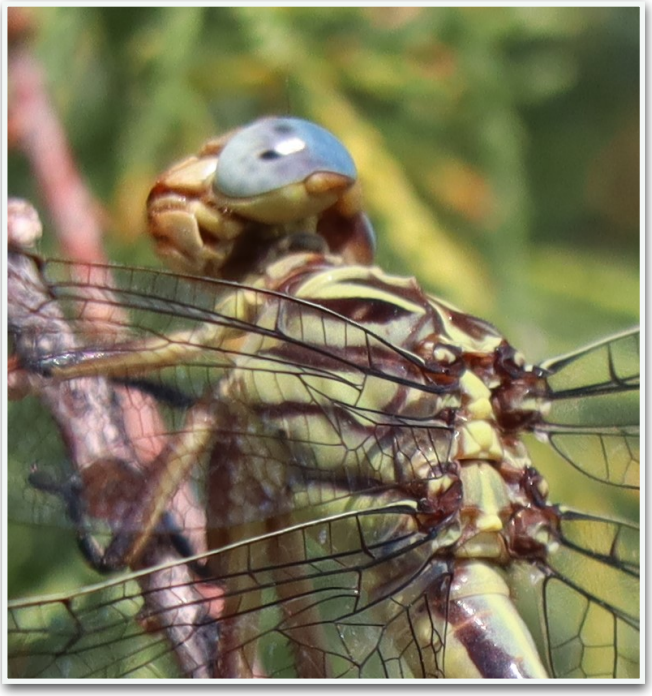


Male RtC vertically perched on and hunting from a small branch of a Tamarisk/Salt Cedar, *Tamarix ramosissima* (Ledeb.) established along the bank of the Rio Grande. Note his high perch site (2.5-3.0m) from the upward angle of the image.

perches were tree branches/twigs, shrub leaves and branches, and leaves and stems of herbaceous grass and forb species. Perching site heights ranged from near ground level to over head-high (~2.5m). Also documented was the presence of a regional variant of Russet-tipped Clubtail that normally occurs in the Colorado Desert of southeastern California and southwestern Arizona. The local clubtail flight season occurs July to October.

Russet-tipped Clubtail (RtC)

I have photo-documented the RtC in three of the past four flight seasons along the southern Rio Grande



Male RtC head and thorax detail. Note his light-to-medium blue eye color, light yellowish face color, and the pattern of brown, vertical stripes positioned nearly directly across from each thoracic segment (T1-T4).

(between the dates of 08/04 and 10/23); they are predominantly observed late in the monsoon season (August/September) locally. However, Paulson (2009) reports the NM flight season occurring between June and August, matching the typical beginning of monsoon season.

As a species, RtC are distributed in two smaller western areas (Colorado Desert of southeastern CA and southwestern AZ and across southern NM) and a large regional distribution from eastern TX north to the Great Lakes and eastward to NY and southward to the Carolinas; RtC also occurs southward from TX into eastern Mexico's Nuevo Leon region (Paulson 2009).

RtC commonly uses slow-flowing rivers and streams; however large drainage/irrigation canals/ditches are used in desert environments at the western end of their range (Paulson 2009). In the eastern portion of their range they occur mostly in trees when not at/over the water surface. Along the southern Rio Grande, they use riparian habitats characterized by herbaceous, shrubby, and small-tree communities in addition to surface water.

Males and females often are perched, hanging vertically in trees and sometimes horizontally on leaves. The males may conduct sexual patrols, flying back and forth over water/breeding habitats (preferring riffles in streams), but I have not observed this behavior to date. Females are rarely observed, and when mating, pairs perch high, at head-height; females rapidly deposit eggs into open water during flights (Paulson 2009). I have been fortunate to observe several perching female RtC in addition to the males discussed in this article.

Right: Male RtC vertically perched on, and apparently sleeping on, a small branch of Tamarisk/Salt Cedar tall shrub established along the bank of the Rio Grande.



Male RtC vertically perched on and hunting from a Palmer's Amaranth, *Amaranthus palmeri* (S. Wats.), flower spike along the bank of the Rio Grande. Note that Palmer's Amaranth, a tall, weedy forb, is common within the Rio Grande riparian zone and may reach 1.5m tall.



Female RtC hanging from/vertically perched on and hunting from a Kochia/Summer Cypress/Mexican Fireweed, *Bassia scoparia* ([L.] A. J. Scott) tall forb (~2.5m tall) growing ~35m from the Rio Grande bank. Note the lack of a prominent club at the S7-S10 abdominal segments.





Left: Female Russet-tipped Clubtail vertically perched on a southern cattail (*Typha domingensis* Pers.) leaf while ingesting a captured insect, likely an *Orthoptera* species (grasshopper, mantis, katydid, etc.).



Female RtC vertically perched on, and hunting from, a Russian-thistle, *Kali tragus* ([L.] Scop.) forb growing near the Rio Grande bank. These round, prickly tumbleweeds are common along the Rio Grande as invasive plants. (Dried individuals break from the root and blow into the riparian zone from adjacent agricultural land.)



Male RtC horizontally perched on, and sunning and hunting from, a dead forb stem lying close to the soil surface along the bank of the Rio Grande. Note he is avoiding gusting wind (to 40mph) by using this low perch located behind a dense stand of coyote willow tall shrubs acting as a wind-break.



Left: Paulson (2009) recognizes a southwestern form of Russet-tipped Clubtail, stating: "Populations in the Colorado Desert (southwestern Arizona and southeastern California) rather different and do not bring to mind "Russet-tipped" when sighted. They are paler overall, with narrower thoracic stripes, middle abdominal segments whitish, terminal segments yellowish rather than russet, and with contrasting brown markings, and abdomen with bold black stripes that give them much more patterned look than their relatives to the east. In this population, eyes quite blue and club wider." I also relied on comments provided by experts who identified Russet-tipped Clubtail images I posted to the iNaturalist site for guidance in my attempts to avoid any identification mistakes.

Here a male RtC, southwestern form, is horizontally perched on, and is hunting from, Whorled/Horsetail Milkweed, *Asclepias subverticillata* ([Gray] Vail) flowers and buds, growing adjacent to the Rio Grande. Note the medium-blue eye color, blue thorax and abdomen base color, narrow and black thoracic stripes, and his expanded club at S8-S10.



Below Left: Male Russet-tipped Clubtail southwestern form perched on, and hunting from, whorled (horsetail) milkweed flower buds adjacent to the Rio Grande. Note his light bluish face, light-to-medium blue eyes, light blue thorax base color, and narrow black (instead of wide brown) vertical stripes.

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Top: Male RtC probable southwestern form horizontally perched on, and hunting from, dried Johnsongrass leaf adjacent to the Rio Grande. Note his mostly yellow and light brown club coloration.

Bottom: Male RtC probable southwestern form vertically perched and sleeping on a dried Climbing/ Twinvine Milkweed, *Funastrum cynanchoides* ([Decne.] Schltr.) stem, draped over coyote willow tall shrubs adjacent to the Rio Grande. Note his narrowed middle abdomen, expanded club, and yellow and brown club coloration.





Brimstone Clubtail (BC)

I was fortunate to photo-document a BC once (09/23/2019) in the past four seasons of photo-documentation inventory along the Rio Grande. As a species, they are distributed patchily in a narrow, diagonal band from northwestern New Mexico to southwestern Texas (this southern Rio Grande observation is somewhat west of the delineated distribution); in the southeastern quadrant of Utah; across the Imperial Valley in southeastern California; in the northeastern part of Kansas in its entirety, plus the western and northern parts of the state; southwestern Iowa; northwestern Missouri; and north of Montana in a linear diagonal in southwestern Saskatchewan (Paulson 2009). The Brimstone Clubtail flight season in New Mexico occurs between June and August, typically the beginning-to-middle of the monsoon season. The individual observed herein was nearly a month outside [September] of the stated flight season.

Brimstone Clubtail behavior includes using slow-flowing and warm muddy rivers and irrigation canals supporting riparian shrub and woodland plant communities. Females are typically observed perched low in shrubs near the water while males tend to perch on streamside shrubs or on logs. The males fly rapidly back and forth, low over water, and sometimes hover (Paulson 2009).





Above: Male BC perched vertically on a Johnsongrass leaf adjacent to the Rio Grande. Note that the club of the BC tail is quite narrow when compared to other clubtail family species. The morning was cool and humid but sunny, following an intense early morning rainstorm. Above Right: Male BC horizontal view (same individual). Site is within 2 meters of the Rio Grande bank.



Detail of the BC male head, eyes, thorax, wing bases, and abdominal segments S1/S2 dorsal view. Note: eyes separated and light blue, face pale yellow, thorax narrow, abdomen yellow with black hourglass markings on sides, but with few other dark markings.

Eastern Ringtail (ER)

Gordon Berman was fortunate to photo-document an ER once at MVB (07/11/2020) along the Rio Grande. Many thanks for contributing his outstanding images to this article. As a species, they are distributed primarily from the eastern edge of New Mexico south through Texas (extending to Durango and Nuevo Leon in the Mexican highlands), and east through Oklahoma, Kansas, Missouri, and Arkansas, to Maryland and Florida; a small area of occupied habitat also occurs north of the New Mexico bootheel (Paulson 2009). The Eastern Ringtail flight season in New Mexico occurs in May-September (before the beginning of the typical monsoon and its end).

Eastern Ringtail behavior includes using sandy and gravelly streams and rivers. Both sexes perch from ground level to head-high and can be some distance from the water. The males fly up and down riffles while occasionally hovering facing into the wind; they then perch on rocks and low vegetation (Paulson 2009). Females oviposit in pools, erratically with a single tap about a meter apart.



Above: Male ER head and thorax detail. Note his pale blue eyes and whitish/yellowish face; thorax is bright yellow in front and on sides, and there are four brown stripes outlining two bright yellow bands with the light yellow belt in-between.



Bottom Right Previous Page: Male Eastern Ringtail facial detail. Note the widespread, light bluish eyes; black ocelli and antennae between the eyes; yellowish (upper) postfrons and antefrons; whitish (middle) postclypeus and anteclypeus; whitish (lower) labrum; and dark, (lowest) mandible. Also note the brown, incomplete stripes on the yellow thorax front that are important in identification within the iNaturalist.org and Paulson (2009) literature sources.

Right: Lateral view of male Eastern Ringtail obelisking while perched on the burned end of a branch in Mesilla Valley Bosque State Park, hunting near the Rio Grande. Note that his club is bent down while perching, a behavior sometimes exhibited by individuals in the clubtail family.

Below: Frontal/dorsal view of male Eastern Ringtail obelisking while perched on the burned end of a branch, hunting near the Rio Grande in Mesilla Valley Bosque State Park. Note his light blue eyes, whitish face, dark stripe on front of his thorax, and dorsal stripe and ring pattern of the abdomen segments (S1-S6).





White-belted Ringtail (WbR)

I have observed WbR in two of the past four flight seasons along the Rio Grande, late in the monsoon season (between the dates of 08/09 and 09/30). However, Paulson (2009) reports the New Mexico flight season occurring between June and August, matching the beginning of monsoon season. WbR are distributed from southwestern Texas and southern New Mexico, northwestward through west-central Utah, most of Nevada, southern California and the Central Valley, and extending from southeastern Oregon into south-central Washington; they also occur south into Mexico's Sonora and Baja California Sur regions (Paulson 2009).

White-belted Ringtails commonly uses open, sandy streams, rivers, and irrigation canals/ditches of desert environments. Males may perch on the ground, among grass and forbs, or in low branches. Both sexes use the water to perch and hunt during the warmer part of the day and use adjacent shrubs and trees to perch and sleep at the hottest part of the day and through the night (Paulson 2009).



Male White-belted Ringtail head and thorax detail with light blue eyes and white face. Note the solid brown thorax stripes against the white-to-light green matrix color.



Male White-belted Ringtail horizontally perched on a Johnsongrass stem. Note that the males have conspicuous abdominal clubs (S7-10) that may be colored a mixture of yellow, brown, and black. The abdomen is strongly black-and-white striped and the wing bases are clear on males.



Male White-belted Ringtail horizontally perched on a tamarix branch. Note his abdomen is black-and-white ringed and the last four segments (S7-10 - the club area) are yellow-to-brownish-black.







Left Top: Female White-belted Ringtail detail. Note her pale blue eyes and whitish face; thorax is yellow to pale green in front and on sides, and there are four thick, dark brown stripes with two bright yellow bands and her white belt in-between.

Left Middle: Female WbR horizontally perched on a low forb emerging from Bermuda Grass, *Cynodon dactylon* ([L] Pers.), has only a slightly wider abdomen tip, colored yellow to brownish-black (S7-10) and preceded by five distinct rings.

Left Bottom: Female White-belted Ringtail horizontally perched on a low branch and hunting for small insects. The white-colored leading edge of each wing is common to the species.

Below: Female WbR facial detail. Note: widespread, light bluish eyes; black ocelli and antennae between the eyes; yellowish (upper) postfrons and antefrons; whitish (middle) postclypeus and anteclypeus; whitish (lower) labrum; and black (lowest) mandible.



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Top: Female White-belted Ringtail perched on and hunting from an ~2.5m tall southern cattail stem. This more vertical perching behavior/form is called obelisking" (Paulson 2009).

Bottom Left: WbR female perched near ground level on a dead forb stem, avoiding strong wind while hunting for insects on the lee side of coyote willow tall shrubs. (Note: distance from flowing water is ~25m.)

Bottom Right: Female White-belted Ringrtail detail of head, eyes, thorax, wing bases, and abdominal segments S1/S2. (Note: the wing bases of females have brownish coloration).

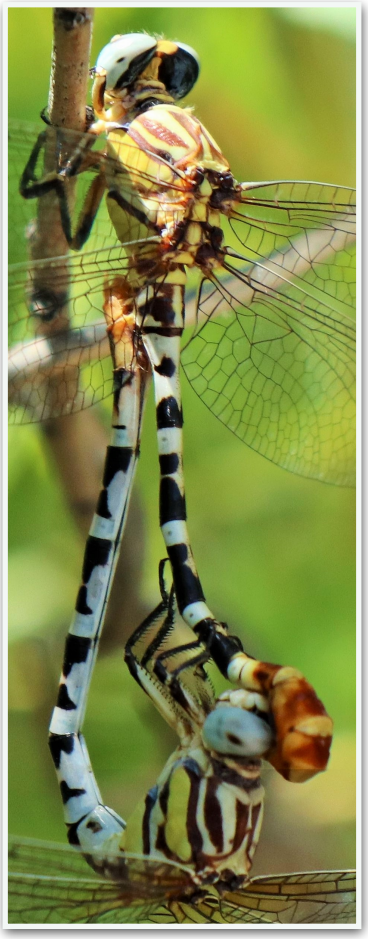








Above: Female White-belted Ringtail dorsal view while perched on (obelisking) and hunting from a dead southern cattail stem. (Note: perch height is ~2.5m as illustrated with upward photograph angle.)



White-belted Ringtail Mating

(Left, below, and on the Following Page)

I have only observed mating within the clubtail family once (08/09/2020). To achieve this stage of mating (mating wheel configuration) required the following behavioral activities: 1) breeding-ready male perching in a likely habitat to locate an





available female; 2) male flying periodic sexual patrols to search for females and perhaps defend a territory by being aggressive towards other males; 3) male locating and grabbing/capturing a female (attaching his paraprocts (located S10) to the back of her head, thus forming a tandem linkage); 4) female must choose whether to mate or not; 5) male sperm transfer from his genital opening (located S9) to his seminal vesicle (located S2); and female attaching her genital pore (located S9) to his penis (located S2); to form the mating wheel (for sperm transfer to her vagina for fertilization of eggs).

Above: Mating wheel lateral view with White-belted Ringtail male (R) and female (L). The pair may mate for an hour or more in this configuration, then disconnect and the female deposits eggs. I did not observe this pair engage in egg-laying in the adjacent Rio Grande.

Preceding Page

Bottom Left: Mating wheel lateral view detail with White-belted Ringtail male (R) supporting the pair and female (L). Note connection of male paraprocts (S10) attaching behind the female's head and her genital pore (S9) joined with his penis (S2) to transfer sperm and fertilize eggs in her vagina.

Bottom Right: Mating wheel dorsal view with male (upright vertical, note his clear wing bases) and female (below, note her brownish wing bases). This pair perched low (<0.5m) on a coyote willow branch, located on the shady side of a dense, tall stand; the afternoon temperature was hot.

American Rubyspot Damselfly
Hetaerina americana
by James Von Loh

These photographs of American Rubyspot Damselfly, *Hetaerina americana*, were taken by James Von Loh on September 18, 2019. A male is shown at the right, male and female in the two images directly below, and a female at the bottom.









Dragonflies: The Skimmer Family - *Libellulidae*

by James Von Loh

Meadowhawks

- ***Sympetrum corruptum*** **(Hagen, 1861), Variegated Meadowhawk**
- ***Sympetrum semicinctum*** **(Say, 1839), Band-winged Meadowhawk**
- ***Sympetrum vicinum*** **(Hagen, 1861), Autumn Meadowhawk/Yellow-legged Meadowhawk**

The discussions of dragonflies as individual species and collectively as a taxonomic family, *Libellulidae* (meadowhawks in the skimmer family), within the order *Odonata* are presented herein. Images to support each species identification and their associated behavior(s) were collected predominantly from Doña Ana County, NM (by the author unless otherwise credited) between 2019 and 2022. For this article, three comparative images collected regionally are incorporated to enhance reader understanding.

Habitats attractive to meadowhawks include the Rio Grande drainage, Mesilla Valley, and surrounding Chihuahuan Desert flats, slopes, and mountains. Because one species of meadowhawk occurs year-around using aquatic/wetland/riparian habitats of the Rio Grande and its associated irrigation and wastewater canals, many of the representative images herein were acquired in the Mesilla Valley. Adult meadowhawk individuals, behavior types as defined in *Dragonflies and Damselflies of the West* (Paulson, 2009), and when possible, instances of predation by these dragonflies, are presented. This article benefited from images of egg-laying adults and larvae that had emerged and made the collection of photographs showing developing, immature Variegated Meadowhawk life stages possible (a gap remains for the aquatic larval life stage).

Behaviors that may be illustrated within the meadowhawk discussions were presented and defined in Paulson (2009), as follows: perching; sleeping; flight; vision; feeding; predators and predator defense; sexual patrol; courtship and mating; egg laying and hatching; larval life history; and metamorphosis and emergence.

Meadowhawks are the only small red (males, predominantly) dragonflies observed over most of North America and across Eurasia (Paulson 2009). Adult female meadowhawks are primarily brownish and can be mistaken for other species, particularly dragonlets; however, there is little overlap in range as meadowhawks are temperate while dragonlets are tropical in origin (Paulson 2009). Variegated Meadowhawks are noteworthy for migratory and wandering tendencies; they may be observed far away from water during migration. A common meadowhawk trait is to perch with their wings projected or "drooped" forward. In addition, all meadowhawks oviposit when in tandem linkage and may fly long distances in tandem between mating and egg-laying sites (Paulson 2009).

Meadowhawks are numerous and relatively calm/approachable and as a result are easy to photograph. Their compactness of form makes it easier to focus and produce images in crisp detail. They tend to perch horizontally, may obelisk (extend abdomen nearly vertically), and often perch on or near the ground. At times, their abdomen may be angled downward from the perch, which usually occurs at the hottest part of the day.

Locally, Variegated Meadowhawks use the Rio Grande and associated riparian habitats year-around and upland habitats as the temperatures warm during the daytime. Peak use occurs from July to October and we documented mating and egg-laying through November. Irrigation and water-compact flows carried in the Rio Grande from June through September enhance the available



Male Variegated Meadowhawk perched on, and hunting from, a twig over the Rio Grande. His abdomen orientation is downward, a behavior often associated with hot air temperature. Note also that his anterior wing veins appear a coppery-red color and may reflect brightly under the sun similar to a shiny, new penny. August 21, 2019

habitat for meadowhawks but are not required, as with many other dragonfly species. Mountain arroyo, slope, spring and pond use reaches peak beginning in August and continuing through October with mating and immature emergence each month.

Meadowhawk species perched, hunted, sunned, slept, conducted sexual patrols, mated, deposited eggs, emerged as mature larvae, and developed into flying immature individuals. Common perches were tree branches/twigs, shrub leaves and branches, leaves and stems of herbaceous grass and forb species, on the bike path and on bare ground, particularly Southern Pocket Gopher, *Thomomys umbrinus* (Richardson, 1829) excavated soil mounds. (See following article.) Perching site heights ranged from ground level to over head-high (~3.0m).

Variegated Meadowhawk (VM)

Variegated Meadowhawks are easily the most common dragonfly species in south-central New Mexico; I have photo-documented them year-around during the past four flight seasons along the southern Rio Grande and during warmer weather in aquatic, wetland, and upland habitats extending from the Mesilla Valley to the slopes of the Organ and Doña Ana mountains; they are observed in large numbers during the monsoon season (June to September/October) locally. Paulson (2009) reports the New Mexico flight season occurring all year.

As a species, Variegated Meadowhawks are distributed throughout the contiguous US, into southern and north-central Canada, and south through Mexico to Belize and Honduras (Paulson 2009). Breeding habitat includes the Rio Grande perennial wastewater and summer irrigation/water-compact (bank-to-bank) flows; ponds (e.g., constructed wetlands, stormwater retention/catchment ponds/basins, local dams and livestock ponds, etc.); flowing arroyos; and seeps and springs. In each habitat they use, areas with adjacent herbaceous, shrub, and/or tree growth are preferred for breeding/egg-laying sites.



Perhaps the most fun you will have in the field is when you spend time photographing the ubiquitous VM; scientific jargon is pushed aside for terms like "cutie", "pal", "buddy", etc. This red-eyed/orange-red-faced male is perched vertically on a twig at knee height, hunting for small insects and likely attempting to locate a mate.

Variegated Meadowhawks typically perch horizontally or they obelisk while hunting/seeking mates from twigs, stems, leaves, low-growing grass and forb species, and



Male VM head and thorax detail. Note the two prominent, yellow spots on his lower thorax, important for positive identification; his orange-red and white-rimmed face; brownish-red over lavender eye color; brownish-green thorax base color; and yellowish stripe running the length of his leg.

and on bare soil. They usually perch vertically when sleeping within shrub and tree stands during the hottest part of the day and at night. Perching Variegated Meadowhawks often drop their abdomen downward during the hottest part of the day. They make frequent flights over water, and following mate selection/mating behaviors, pairs oviposit in tandem while flying low over water and dropping to the surface, where the female "taps" eggs into the water or onto floating aquatic plants during the flights.

Various Variegated Meadowhawk behaviors (perching, hunting, sleeping, and displaying to locate mates) are described in the following section.



Male perched horizontally and hunting/ sexually displaying from a three-square bulrush stem overarching the Rio Grande.



Male perched horizontally on, and hunting from, flower buds of a tall, lavender-flowered mallow (*Sphaeralcea* sp.) growing adjacent to the Rio Grande Trail. VM commonly perch and hunt in the open, from almost any available, open perch at ground level to over 2.0m high.



Male perched horizontally on and hunting from a twig along the Rio Grande. Note the conspicuous yellow spots at the base of its thorax. Immature of both sexes are more vividly marked, including bright white spots low on the abdomen bordered with black stripes and the richer orange-brown bands at segment sutures.



Male Variegated Meadowhawk perched in an obelisking form on a small twig over the Rio Grande. Note his visual scan of a large area in front of the perch and his dark, brownish-red thorax. August 26, 2019



Male VM perched horizontally on, and hunting from, a dried twig adjacent to the Rio Grande. Note his wings projected forward, two prominent yellow spots at the base of his thorax, and the patterned orange-red color of his abdomen.

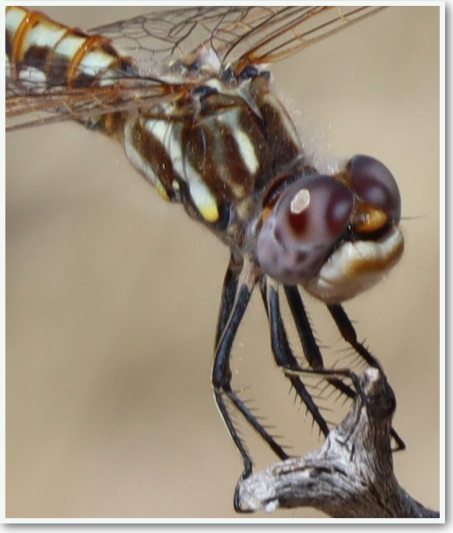


A female Variegated Meadowhawk perched horizontally on and hunting from a dead Creostebush, *Larrea tridentata*, branch on the east-facing lower slope of Tortugas Mountain. The habitat is a desert grassland with low cover from desert short-shrubs; most plants were dormant during the early April timeframe due to drought conditions. Note the prominent yellow spot on her basal thorax and the grayish-green color of abdominal segments between the yellowish-orange cross-stripes.

Following Page, Upper Left: Male VM (upper), a relatively small dragonfly, perched horizontally on a Barnyard Grass, *Echinochloa crus-galli* ([L.] P. Beauv) flowering spike along the Rio Grande. This image provides an opportunity to compare his size and gross morphology versus that of the female American Rubyspot, *Hetaerina americana* (Fabricius, 1798) (lower) a larger-sized damselfly.



Female VM perched horizontally at ground level on a mat of dried grass, leaves, and twigs. VM often perch (and hunt by flying upward to capture prey) at ground level on bare soil and on litter, more so in colder/windy weather conditions. Note how well-camouflaged she becomes over this background.



Female VM head and thorax detail. Note the two prominent, yellow spots on her lower thorax at termini of white thoracic stripes, important for positive identification; her predominantly white face; mostly lavender eye color; brownish thorax base color; and grayish-green dorsal abdominal base color, between yellowish-orange segment sutures.





Above: Female VM perched in an obelisk position on a dried Southern Cattail, *Typha domingensis* (Pers.), leaf tip adjacent to the Rio Grande. She is hunting for flying insects, and may be posing to attract a mate. Note her head placement as she views the space around her.

Middle Left: A male Variegated Meadowhawk, a relatively small dragonfly, perched vertically on rock along the Rio Grande, provides an opportunity to compare his size and gross morphology versus that of the male Desert Firetail, *Telebasis salva* (Hagen, 1861), a near average-sized damselfly at the lower left.



Bottom Left: A male VM, a relatively small dragonfly, perched horizontally on dried Whorled (Horsetail) Milkweed, *Asclepias subverticillata* ([Gray] Vail) fruits along the Rio Grande, provides an opportunity to compare his size and gross morphology versus that of the large milkweed bug, *Oncopeltus fasciatus* (Dallas, 1852) at the lower left. Note that the VM has 'drooped' his wings forward, a trait of meadowhawk species.







A female VM ingests a captured arthropod along the Rio Grande, above. At the right a male does the same.

Band-winged Meadowhawk (BwM)

Gordon Berman and I have photo-documented the BwM in two of the past four flight seasons along the southern Rio Grande (between the dates of 07/17 and 09/06); they are predominantly observed late in the monsoon season (August/September) locally. However, Paulson (2009) reports the New Mexico flight season occurring from June to October, matching the entire monsoon season.

As a species complex, BwM are distributed across the entire western US and southern northwestern Canada, except for the US desert southwest, making our observations southern outliers to the general distribution. Paulson (2009) states: "Western populations of this species were long considered a separate species, Western Meadowhawk, *Sympetrum occidentale* (Bartenef, 1915). Subsequently, intermediate specimens have been found just east of region, but no one has conducted thorough study to document extent of intermediacy. Three subspecies named from west. Much variation, however, and more research needed. Eastern distribution from southern Ontario and Nova Scotia south to IL and NJ, also in mountains to northern AL."

Band-winged Meadowhawks commonly uses permanent open ponds and marshes and sometimes small seepage areas in open or wooded country; they also spend time in grassy meadows (Paulson 2009). Along the southern Rio Grande, they use riparian habitats characterized by herbaceous, shrubby, and small tree communities in addition to surface water; often they are perched on branches from 1.0m-4.0m high.

BwM often are perched horizontally on branches and twigs. They fly back and forth over clearings, some flying 10m high, stopping to hover many times. These may be feeding individuals or possibly they are on sexual patrol (Paulson 2009). Pairs are frequently observed away from water, flying in tandem cross-country. The conspicuous wing colors may help individuals find each other when



Above: Male Band-winged Meadowhawk perched on a small branch while obelisking (raises abdomen nearly vertically upwards), surveying the adjacent habitat, and hunting. Note the bold, extensive orange-brown wing markings beginning at wing bases; also his bright red abdomen. Note also his head position and eyes scanning in all directions to locate small, flying insects to capture and ingest; full display of wing patches may also serve to attract a female to mate.

Below: Male perched horizontally on a small branch, surveying the adjacent habitat, and hunting. Note the prominent black spots on dorsal abdomen of segments S8/S9, also his red-brown over greenish-tan eye colors.



Ovipositing occurs in tandem, in shallow open water, often among emergent plants.

We document BwM perching, hunting, and possibly displaying to locate mates in the following section.



Male BwM head and thorax detail. Note the yellowish facial color, brownish-red over greenish-yellow eye color, orangish-brown thorax front color (and cover of fine hairs) and the orangish-brown basal wing coloration (reddish spots where the wings connect to the thorax.







Male Band-winged Meadowhawk perched horizontally on a twig to hunt and possibly to attract a female to mate. Note his full visual field and display of prominent wing patches and bright red abdomen.

Previous page upper right: Meadowhawks, like this male Band-winged Meadowhawk, often hold their wings positioned aggressively forward when perched (sometimes described as allowing them to "droop" forward), which is also effective in displaying their prominent wing patches and brightly colored abdomen. Image provided by Gordon Berman, collected in Mesilla Valley Bosque State Park (MVB).

Previous page middle right: Female BwM along the Rio Grande, perched horizontally on a dried Three-square Bulrush, *Schoenoplectus pungens* ([Vahl] Palla) stem with wide visual field to hunt for flying insects and possibly to display to attract a male. Note how she droops her wings slightly forward, also note that her abdomen color is grayish-green rather than yellow; Paulson (2009) exhibits a similarly-colored female occurring in Oregon.

Below: A female Band-winged Meadowhawk within MVB, perched horizontally on a small branch (~3.0m high) with open visual field to hunt for flying insects and possibly to display to attract a mate. Note how the backlighting allows examination of the size and color of her large, bright wing patches, their prominent display, and wing venation pattern.











Left: Female BwM perched horizontally on a small branch along the Rio Grande providing a wide visual field, hunting for flying insects, while projecting her wings forward. Note the bold, extensive yellow-brown wing markings beginning at wing bases, her bright yellow thorax and abdomen, and the brownish-red over mostly yellowish-green eye color.

Middle Left: Female BwM. Note her full display of bright yellow abdomen and wing patches on drooped wings, which may also serve to attract a male to mate.

Lower Left: Female BwM. Note that she appears to have a parasitic red mite attached to her foot.

Bottom Left: Female BwM. Note her well-exposed, bright yellow abdomen dorsal surface and black lateral surface.

Bottom Right: Female BwM head and thorax detail. Note the yellowish facial color, brownish-red over yellow eye color, brownish thorax front color and bright yellow color of the sides with black, narrow, vertical stripes, and the orangish-brown basal wing coloration.

Top of the following page: The same BwM female as that shown at the bottom left of this page, returning to the perch following a short flight and holding her wings horizontally while slightly elevating her prominently displayed abdomen. Note that at this angle her wing spots brightly reflect sunlight, potentially important in mate attraction.





Autumn/Yellow-legged Meadowhawk (AM)

Gordon Berman provided images documenting an AM male in McKittrick Canyon, Guadalupe Mountains National Park in November 2022. AM occurs in two disparate populations, one in the Pacific NW (southern British Columbia to northern California) and the largest occurs in southeastern New Mexico to northwestern Texas, north to the Canadian border, and east to Nova Scotia and south to Florida (Paulson 2009). While distributed east of our area and unlikely to be observed locally, these images are important to illustrate similarities and differences in AM morphology with BwM.

Habitats commonly used by both BwM and AM include permanent open ponds/lakes in wooded country (Paulson 2009). Males of both species are red in dorsal view, but BwM has two black abdominal spots (S8/S9) while AM has a single black abdominal spot (S8); on the lateral abdomen, BwM has a black line while AM is entirely red; and the BwM wing spot is prominent in size and deep color while the AM has only small, brownish-red spots at the wing bases.

Generally, AM adults occur in clearings and at forest edges near breeding sites. They perch from ground level to high branches and leaves. Pairs arrive at water in tandem linkage near midday, accumulate on dense vegetation at water, and often make wide-ranging flights around the area prior to egg-laying. Ovipositing occurs in tandem, in shallow open water, on wet vegetation (moss-covered logs, wet mud, floating aquatic mats).

Paulson (2009) states that AM are the latest species to fly from northern habitats, remaining until the first heavy frosts; they maintain activity by constantly basking in the sun. Along the southern Rio Grande, this is the same behavior exhibited by Variegated Meadowhawks, which are the only dragonfly species observed locally from December to February in most years.





Previous Page Bottom: Male AM horizontally perched over small gravel. Note his legs are light reddish-yellow in comparison to the black legs of BwM.

Left: Male AM vertically perched on a cobble while sunning and hunting within the Guadalupe Canyon bottom. Note that AM is all red as is the BwM; AM has small, brownish-red basal wing spots when compared with the large wing spots of the BwM; eyes reddish-brown over lavender compared to reddish-brown over brownish-yellow of the BwM.

Below: Male AM horizontally perched on a cobble. Note that his thorax color is similar to that of the BwM (brownish-red with many fine hairs); abdomen of AM is all red with no black line on the lateral side; on segment S8 there is a single black dorsal spot compared to two black dorsal spots (S8/S9) on the BwM.



Southern Pocket Gopher *Thomomys umbrinus* (Richardson 1829)

by James Von Loh

Sites along the Rio Grande devoid of vegetation are commonly used by insect species (butterflies, dragonflies, damselflies, robber flies, etc.) to perch, warm in the sun, hunt, display to locate mates, etc. Two popular barren sites locally are the Rio Grande (bike/hike) Trail and an amazing number of Southern Pocket Gopher burrows! Southern Pocket Gophers represent an important/bountiful food source for a number of mammal, bird, and snake predators.



Top Right: Fresh mound and burrow of a Southern Pocket Gopher in a matrix of Bermuda Grass, *Cynodon dactylon* ([L.] Pers.) in La Llorona City Park near NMSH 70 bridge.



Middle Right: A Southern Pocket Gopher burrowing for plant roots, seeds, and shoots at the southern end of the Rio Grande Trail north of Calle del Norte Road. Note that there are a large number of burrows and excavated soil mounds throughout the Rio Grande floodplain, and it's easy to sink up to your ankle with each step: I suggest treading lightly or perhaps repurposing your snowshoes.

Editor's Note: 2023 was an especially good year for rodents in the Black Range. Unfortunately, large numbers of dragonflies did not follow suit. July 2023 was the hottest and driest July on record for Hillsboro, squeaking by with .03 (yes, 3 hundredths) of an inch of rain.



The lack of rain did not seem to affect the pocket gopher population. In Hillsboro, the common (very common) pocket gopher is thought to be the Botta's Pocket Gopher (image right). It lacks the black line down the back which is characteristic of the Southern Pocket Gopher. There are 15 subspecies of Botta's Pocket Gopher, Thomomys bottae, in New Mexico.

Greater Short-horned Lizard, *Phrynosoma hernandesi brevicauda*

All of the images of a Greater Short-horned Lizard, *Phrynosoma hernandesi brevicauda* (see following page for subspecies determination) were taken at about 9,000′ on the trail from Emory Pass to Hillsboro Peak on September 2, 2023.

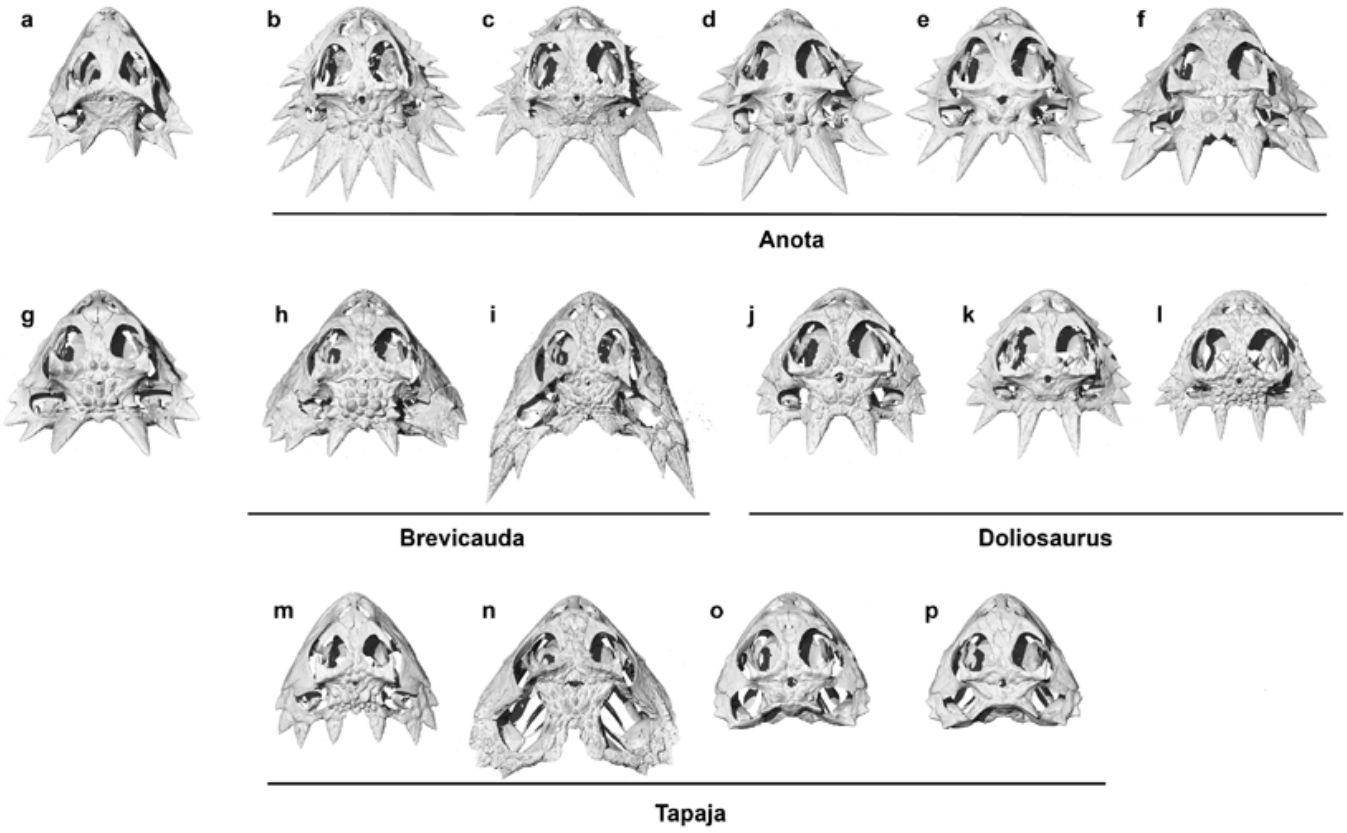
There are 21 species of *Phrynosoma* (the Horned Lizard genus), 15 are found in the United States. The genus has undergone its share of "splitting" in the recent past. In "Shape Variation in the Dermatocranium of the Greater Short-Horned Lizard Phrynosoma hernandesi . . ." (Paywall) Powell et al. address the shape and horn morphology of the subject species. The graphic comparing skulls, from the referenced study, is shown at the top of the next page.

The horns of horned lizards are just that, horns. They are made of bone covered with a sheath. The spines which cover the back and poke out from the sides of the body (in the case of the subject species) are modified scales.











Three species of Horned Lizard are regular in the Black Range. (See Randy Gray's article in this journal, "Horned Lizards of the Black Range", Volume 2, Number 1, January 2019.) As noted in the article by Powell et al., there is a fair amount of variation in *Phrynosoma hernandesi*, with the one depicted here probably in the *brevicauda* group (compare "h" in the diagram above with the photograph directly above). Eight, perhaps more, of the horned lizard species (including this one) are able to squirt blood from their eyes. This is a significant act and involves building blood pressure in the head, by restricting its outflow. This ruptures blood vessels at the eyelid and blood shoots outward. This stream of blood is directed and can be shot as much as 5 feet. This defensive action can be effective in deterring mammal but not bird species. In addition to being distracting, some posit that the blood is distasteful to canine and feline predators. That claim should be assessed more closely, not only because of difficulty in determining the perception of others (and other species) but also because the logic may be strained, or at least need to be explained. If the taste of squirted blood is sufficient to deter a predator, would it not seem logical that eating the lizard might not be the most pleasant thing in the world - and tend to be avoided? At one time, it was thought that the "bad taste" was added by glands in the eye lid. This is now known to be untrue. Exactly how the distasteful compounds come to be in the blood (and they are present) is unknown, although some posit that they come from the ants that the lizards eat. In any case, another species found in the Black Range, the Texas Horned Lizard (*P. cornutum*) is also known to squirt blood. On the other hand, *P. modestum* (the Roundtail Horned Lizard - the third species found in the Black Range) may not have this ability. The distribution of the Greater Short-horned Lizard is shown on the range map which follows (provided by Simon Pierre Barrette under a Creative Commons license).



Horned lizards rely heavily on their camouflage, and it is quite effective. Even when you know they are there they can be difficult to pick out from the stones and debris. When their camouflage fails, they will run swiftly for a short distance and then stop instantly. If you are following the lizard with your eye you will overshoot where it stopped and have to pick it out of the background clutter anew. *Phrynosoma hernandesi* is found at all elevations in the Black Range.

Metcalfe's Penstemon and Mimbres Figwort Survey

On September 2, 2023, we (Bob Barnes and Rebecca Hallgarth) took a walk up Hillsboro Peak to survey the Metcalfe's Penstemon (*Penstemon metcalfei,* Wooton & Standley) site where the trail cuts across Cross-O Mountain. A photograph from that location is on the back cover of this issue; the photographs on this page were taken at the same time.

Other species of note on this walk are shown on following pages, including Crag Lily, Rusby's Primrose, and Pringle's Catchfly. These and other photos (including the Greater Short-Horned Lizard images from the previous article) have been added to the Black Range website.













Left: Crag Lily, *Echeandia flavescens* ([J.A. & J.H. Schultes] Cruden)

Bottom Right: Pringle's Catchfly, *Silene scouleri* (Hooker)

Above, Bottom Left, and Top of following page: Rusby's Primrose, *Primula rusbyi* (Greene)







The fruit of Banana Yucca, *Yucca baccata*, were ripe on this day (9/2) and were prolific along the lower section of the Hillsboro Peak Trail (right and below).

The indigenous people of this area ate the flower stalks of this species, the younger the better, but always removing the outer covering. The fruit, shown here, can be eaten raw, cooked, or dried for food during the winter. The fibers from the leaves were used to make cordage and sandals.

This species is found from the American southwest to Colombia. There are three subspecies. The nominate subspecies is found throughout its range; var. *brevifolia* is found in Arizona and New Mexico.













Above and Left: *Sedum cockerellii*, Cockerell's Stonecrop. The flower garden at the Metcalfe's Penstemon site had many varieties of flowering plants, including these sedums.

Below and following page: Birdbill Dayflower, *Commelina dianthifolia*













The dayflower and the Mountain Parsley, *Cymopterus lemmonii*, shown below, were both attracting a number of pollinators.





The Earth Stars (*Gasteromycetes*) found along the trail were in varying stages of fruiting (above).

The basal leaves of the Skyrocket, *Ipomposis aggregata*, were covering the ground at Cross-O Mountain, just as spectacular as the flowers (below left).

Gambel's Oak, *Quercus gambelii* (below right) and Emory Oak, *Quercus emoryi* (bottom right on the following page) were both laden with acorns. I am not sure that it would qualify as a mast year - but it is a very good year.

***Pneumonanthe affinis*, Pleated Gentian (upper left on the following page) was represented by a few plants at its traditional location just before you enter the Aldo Leopold Wilderness for the first time.**

One of the most frequently heard sounds along the trail was made by Cliff Chipmunk, *Tamias dorsalis* (bottom left on the following page).







We completed our short survey of the two endemics with a walk up Railroad Canyon on September 4, 2023. We found several specimens of Mimbres Figwort, *Scrophularia macrantha*, in the section of trail between the corral and the first trail junction (Gallinas Canyon Trail and Railroad Canyon Trail). This year we have received little rain, but when it did come most came in short periods. During one or more of these times, Railroad Canyon had washed fairly badly. We found the trail rerouted in a few places. That also means that the Mimbres Figwort sites were affected since this species has a tendency to grow fairly close to the stream. We found fewer plants (a bad knee may have limited observer coverage, however) but some were at new locations along this section. Photographs of Mimbres Figwort from this section of trail are shown on the following page.

In twenty minutes at the Gallinas Canyon trail junction, the Merlin app reported Painted Redstart, White-breasted Nuthatch, Plumbeous Vireo, Cassin's Vireo, American Robin, Black-headed Grosbeak, Evening Grosbeak, Brown Creeper, Steller's Jay, Grace's Warbler, Mountain Chickadee (and Black-capped Chickadee - which is problematic), and assorted neotropical species not found here.







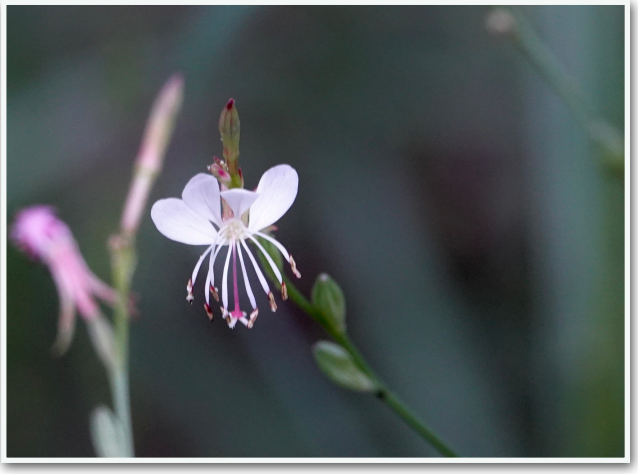




This page and top left on the following: Mimbres Figwort, *Scrophularia macrantha*, Railroad Canyon, Black Range, September 4, 2023.













***Monarda pectinata*, Pagoda Plant (directly above) was prevalent along the first half mile of the trail but was not attracting the numbers of pollinators that I would expect. *Oenothera laciniata pubescens*, (or *O. pubescens* in some sources) Silky Evening Primrose (top right) and *Oenothera suffrutescens*, Scarlet Beeblossom/Scarlet Gaura (middle top at the right) were interspersed along the trail. As in many other areas of the Black Range, Scarlet Penstemon, *Penstemon barbatus,* was common (bottom middle at right).**

Tassel Flower, *Brickellia grandiflora*, immediately above, was also very common in the area.













The flowers along this section of trail included: Sweet Four O'clock, *Mirabilis longiflora* (upper left); New Mexico Evening Primrose, *Oenothera neomexicana* (middle left); Long Leaf Cologania *Cologania angustifolia* (lower left); Coulter's Balsam Apple, *Echinopepon coulteri* (upper right); Wright's Buckwheat, *Eriogonum wrightii wrightii* (middle right); and Purple Morning Glory, *Ipomoea capillacea* (lower right).

Both endemics are still present at these traditional sites, although the figwort population seems diminished.

Tidbits From The Literature

General Studies Pertinent to the Black Range

"Soils' coating helps keep dust storms at bay", Elizabeth Pennisi, *Science*, 20 May 2022, Vol 376, Issue 6595, pp 786-787 And "Global cycling and climate effects of aeolian dust controlled by biological soil crusts", Rodriguez-Caballero, E., Stanelle, T., Egerer, S. et al., *Nature Geoscience*, 15, 458–463 (2022).

Overgrazing and other activities which destroy biocrust have ramifications which are greater than the simple loss of productivity.

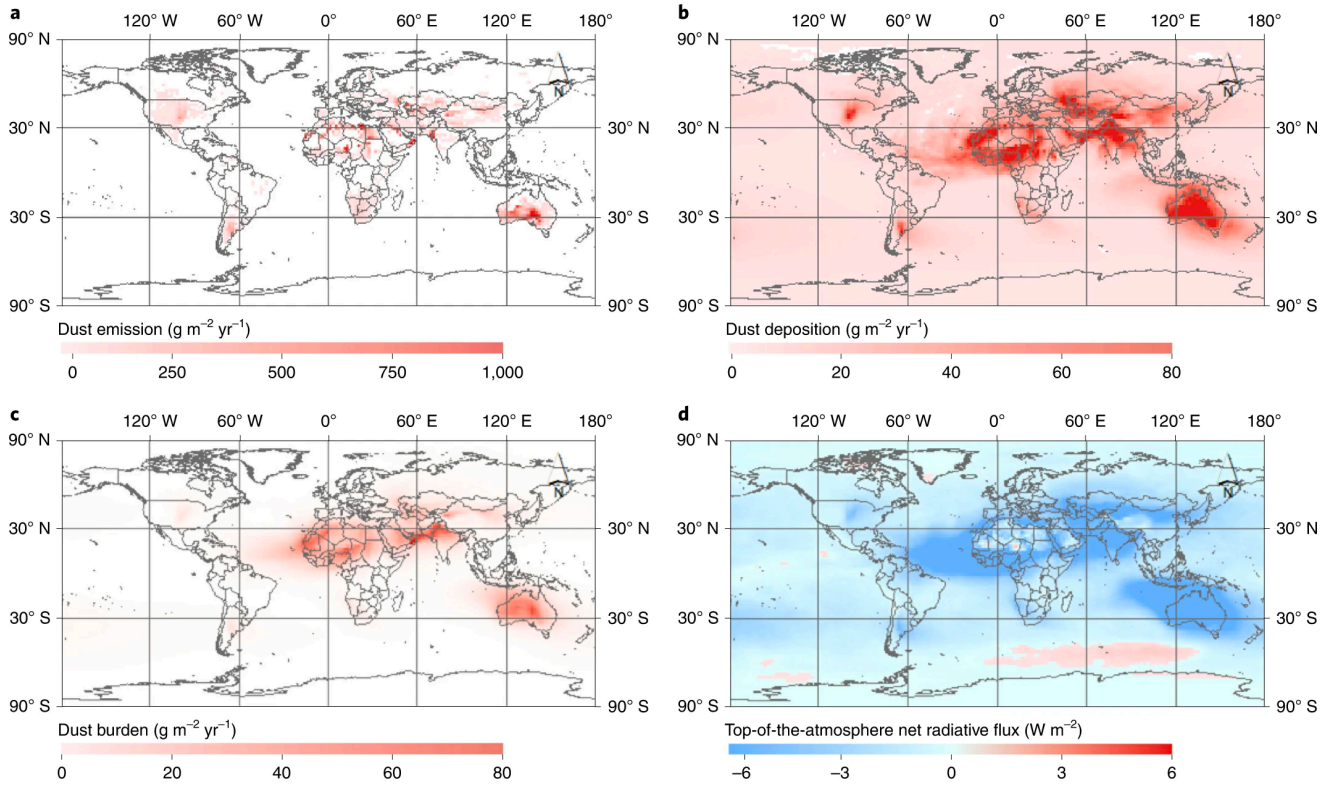
Pennisi notes that biocrust "is a hard surface coating, or 'skin,' typically a few millimeters thick, containing a thriving community of fungi, lichen, moss, cyanobacteria, and other microbes." That when the biocrust is "trampled by livestock and scorched by climate change (it) . . . . is likely to become weaker in the future . . . . . leaving the soil to the wind."

As noted in the cited article (above) biocrust, which covers about 12% of the global land surface, reduces the dust in the air by 700,000,000 tons per year.

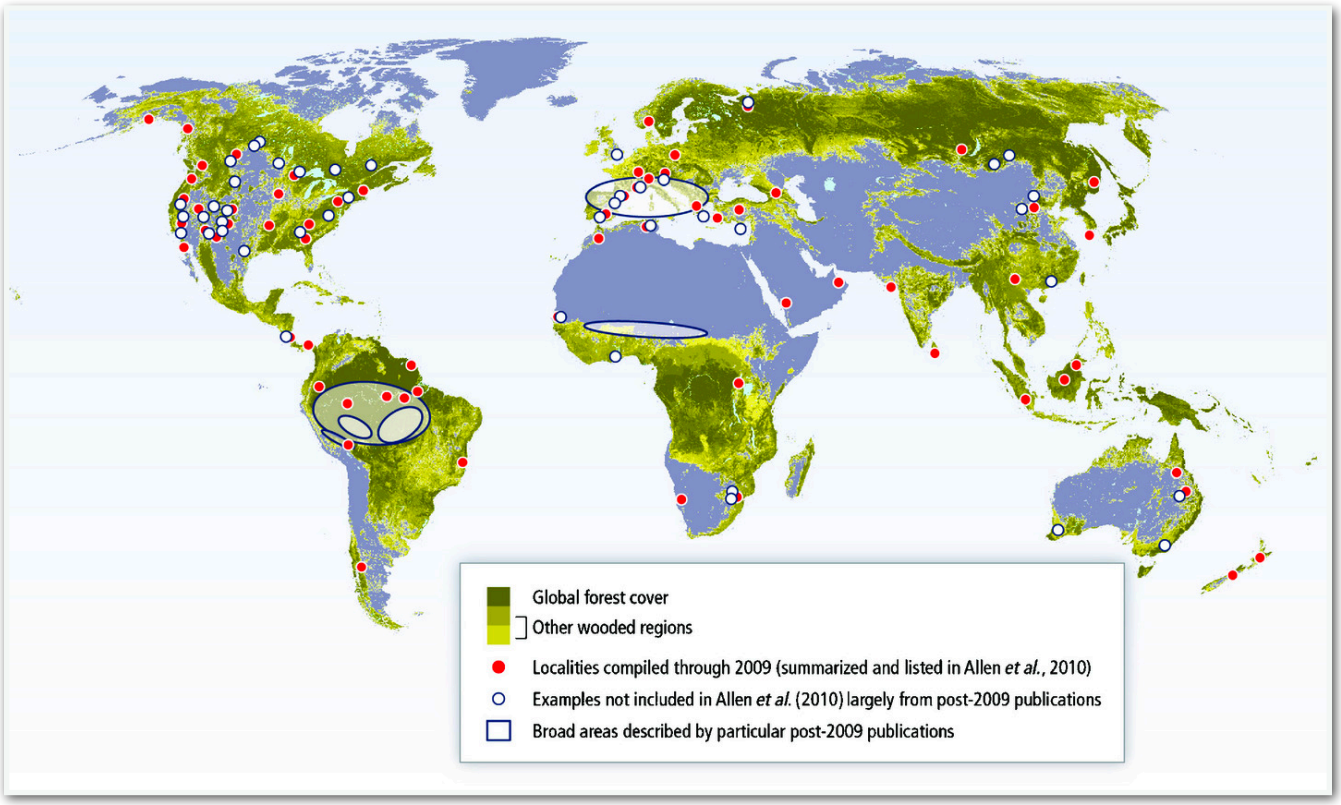
"Research frontiers in drought-induced tree mortality: crossing scales and disciplines". Henrik Hartmann et al., *New Phytologist*, 12 January 2015. And "Drought resilience of conifer species is driven by leaf lifespan but not by hydraulic traits", Yanjug Song et al., *New Phytologist*, 26 April 2022.

Hartmann et al. note that "global trends in tree mortality and their potential to have ecological and climatological consequences remain highly uncertain." Since Hartmann, many studies have attempted to address the issues associated with "drought resistance". Song et al, for instance, was a multi-variant assessment of attributes which might be indicative of resistance to drought or the lack thereof.

The Song et al. study assessed 28 conifer species, only one of which, the Douglas Fir, *Pseudotsuga menziesii,* has a native range in our area. Among other things, the study concluded that "Conifer species with long-lived leaves suffer from drought legacy effects, as drought-damaged leaves cannot easily be replaced, limiting growth recovery after drought. Leaf lifespan, rather than hydraulic traits, can explain growth responses to a drier future." The researchers noted that "To our knowledge, this is the first study that shows that species with a conservative leaf economics strategy (long leaf lifespan) have such a lower drought recovery. This adds an important ecological dimension to leaf lifespan, which is known as a key trait for multiple functions of plant strategies, such as increasing stress tolerance and conserving nutrient, carbon and nutrient cycling (Edwards et al., 2014; Yu & He, 2017). Whether the observed legacy effects



a–d, Hypothetical change of total annual dust emission (a), total annual dust deposition (b), mean annual atmospheric dust burden (c) and mean aerosol net radiative effect at the top of the atmosphere (d) upon complete removal of biocrusts. All calculations refer to mean annual values for the period 1990–2020 and are based on the mean effects of biocrusts on threshold friction velocity. From the cited article on biocrust.



Locations of substantial drought- and heat-induced tree mortality around the globe since 1970 (global forest cover and other wooded regions based on FAO, 2005). Studies compiled through 2009 (red dots) are summarized and listed in Allen et al. (2010). Localities and measurement networks not included in Allen et al. (2010), which are largely from post-2009 publications, have been added to this map (white dots and shapes) © IPCC. Fig. 4-7 from Settele et al. (2014 and references within). From Hartmann et al.

of leaf lifespan on drought recovery is something particular for conifers, or also occurs across broadleaf species or other forests, remains to be tested".

Although the Song et al. study focused on drought, it may be that any event (e.g. fire) which damages leaves will have long-term, species-specific, impacts.

All of the studies referenced above are a warning about the resilience of the flora and fauna of this planet. It is increasingly probable that the speed of human-induced climate change will outstrip the capability of the planet's species to cope with it.

"Climate-induced changes to provisioning ecosystem services in rural socioecosystems in Mexico", Rafael A. Arenas-Wong, Agustín Robles-Morúa, Adrián Bojórquez, Angelina Martínez-Yrízar, Enrico A. Yépez, Juan C. Álvarez-Yépiz, *Weather and Climate Extremes*, Volume 41, September 2023.

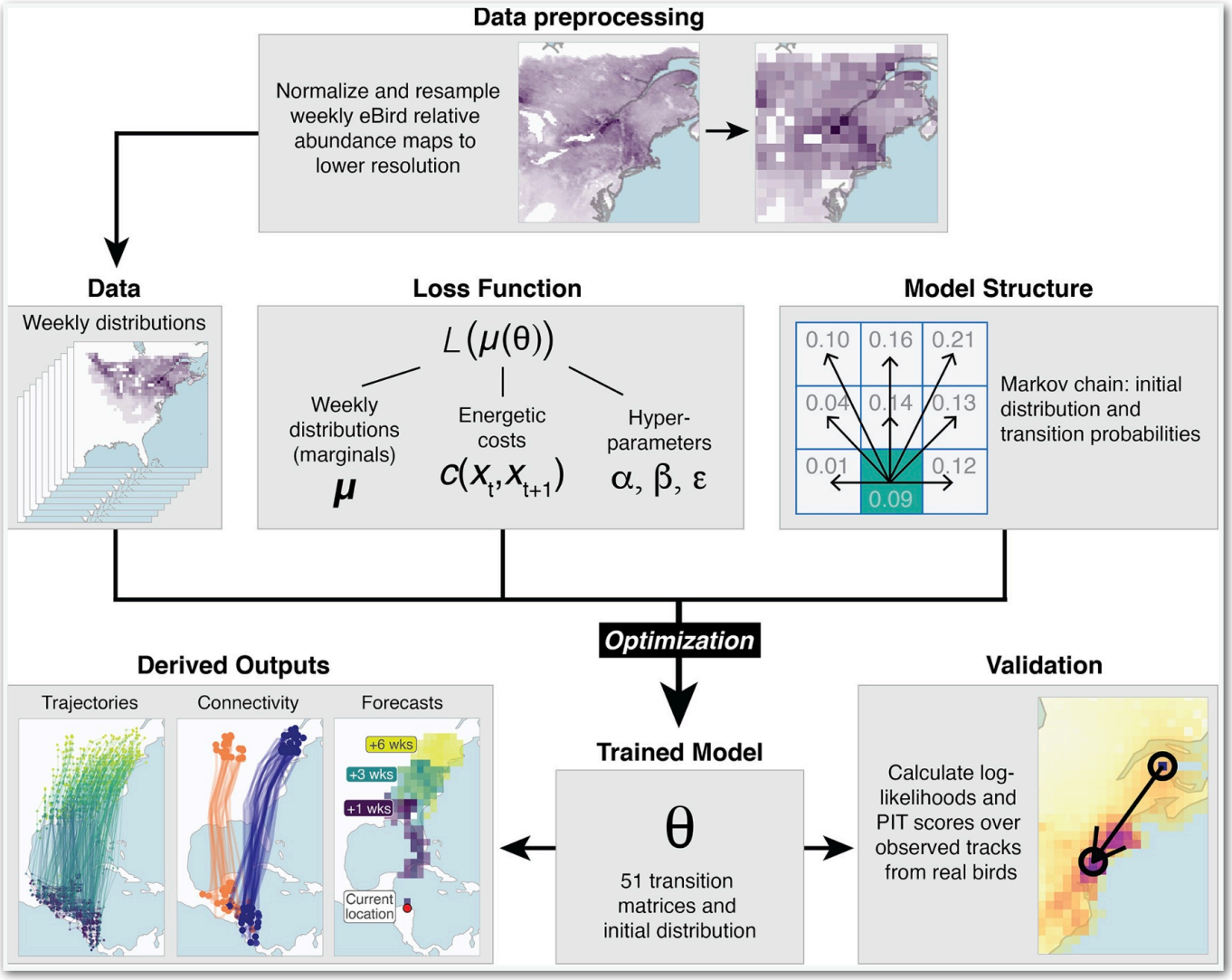
There are two aspects of this study of interest to us: First, this is a detailed study of the effect significant climate events (in this case, excessive cold weather) have on fauna; and second, it presents a case study in how to integrate the knowledge base of local populations and other non-institutional entities into institutionally based efforts. As one of the authors noted, "To reduce local knowledge to being worthless until it is verified and validated by my academic methods is disrespectful." And, we might add, dysfunctional.

"Climate Model Code Genealogy and Its Relation to Climate Feedbacks and Sensitivity", Peter Kuma, Frida A. M. Bender, Aiden Jönsson, *JAMES - Journal of Advances in Modeling Earth Systems*, 12 July 2023.

In this study, the authors explored the "black boxes" used in weather modeling and found similarity in the model coding, which introduces bias into any study which assumes the different models are independent views of the world. To quote the study: "Many models in the MMEs of the Coupled Model Intercomparison Project (CMIP) have a common development history due to sharing of code and schemes. This makes their projections statistically dependent and introduces biases in MME statistics. " (underline added - MME = Multi-Model Ensembles).

"BirdFlow: Learning Seasonal Bird Movements From eBird Data", Fuentes, Van Doren, Fink, and Sheldon, *Methods in Ecology and Evolution,* 31 January 2023.

This research has the potential to increase our knowledge of seasonal bird movements significantly. At the time of the paper, 11 North American bird species had been tracked



Data preparation and modeling procedure. First, we pre-process eBird Status & Trends data to produce weekly population distributions at a spatial resolution appropriate for the model. We specify a loss function that uses those weekly distributions, along with a proxy for energetic costs, to score potential models. We select a model structure. We fit the model through an optimization procedure to minimize the loss function, producing a trained model. We use observations from tracked birds to evaluate the quality of the model and refine hyperparameters. The final trained model produces various outputs of scientific interest. (Graphic and caption from"BirdFlow: Learning Seasonal Bird Movements From eBird Data".)

successfully, and their movements predicted, by using eBird data and a new predictive model.

From the Abstract: "*Researchers can extract a number of behavioural inferences from model results, including migration routes, timing, connectivity and forecasts. The BirdFlow framework has the potential to advance migration ecology research, boost insights gained from direct tracking studies and serve a number of applied functions in conservation, disease surveillance, aviation and public outreach.*"

On a local level, having an enhanced prediction of the arrival (and departure) dates of specific species, based on of-the-year data, may be especially useful for studies in an environment which is changing more quickly than in the past.

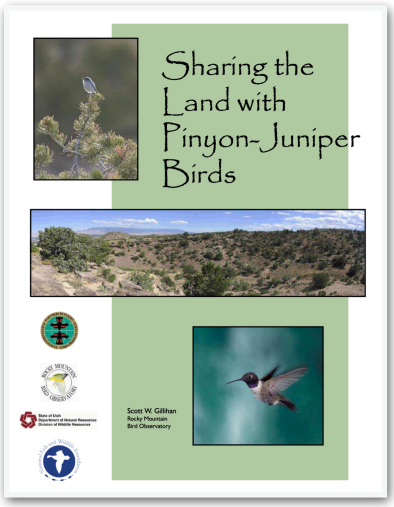
"Wildfire severity and vegetation recovery drive post-fire evapo-transpiration in a southwestern pine-oak forest, Arizona, USA", Helen Poulos, Andrew Barton, George Koch, Thomas Kolb, and Adrea Thode, *Remote Sensing in Ecology and Conservation*, Vol. 7, issue 4, December 2021.

The authors use sophisticated remote sensing systems to evaluate the interplay between type of vegetation, fire intensity, and vegetation recovery and change. They conclude that the "Forests in the desert Southwest comprise a critical water-provisioning ecosystem service in an arid region. Most projections indicate that western North America will continue to experience increasing aridity and larger, more severe, and more frequent wildfires, which may threaten this water resource. The intensification of fire-climate interactions over the coming decades could lead to the persistence of wildfire-generated shrublands which have surprisingly high ET, according to our results." (Internal cites stripped. ET = evapotranspiration)

Pinyon Juniper Birds

In the last issue of this journal we wrote about the natural history of the Two-needle Pinyon. Part of that article described the importance of the pinyon-juniper forest to the Pinyon Jay. There are, of course, many other bird species which use that habitat extensively.

Scott Gillihan's Sharing the Land With Pinyon-Juniper Birds is a great resource for those interested in this topic. At 43 pages, this .pdf is chock-full of information (download at link).



The Black Range Exchange Reset

The Black Range Exchange is one of the websites established as part of our greater Black Range project (this journal, other publications, the Black Range website, etc.) It was developed to bring people together around particular projects - a sharing of resource, knowledge, and effort. Under the concept, individuals could submit proposals for study, the website would publicize the effort and hopefully help people who are interested in the topic to get together.

Three projects were identified initially: 1) A historical/temporal mapping of relationships between naturalists working in the American



Southwest; 2) A multifaceted study of the natural history of the Arizona Cypress and initially, assuring a definitive description of its (current) native range in New Mexico; and 3) A compilation and history of bird illustrations made prior to 1930. All of these topics remain of interest but the additive aspect of The Exchange has become increasingly suspect. (Try something; if it fails let it go.)

The Exchange remains but its core concept has been "reset". We are not quite sure what it is, more sure of what it is not.

In the short-term, the effort at compiling historical depictions of bird species will continue. At this point the material includes thousands of images. Much more remains to be done, but it is already a significant resource for those interested in this topic.

The home page and the material describing the two other projects are mothballed.

Your ideas about the site and how it might be used will be appreciated. (Hint: I am not interested in established a message board of job openings, offerings of used microscopes for sale, or personal ads - too much work for the site's mayordomo [me]). But, it might be a site where upcoming professional symposia are listed, new publications or efforts relative to the natural history of this area are announced, etc. All depends.

Or it might become the hosting site for the bird illustrations effort and not much more.

Thanks, Bob Barnes

Tools of the Trade
Tracking

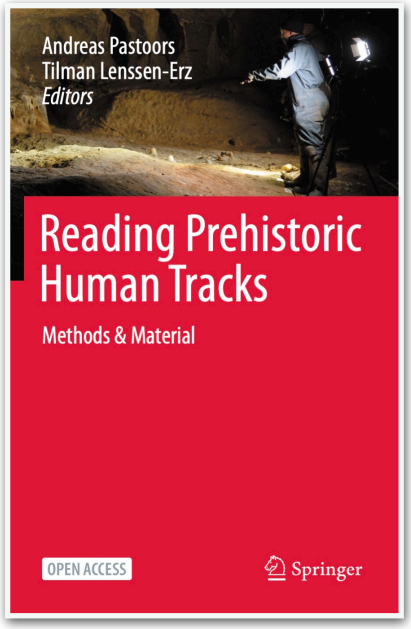
Earlier in this issue we discussed the study of animal tracks and other sign as a way of understanding the creatures who had passed a place before. Using tracks in this manner is a very old human skill. Sometimes it was a skill used by hunters to meet basic needs. Today it may be used to understand ancient human history.

The *Science* website (13 September 2023) included an article about a prehistoric rock art site in Namibia. What makes it germane for us is that the site is one where animal tracks were carved into rock with incredible accuracy, thousands of years ago (see image above from article). Namibian trackers who surveyed the tracks were able to identify 39 different species, often including sex and age. As noted earlier in this issue, it is not unusual to discover rock art of animal tracks at the sites located in the Black Range.



And in Namibia, as in the Black Range, the human footprint is also depicted in rock art. The image above is from Frying Pan Canyon in our neck of the woods.

Human footprints may be carved into rock or they may have been left behind by our ancestors. A survey of the insights gained from studying



their tracks is included in *Reading Prehistoric Human Tracks* (Andreas Pastoors and Tilman Lenssen-Erz, editors). This book does not include the latest findings from White Sands, which for all intents and purposes demonstrate that humans were walking around the ancient lake bed between 23,000 and 21,000 years ago, these dates being verified by three dating technologies.

High Tech Tools Used To Determine Biodiversity

Earlier we discussed the low-tech tools we can all use on any outing to determine (fill in the blank) - this survey will continue in our next issue. In more institutional settings ground-breaking tools are being developed to do the same. In the case of determining the biodiversity of an area, two developments are intriguing.

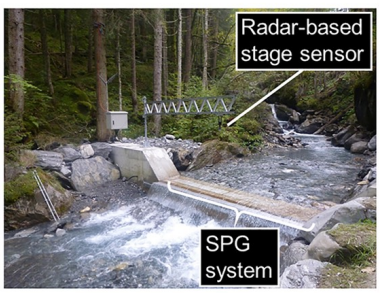
Jörg Müller (Universität Würzburg) is using animal sounds to determine the biodiversity of tropical rainforests. No big change in using the sound of a rainforest to determine its complexity. What is new here is that he and his collaborators are using machine learning (artificial intelligence algorithms) to parse the audio information on recordings. Many people who venture into the Black Range use computer applications like Merlin to determine what birds are in an area (from their vocalizations). It may be that in the relatively near future much more sophisticated tools will become broadly available for our use, based on the efforts of people like Müller.

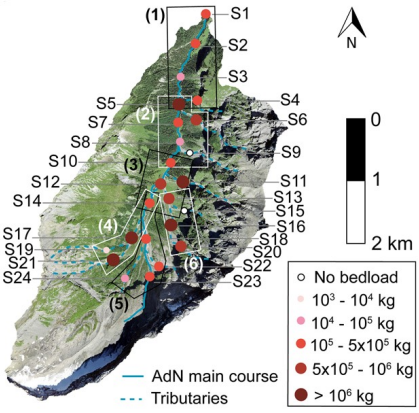
Seismometers are being used in research in Switzerland to listen to rivers and measure the amount, and type, of sediment being transported by the water.

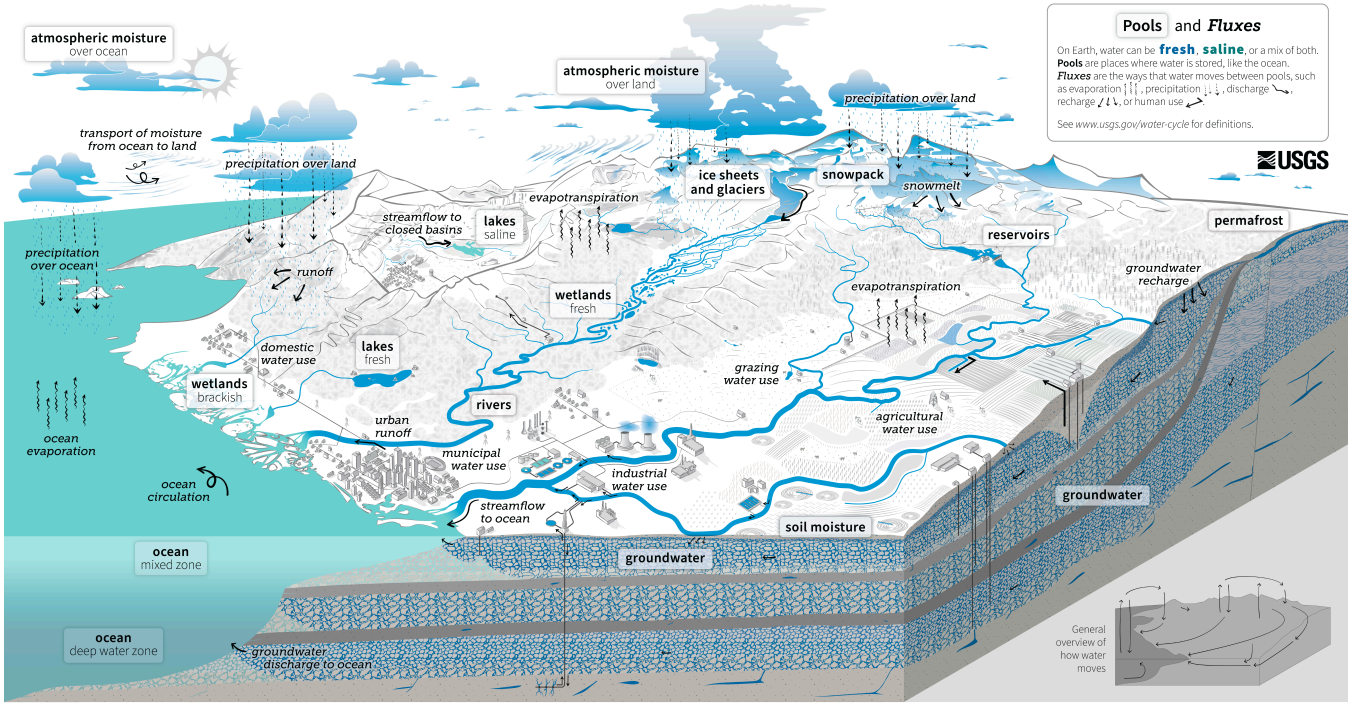
The images shown at the bottom of this page are from that study, in which "Streamflow is continuously measured through a calibrated radar-based stage sensor, and 10 calibrated units of the Swiss Plate Geophone system provide a continuous monitoring of bedload transport." Not something you put into your pocket as you head out the door at 6 a.m., but an indication of what is possible. Ignorance is increasingly a poor excuse for poor policy.

For a full discussion of these efforts see "Anatomy of an Alpine Bedload Transport Event: A Watershed-Scale Seismic-Network Perspective", Gilles Antoniazza et al., *JGR Earth Surface*, American Geophysical Union, August 7, 2023.

And lastly, check out how far DNA analysis has come. In "Vertebrate environmental DNA from leaf swabs", *Current Biology*, Volume 33, Issue 15, August 21, 2023, Christina Lynggaard et al. describe how their team "detected 52 wild vertebrate genera, including 26 avian and 24 mammalian genera; 30 of these assignments could be refined to the species level. We detected an average of 7.6 genera per swab. This approach, with its inexpensive and simple collection and DNA extraction, opens the door for inexpensive large-scale vertebrate biomonitoring." Walking into a location, stroking a leaf with a Q-tip, taking the Q-tip back to the lab and determining (some, perhaps a great deal of) the biodiversity of an area is truly something out of science fiction - but not only possible - happening.







The Water Cycle

The water cycle describes where water is on Earth and how it moves. Water is stored in the atmosphere, on the land surface, and below the ground. It can be a liquid, a solid, or a gas. Liquid water can be fresh, saline (salty), or a mix (brackish). Water moves between the places it is stored. Water moves at large scales and at very small scales. Water moves naturally and because of human actions. Human water use affects where water is stored, how it moves, and how clean it is.

Pools store water. 96% of all water is stored in **oceans** and is saline. On land, saline water is stored in **saline lakes**. Fresh water is stored in liquid form in **freshwater lakes**, artificial **reservoirs**, **rivers**, and **wetlands**. Water is stored in solid, frozen form in **ice sheets** and **glaciers**, and in **snowpack** at high elevations or near the Earth's poles. Water vapor is a gas and is stored as **atmospheric moisture** over the ocean and land. In the soil, frozen water is stored as **permafrost** and liquid water is stored as **soil moisture.** Deeper below ground, liquid water is stored as **groundwater** in aquifers, within cracks and pores in the rock.

Fluxes move water between pools. As it moves, water can change form between liquid, solid, and gas. **Circulation** mixes water in the oceans and transports water vapor in the atmosphere. Water moves between the atmosphere and the surface through **evaporation**, **evapotranspiration**, and **precipitation**. Water moves across the surface through **snowmelt**, **runoff**, and **streamflow**. Water moves into the ground through infiltration and **groundwater recharge**. Underground, groundwater flows within aquifers. It can return to the surface through natural **groundwater discharge** into rivers, the ocean, and from **springs**.

We alter the water cycle. We redirect rivers. We build dams to store water. We drain water from wetlands for development. We use water from rivers, lakes, reservoirs, and groundwater aquifers. We use that water to supply our **homes** and **communities.** We use it for **agricultural** irrigation and **grazing** livestock. We use it in **industrial** activities like thermoelectric power generation, mining, and aquaculture. The amount of water that is available depends on how much water is in each pool (water quantity). It also depends on when and how fast water moves (water timing), how much water we use (water use), and how clean the water is (water quality).

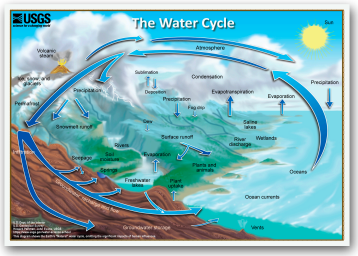
We affect **water quality**. In agricultural and urban areas, irrigation and precipitation wash fertilizers and pesticides into rivers and groundwater. Power plants and factories return heated and contaminated water to rivers. Runoff carries chemicals, sediment, and sewage into rivers and lakes. Downstream from these sources, contaminated water can cause harmful algal blooms, spread diseases, and harm habitats. **Climate change** is affecting the water cycle. It is affecting water quality, quantity, timing, and use. It is causing ocean acidification, sea level rise, and more extreme weather. By understanding these impacts, we can work toward using water sustainably.

New USGS Water Cycle Diagram

The USGS natural water cycle diagram, shown to the right, has been used to explain the concept to people for decades. It is available in more than 60 languages. The agency has published a new diagram (shown above) which is not only more nuanced but also includes the effects of human activity for the first time.

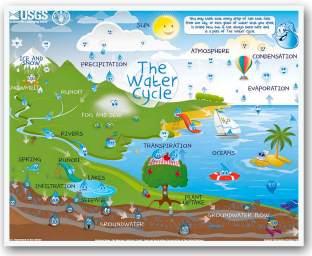
The diagram is now interactive, can be downloaded, is "zoomable", and is available in English and Spanish versions. Versions in other languages will follow shortly. It is easy to enlarge and focus on specific sections. An enlargement of the diagram is shown on the following two pages.

The USGS Water Science School has a wealth of accessible information. These website pages include both narrative and graphic material. This material is designed mostly for primary and secondary school users. The diagram above is a general graphic for primary school use. It is available in several versions, beginner (top of right column), intermediate (center of right column), and advanced (bottom of right column).



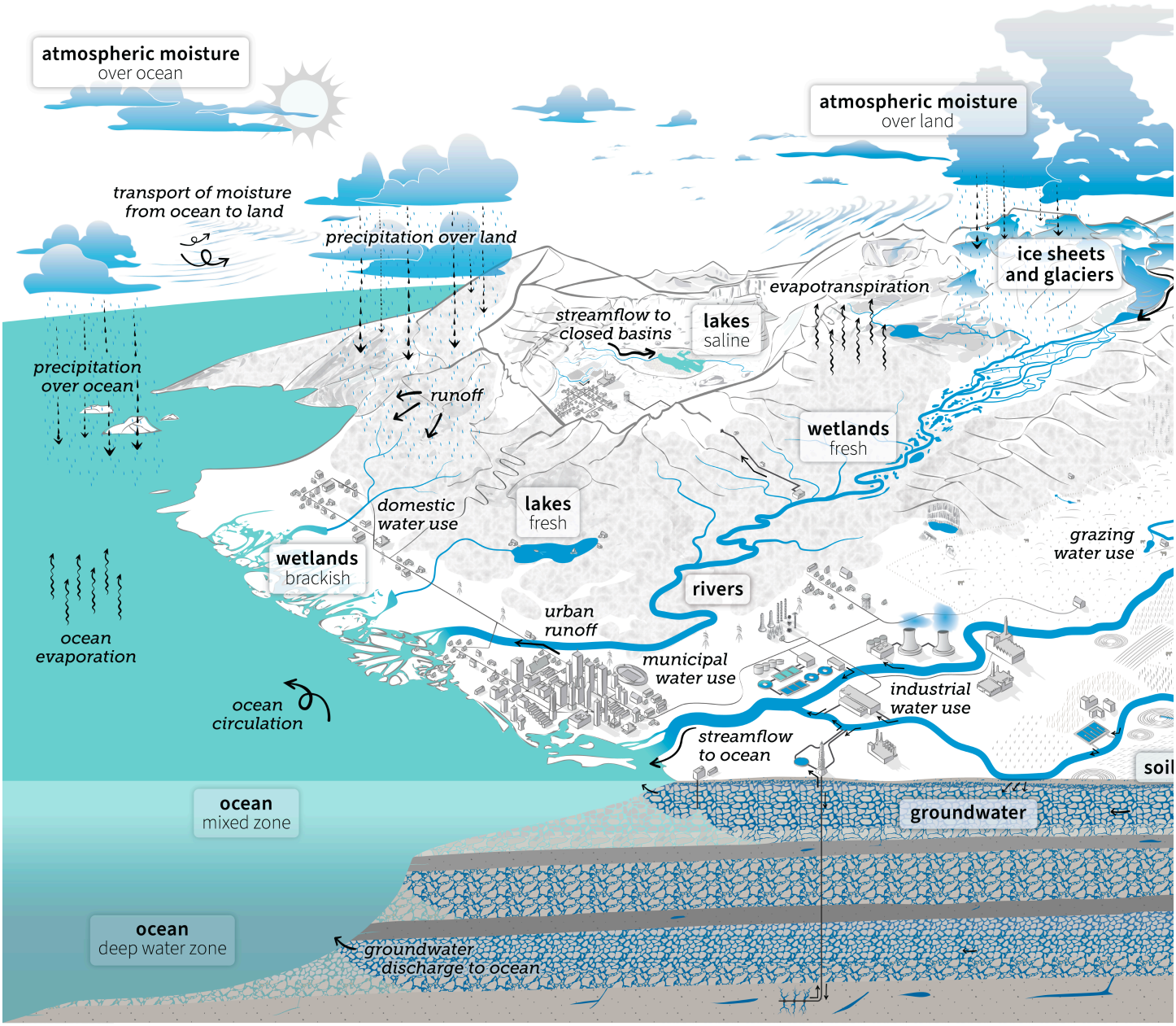








Each of the above graphics has interactive buttons which provide access to "age-focused" information.



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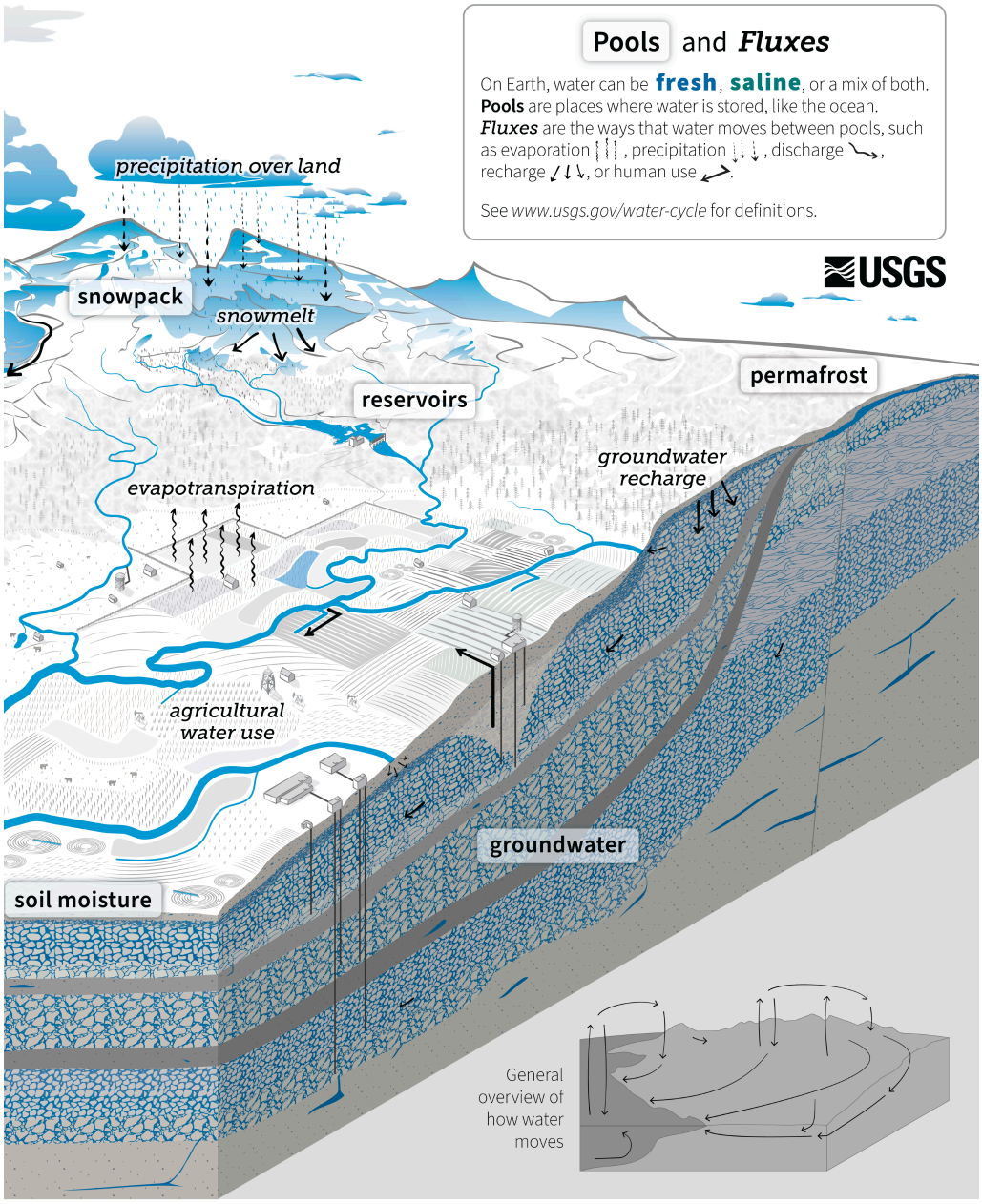

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Creative Voices

The 10th Natural History of the Gila Symposium will be held in Silver City, on the campus of Western New Mexico University. The Symposium is a multi-day (February 28 - March 1) multi-track event. It is always an exceptional opportunity for those interested in the natural history of our area.

At the start of the event, the night of February 28 (please verify the date as the event approaches), the Symposium holds "Creative Voices", a reading of natural history and other science. It is a melding of art and science, the message and the medium, and it sets the tone for the excellent presentations of science which follow.

In "Why - and How to - Engage Artists in Science" Blaeser et al., *Eos*, 18 August 2023, noted this quote from Leopold: "And naturalist Aldo Leopold, in his 1949 book *A Sand County Almanac*, claimed, 'We can only be ethical in relation to something we see, understand, feel, love, or otherwise have faith in.' For many, numbers are not enough to achieve this relationship." Creative Voices is a fitting beginning to this year of celebration. One of the featured speakers will be A. T. Cole.



There will be two keynote speakers at the 10th Symposium.

On February 28, 2024: Teresa Martinez, the Executive Director of the Continental Divide Trail Coalition, will Speak.

On February 29, 2024: Wolfhorse Joe Saenz will speak. He is from the the Chiricahua Warm Springs Nde (Apache).

Why I Wrote a Book

By A. Thomas Cole

There must be a dozen reasons why people write books. George Orwell wrote an essay in 1946 "Why I Write" and gave us four: [1] sheer egoism, a desire to seem clever and be talked about, [2] aesthetic enthusiasm, an interest in the perception of beauty in the natural world, [3] historic impulse, a desire to see things as they are and store them for posterity, and [4] political purpose, in the broadest sense of wanting to push the world in a certain direction.

I wholeheartedly subscribe to Wes Jackson's succinct, all-inclusive bottom line: "We live in the most important moment in human history."[1]

I'd like to think I fall into category number four, wanting to do something about the mess we're in. The Earth's temperature is higher than any time in human history. We have just endured the hottest decade on record; the Gulf and East Coast of the United States are awash in drastic weather. People are drowning in their basements, burning to death as they flee. The Lahaina fire chased people into the ocean at the speed of one mile a minute, that's fire racing 60 mph! The death toll is almost a hundred. A "heat dome" cooked British Columbia, Oregon, and Washington, killing 500 people in Canada, at least 95 in Oregon, and possibly more than a billion marine animals globally. California and Australia are ablaze, fires never more extreme or this frequent. California has suffered severe drought, then horrendous flooding, an environmental whipsaw. One-third of Pakistan was under water, affecting 33 million people. Earth's species are undergoing a rate of extinction from 1,000 to as much as 10,000 times higher than normal. One million species are at risk of extinction. Soil is depleted and washed away with only 60 years of productive agriculture remaining if we continue business as usual. Human population growth, resource extraction, and consumption are headed toward tipping points. Humankind is ensnared in an accumulation of climatological and geological changes that are modifying the basic physical processes of the planet.

António Guterres, United Nations secretary general, warns that the climate crisis is now "inevitable, unprecedented, and irreversible," our lack of progress dealing with it is "suicidal;" he calls it "code red for humanity," as we approach "ecosystem meltdown." As one writer put it, we're in the midst of "a multi-species mass extinction, and the beginning of the end of civilization as we know it. Not one of us is innocent and not one of us is safe."[2] Yet, most scientists maintain there is still time, it's not too late, but we must act now. I wrote this book (ed.: see review on page 90) in an effort to urge people to acknowledge our environ-mental crisis, accept the fact that we Americans bear a disproportionate share of responsibility for the mess we're in, encourage people to commit to change their convenient, overly consumptive way of life and to protest for change, take to the streets and become part of the Voice of the Streets. The work we've been doing on the Pitchfork Ranch over the past two decades has helped this land, interesting and beautiful in its own right, become an ideal setting to make the case that everyone needs to pitch in and how each of us can make a difference, how to save us from ourselves.

During our work lives, Lucinda and I had participated in a dozen or more two-week Sierra club volunteer trips where we camped out, collected sherds, surveyed archaeology sites, drilled beams, other tasks in Chaco Canyon, and restored habitat in half a dozen locations. Stung by the restoration bug, we decided to repair land as a retirement project, purchased the Pitchfork Ranch south of Silver City, New Mexico in 2003 and, with the help of 18 government grants, installed more than 1,000 grade-control structures and planted or propagated a similar number of trees, raised the 8.3-mile reach of the 48-mile-long Burro Ciénaga water-course two to five feet, introduced several at-risk species and improved this wilderness-like place for wildlife to breed, birth and raise their young. We never discussed it, but the restoration was our swan song, a backpacker's way to leave this place a

little better than we found it. The water was given top priority, as the ranch's restorable ciénaga is one of the few remaining in the Southwest, with up to 95% of ciénega habitat having been lost since European arrival.[3] The few remaining are but a shadow of their former selves.

We learned that recent science found up to 37% of excess atmospheric carbon, the main cause of the climate crisis, could be drawn down by 21 natural climate solutions and that the work here was one of them, one of the more significant ways to return carbon to the soil where it can serve life, rather than death.[4] Those papers prompted us to investigate soil, photosynthesis, and the exhaustive and remarkable subsurface world and how restoring land was a realistic way – something beyond the seven "R's," – to pursue our personal climate stabilization potential and play a meaningful role in the hoped-for transition from a world of progress and profit to stability and survival. We recognized the ranch and our work provided us with the opportunity to interest others in restoration. I'd given talks, shared our progress at the Natural History of the Gila Symposium, written about ciénagas for Wikipedia and other writings and activities, explaining the importance of ciénagas and the results of the habitat restoration on the ranch. Spadework and drafts of a book had been in the works for some time, but when carbon drawdown potential entered our thinking, the throttle hit the floorboard.

As you can see here, it was clear that restoration worked and the potential for landscape scale repair was viable. Having done some of the work and overseen most it, we could see how individuals of every stripe could get involved, do the work. There are changes we can make to our yards, larger pieces of land, and with restoration groups as part of the significant adjustments we're all going to make if we're going to see civilization, as we know it, survive.

The challenge is to call attention to the myriad crises overwhelming the planet while people want to go about their lives, complicit, wanting to continue "business as usual." It's not



2005 2021



2005 2021



2008 2022



2005 2017



2009 2021



2005 2011

easy to make this case without sounding accusatory, blaming, pious, or self-righteous. But the facts are frightening. One of the major contributors to these crises is air travel, and the United States population racks up more miles per year than the next ten countries combined. There are reasons nobody wants to quit flying. When we took a train to visit our daughter in Seattle, the round-trip cost, per person, was $2,100 and the trip took two days each way. Air travel would have cost only $493 roundtrip and 7 hours (three-hour drive time to the airport and check in) each way. However, with infrequent exception, we've stopped flying. When our friends learn we no longer travel by air and ask why, it gets awkward. It's hard to tell, but their reaction appears to range between thinking our policy is silly and guilt. It's untenable to encourage our friends to give up flying, but they sense the suggestion; it's uncomfortable.

The writing was near completion, when another science paper reported that wetlands, bogs, marshes, and similar "sweet spots" like ciénagas "disproportionately contribute to carbon sequestration globally," capturing five times more carbon than forests and 500 times more carbon than oceans.[5] With an active, restorable ciénaga – the only one in New Mexico being restored on private property – the story of the restoration became far more important than our earlier thinking in terms of wildlands and wildlife.

Orwell's notion of pushing the world in a certain direction, urging people to respond to the seriousness of these crises, is the task. As complicated and difficult as it is to make the changes necessary to contend with these crises, the way we arrived at the predicament is straightforward. The problem of carbon and warming has been known for almost 200 years, the fossil fuel interests and our government knew about it since the 1950s, the risk was scientifically documented by a variety of scientists independent of one another. The criminals who created these crises and their efforts to prevent solutions are now beyond dispute. They continue their efforts.

This is the biggest crime in human history. The predictable consequences of spewing carbon, methane and other climate poisons are well known. Over heating the planet is killing thousands of innocent people, most of whom have contributed few heat-causing emissions. I've endeavored to explain the conspiracy, our complicity, tell how previously ignored science has had tragic consequences in the Southwest, yet ignoring science this time has us walking over a cliff. There are ways each of us can help solve these crises. We'd best do it now if we care about leaving our grandchildren with hope of survival.

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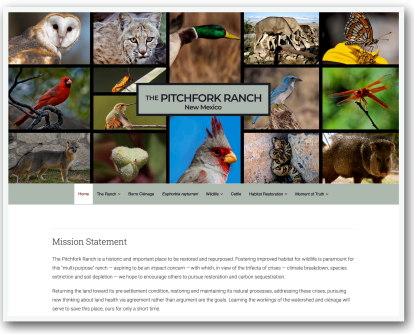
1. Courtney White, *The Age of Consequences: A Chronicle of Concern and Hope* (Berkeley: Counterpoint, 2015), p. 3.
2. Roy Scranton, *We're Doomed, Now What?* (New York: Soho Press, 2018), p. 3.
3. A.T. Cole and Cinda Cole, "An Overview of Aridland Ciénagas, with Proposals for Their Classification, Restoration, and Preservation," *New Mexico Botanist*, Special Issue, no. 4 (September 2015) p. 36.
4. Bronson W. Griscom et al., "Natural Climate Solutions," *Proceedings of the National Academy of the Sciences* 114, no. 44 (October 17, 2017): 11645-50, https://doi .org/ 10 .1073/ pnas. .710465114. Joseph E. Fargione et al., "Natural Climate Solutions for the United States", *Science Advances* 4 (11), 14 November 2018, DOI: 10.1126/ sciadv.aat1869, Justin Adams, et al., Consultation: Nature and Net Zero, World Economic Forum, January 2021.
5. Temmink et al., "Recovering Wetland Biogeomorphic Feedbacks to Restore the World's Biotic Hotspots," *Science*, Vol. 376, issue 6593, May 5, 2022.



Restoring The Pitchfork Ranch

A Book Review
by Harley Shaw

When I opened *Restoring the Pitchfork Ranch* and read the opening two pages of praise, I was tempted to forego writing a review. I wondered what, if anything, I might add. If attracting readers was my goal, just quoting that list of esteemed scientists and environmental writers in the front of the book would do the job. But I had promised Bob Barnes I'd write a review, so continued reading and started writing. 'Tis a book about which one might write a book.

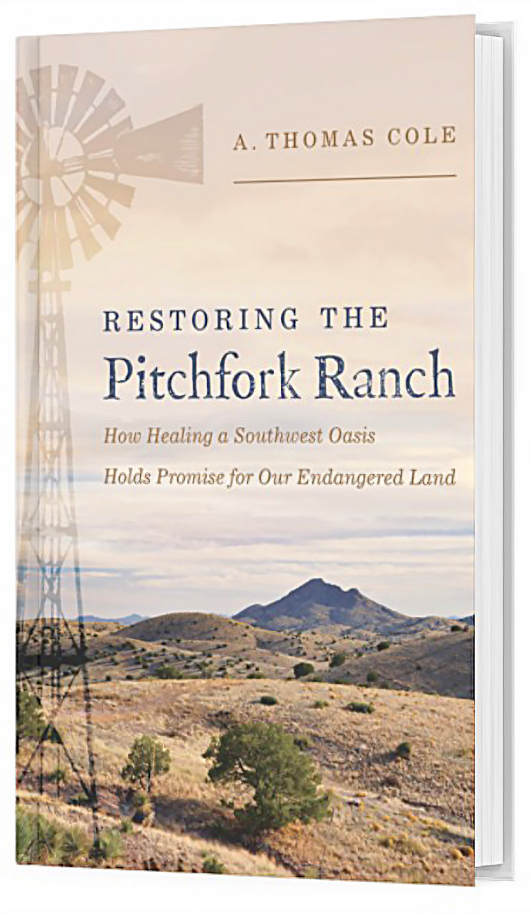
First, *Restoring*. . . is clearly written and well organized. In that sense, it is easy to read. It intertwines current events, archaeology, local history, world history and classical literature, philosophy, natural history, and modern landscape ecology better than anything I've read as applied to our current environmental morass. However, in terms of its message and demands, the book isn't fun to read; it's painful. Author A. T. Cole is a retired trial lawyer, a profession built upon effective usage of words. Cole learned his trade well and uses the skills of research, synthesis, and argument to present the most important message all of us will face in our lifetime: if we don't get off our butts and act, our species, perhaps life itself on Earth, is doomed. And time is running out.

The title is misleading. Only chapter six deals in detail with the ranch restoration process that A. T. and Lucinda Cole have engaged themselves in for the past twenty years. The remainder of the book ranges widely to expose the current state of the planet and to outline what is needed to reverse the effects of one species, our own, on our very existence. Cole's recommendations are not derived from speculation. In applying time-tested concepts espoused by John Wesley Powell, Aldo Leopold, Wendell Berry, Wallace Stegner, Wesley Jackson, Courtney White, Bill Zeedyk . . . the list goes on, the Coles have spent their own money and their retirement years reversing over 100 years of abuse to a New Mexico ranch and an enclosed ciénaga. The depth to which Cole has explored multiple subjects is exemplified by his entertaining essay on the derivation and correct spelling of "*ciénaga (cienega?, sienakey?, etc.)*" In ranging wide to expose the dangers that our children, if not us, will face, Cole hasn't lost his sense of history or skill in telling tales.

He doesn't stop with defining the problem; he delineates his vision of the solution, and he speaks loudly, with courage and hope, that we can stop our destructive ways. In so doing, he doesn't let anyone off the hook. The ecological route to stopping the devastating effects of climate change must be found and implemented, NOW, by us. The demands for change must be taken to the streets, must happen to *our* lifestyles and in *our* lifetimes. We can't rely upon big business or big government; in grubbing for wealth and power, the so-called leaders in our society aren't even likely to acknowledge the problem. And we can't pass it off to the next generation. But Cole feels that we still have time, if we as individuals make necessary personal adjustments and demand the needed change in priorities by our purported leaders. The old models and systems of belief, political, commercial, religious, won't get us there.

In *Restoring the Pitchfork Ranch*, the ranch becomes a metaphor for the planet earth, and Cole ranges widely to develop his message. The big job will be getting it read by the people who need it most.

'Tis a book about which one might write a book . . . He doesn't stop with defining the problem; he delineates his vision of the solution, and he speaks loudly, with courage and hope . . .
- Harley Shaw



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