

## UNUSUAL SUSPECTS:

“Allies in the Park, Are Closer Than They Appear”

Candace Gossen, PhD



### Summary

One season, 1039 hours, as a Park Ranger at Mesa Verde National Park. Interps we are called, observing, telling stories, being stewards of the past, present and future of wildness. Wildness in the animal world is reserved to only 4% of the planets millions of animals, Wildness is why people come to the National Parks, they are the last stronghold of beauty that bears presence in each of our souls. As a Field Scientist it is all about observation over time, and if you are lucky even, at the right time in the right place, a story makes itself known. This year, 2021, finally after the unlucky stall of 2020, we were back at work in the park and I am the lucky one to tell this story of how nature is working together as allies to regrow the burned forests of this place. Who are the characters in nature that are regenerating this burned landscape? I call them the “Unusual Suspects” and use the adage that we all have seen on our review mirrors “Objects in Mirror Are Closer Than They Appear.” I have rewritten those words as “Allies in the Park Are Closer Than They Appear.” Those allies, in this case, the *Yucca baccata* (banana yucca), the most important plant of cultural use by the Ancient Pueblo People at Mesa Verde, the Pinyon-Juniper forest and particularly the *Juniperus utahensis*, Pack rats and horses. There is much more than is visible going on, but these are the key players to the questions I asked: Why are the burned Juniper trees still standing after twenty years, some 90 years ago burned, still standing, how? And where are the new saplings, it appears that the trees are not growing back. The last 20 years the forests have stood still like an eerie Tim Burton movie. This field report includes my daily observations on the mesas over six months, data collection on 175 trees and new discoveries found that indeed new trees are growing back, with the help of their allies, the unusual suspects working together in regenerating life after wildfires. I can say for certain that regeneration takes communication, and in this case it is between nature through chemical signals, electrical impulses and heartbeats, neural networks working under the surface, deep in the earth that are keeping the ecosystem intact, strong and diverse. I’ve offered insight from these types of communication in ecology that we are just learning to understand that are intriguing and calling for all humans to pay attention.

## Intro

Why is this study important? One reason is because the most common question asked by visitors to the park is how is it possible the burned trees still stand? It is the obvious burned and blacked Junipers that call their attention and remind them that a healthy full Pinyon-Juniper forest existed here as recently as 20 years ago. **Everyone wants to know, How and Why are the burned trees still standing? and why does it appear that new trees are not growing back?** This field report is about finding answers to those questions and with pure curiosity as an ecologist, I wanted to know how this ecosystem is working together, whether it is regenerating, and how it is changing with climate warming and devastating wildfire cycles repeating themselves. Yes, we know that there were wildfires in the past, we have scientific methods that show through charcoal accumulation, pollen and other scientific markers that wildfires happen over and over again no matter whether it was 1,000 years ago, 10,000 years ago or twenty years ago. The question is then how fast will the forests grow back? and how will the ecosystems adapt as a result of a changing climate towards dry and hot. And let us not forget the importance to the cultural legacy that demarcates this national park, that the Ancient Pueblo People were here for more than 700 years and surely they lived through these same conditions too. Then, what is nature doing here at Mesa Verde National Park, who and what and where are the living connections keeping this place vital and can our understanding help to inform the past as well as the future?

As an Independent Researcher, this project began simple, I lived on the Mesa in a hogan that Chief Jack, the last Ute Chief, built for the park nearly 100 years ago. For 6 months with the call of coyote and the creaky tree next to the hogan, they became my daily observations. I could see, feel and sense change. I arrived in May 2021, in the budding of spring, when plants and flowers, pollinators, and bears were emerging. Every day walking on this landscape I watched 1039 hours of sunsets. As a Park Ranger I shared the stories of the ancient landscape, I explained about seep springs, snow level changes, medicine and food value of all the trees and plants. How the Ancient Pueblo People built and rebuilt over hundreds of years, how they used the trees and plants, what animals shared the landscape, and conjectured patterns of climate change based upon my



long 15,000 year climate profile created from coring the craters lakes on Rapa Nui. In the stillness there were serenades of owls, coyotes, turkeys, pinyon jays, the emergence of *Platypedia*, a periodic cicada that emerges every 3-5 years, triggered by an early heavy rain, it was their time to come back. Everything synched together, one thing, then another, as one



flower opened, then a new insect arrived, then the fruit, then the animals. In my duties explaining about the ancient dwellings and people of the Mesa, I could begin to understand the shared stories left behind. They told about the mountains of the four directions talking to each other, where the rain clouds form over the LaPlata Mountains to the East which become living ancestors bringing rain to the corn fields, taking care of the families and community of what is now known as Mesa Verde. The visitors often speak out how disparate this place is, how could the ancient people want to be so far away from everything, to work so hard building dwellings out of the ancient sandstone from the cretaceous ocean bed. Nature took a million years to carve these sandstone alcoves, and mold what we see now, but to the visitor it is one moment in time, humans are very impatient! Ecology, the connections in nature take time to pause and seek.



In my daily world, I reminded visitors to stay on the trail, as the fragile soils in the park are living cryptobiotic. Giving kudos to the park administration for having foresight not to cut the burned trees and causing more harm to the soil and possibly sealing the death to hundreds of species through trampling the park. By virtue of observation, the past 20 years post-burn has brought a lot to learn in how life is regenerating. In this report I will give more details about the forests, the trees, the climate and stories about ecological relationships. However the most important characters in this story are about a relationship between the juniper trees, the seeds with their entire potential, the banana yucca, the wild horses and pack rats. This is their story.

### Six months of observations

Within the park boundaries there are various zones defined by certain trees and plants, elevation, rainfall and seep springs, sunshine and shade. The 52k acres within the boundary of Mesa Verde National Park have a primary Pinyon-Juniper forest cover, except in burned areas which now totals half of the park acreage. Serviceberry and Gambel oak (*Quercus gambelii*) have taken full advantage of the open canopies and sunlight and are filling in the landscape. Ultimately it is temperature and moisture that characterize the plant world and it is they who dictate how life folds within these details. This Field Report is primarily focused on Wetherill Mesa, the 6 mile paved loop known as the Longhouse Loop; the walking paths at Far View Sites; the Hogan area where I resided and some random trees that I collected data on the main road. Essentially all of these areas have high visitor contact, are where cars drive and people walk. They are also areas near architectural artifacts and cliff dwellings. Limiting this research space to areas that restricted me to paved paths and not off trail, I used NASA's GLOBE Observer app to collect information on standing trees, living or burned, to understand the forest past and present and to add the information into a global database.



Near to the dwelling areas that have been better protected from fire, thanks to the firefighters of the past, certain plants and trees exist where in other areas they are now gone. In Spruce Canyon there are remnants of an older Ponderosa Pine and Douglas Fir forest with a large canopy of old growth trees. Through successions of hundreds of years of fire and development, these forests have diminished to a native Pinyon-Juniper forest that has opened to an Oak scrubland. Having calculated the age of at least 175 of the Pinyon-Juniper trees during this data collection, there are a few trees that are over a thousand years old still remaining that could give testament to the ancient pueblo people. The common age of the remaining trees are considered old growth juniper and pinyons as they are more than 200 years old, even though they are stunted to 20-30' in

height. The cold winters at -20F, the high elevation between 7000-8500' and the 6% moisture restrained by warming winter temperatures and periodic rainfall, maintains a strong and sturdy forest adapted to this unique environment. Essentially everything here has adapted to the periodic climate cycles, including the cycles of humans.

In May 2021, my attention was spent learning about all of the plants that were near the ancient cliff dwellings, paying attention particularly to the yuccas which were in great abundance in these areas. They were very important to the ancient people as the fibers of the yucca made their sandals, baskets, blankets, and ropes. These yuccas produce large stems that bloom large fragrant white flowers that are very tasty too. Once pollinated they produce large squash like fruit and it is the ants and insects that devour them immediately. Once this scenario is complete, there is a time of pause when the yuccas are soaking up the sun and growing. However, very peculiar I began to make note of how many of the yuccas then were beginning to be filled up with horse dung. Yes indeed, didn't the horses know about the yucca spikes, I am sure many were poked in this process indeed. But why the horses? who love the big white flowers of the yucca like candy, why were they returning and pooping over and over again onto these yucca? Was this happening just near the dwellings, on the trails I walked, and the burned areas? It was confirmed that the answer is everywhere the horses travel there is a yucca full of poop. As summer began to turn to fall, another interesting thing began to happen to the yucca, pack rats were building huge nests on top of the dung encased yucca. It was as if being sealed for the winter. What an unusual host of characters working together I thought. What an amazing ecosystem adaptation, in a place that finds it hard to fix nitrogen in the desert soils, the horse poop was full of the grass and Nitrogen. Made me wonder who was in control here was it the yucca in need of nitrogen, or the horses craving the carbohydrates, who ensured next season's flowers, or the pack rats in need of warm homes for the winter and a place to store the juniper berries they collected? What I discovered next unfolded with a smile.

Using the NASA GLOBE Observer app to collect data on the standing trees, burned or alive, to identify height, circumference, and age. Observing the plants that grew near and under the canopy of each of these trees, and noting allies like fungus, insects, and birds colored the ecology notes. Besides creating a foundation of knowledge about the forests, I also had a mission to locate where I noticed new trees growing. It was very apparent that beneath the living Juniper and Pinyon trees there was a higher probability for new saplings to be found as that is where the viable fruit and seeds fall from the living trees. The larger question asked if new saplings were also growing in the burned

areas, that were far away from living trees? And in every situation, 100% of the cases, the new saplings of juniper trees, which grow at a rate of 1' every 5 years, was found within the leaves of the yucca plants! What better place to grow but in a compost pile of grass, left behind by the horses, nestled within the bark nests of the pack rats who had tirelessly run across the open spaces and tucked away their berries for the winter. Some, falling out of the nests were then becoming the new forests of the future. Thrilled to find these unusual suspects working together regenerating the forests. Our Children's children children may see the park once again as it was twenty years ago. From the human perspective, Stewardship and Conservation are the keys, but Adaptation will come nature, it knows what to do, how to call in the cast of characters when others go extinct, how to work together to get what it needs. I am certain that Mesa Verde National Park could exist well without humans involved at all. In order to co-exist communication is vital. Understanding how these characters are working together to regrow the forest is critical, and I cannot wait to observe more! The following paragraphs seek to explain how nature communicates in amazing ways.

### **Supporting Information for the Curious**

#### About the Park

"Mesa Verde National Park encompasses 51,982 acres (21,000 ha) in southwestern Colorado. First established in 1906 to protect over 4,800 Ancestral Puebloan archeological sites, the park's enabling legislation was amended several times to expand the boundaries and enhance the park's purpose to include the preservation of the forests, wildlife, and other natural features and values and to exclude incompatible uses."(MVNP)



The park became a UNESCO World Heritage Site in 1978. It is the largest cultural legacy in North America, and contains more than 5,000 structures, 600 of which are cliff dwellings. The largest dwellings of which Mesa Verde is known for are unique and limited, there are only 12 of these large community centers with names such as Cliff Palace and LongHouse:

*Mesa Verde National Park was established by an Act of Congress in 1906, before the existence of the National Park Service itself, and was the first archaeological area in the world to be recognized and protected in this way. The eventual inclusion of the area within the National Park system gives it the highest possible level of protection, as it is owned and maintained by the federal government, and assures a high standard of interpretation and public access. Park staff consults regularly on interpretive materials, research and preservation of archaeological resources, and proposed construction plans with representatives from 26 culturally affiliated and traditionally associated Native American tribes and pueblos who consider Mesa Verde their ancestral home. (UNESCO)*

The dominant forests are Pinyon-Juniper mixed with high desert grasslands, Gambel-oak and a diverse desert ground cover of plant species which added up to 80 plant species found in my research area with numerous insects, snakes, birds, and animals.

Free range cattle grazing ceased in the park some 60 years ago, however rogue cows and horses do wander in from the surrounding BLM and Ute land. On a good note, native plants and species are returning. Becoming a Sky Island, there are many plants that are now endemic and restricted within the park boundaries. MVNP has identified an inventory of animal life include five amphibian, 200 birds, 5 fish, 74 mammals, 16 reptiles, and several hundred invertebrate species noted thus far.

For more information see the NPS website: Southern Colorado Plateau Inventory & Monitoring Network found here <https://www.nps.gov/im/scpn/meve.htm>.

### The Forests of the Green Mesa

The common forest on the green mesa is a Pinyon-Juniper Woodland. The evergreen trees include Pinyon Pine, whose revered cone nuts are favored food of human, birds and animals. Pinyon jays are commonly seen pecking cones open to find the nuts within, however this year 2021 all of the nut shells that I observed were empty. The Pinyons only produce viable fruit every 4-7 years, and take at least 25 years to become cone-bearing for the first time. The trees have an average life span of 600 years with some known to reach 1,000 years. They grow between 10 and 60 feet tall with a rate of about 2" per year in height. Once they reach 30' tall they increase their growth rate up to 4'6" in per year. It is very common for the canopy of the Pinyons to spread equally as they are tall, and match size for size with the Junipers that they mingle with.



The wifey twisting Juniper trees are better known as *Juniperus utahensis*. Junipers have short util-stemmed trunks with reddish-brown fluffy bark that cracks easily. Unlike most trees, junipers are dioecious, meaning that individual trees produce either male or female flowers. Fruit is in the form of small green berries, which turn dark bluish purple when ripe. Each berry contains three to six seeds. The junipers have tap roots that travel 25' or longer in search of water. Peter Wohlleben calls this tap root dance, the song of water, in that the tree is following the sound of water as it flows deep into the earth. At Mesa Verde, these deep tap roots come from a central soft tissue core that penetrates through the porous sandstone following the seeping water as snow melts on the mesa. Their lateral roots extend off into the distance 100' and it is through this root process that gives the soil ecosystem integrity. A burned tree standing for 90 years requires a living core tap root, and lateral root system that is tied into the forest. There is no mistaking that the standing burned trees at Mesa Verde are still viable, even though they are not producing leaves and berries, that they are connecting, communicating, transferring moisture and signals to the diverse plants and perhaps more life like the horses and pack rats that

we can't visibly see. During wet years these trees are prolific seed producers with up to 200,000 berries per tree but they only stay viable for 18 months. Wildfire is not a friend to a Juniper with its fluffy outer bark, and what we see standing at Mesa Verde, these artistically crafted trees, is the burned and lost fluff and cambium layers leaving the sapwood darkened, with an



internal heartwood hardened still tapped into the sandstone, dark and strong, still standing. Junipers grow their multiple stems simultaneously, therefore it is incredibly difficult and unwise to count growth rings of a juniper, the best way to guess age is a combination of circumference and height.

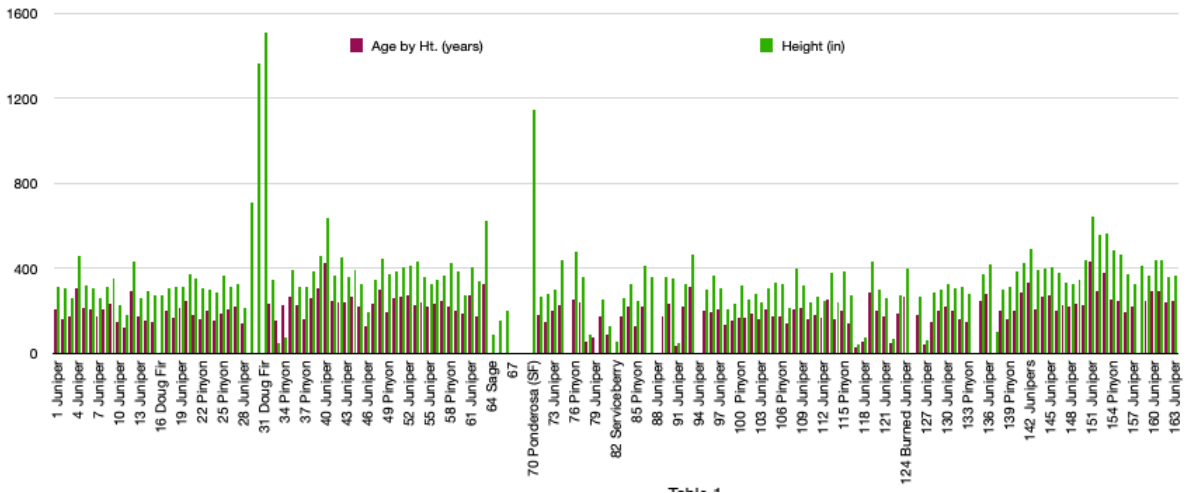
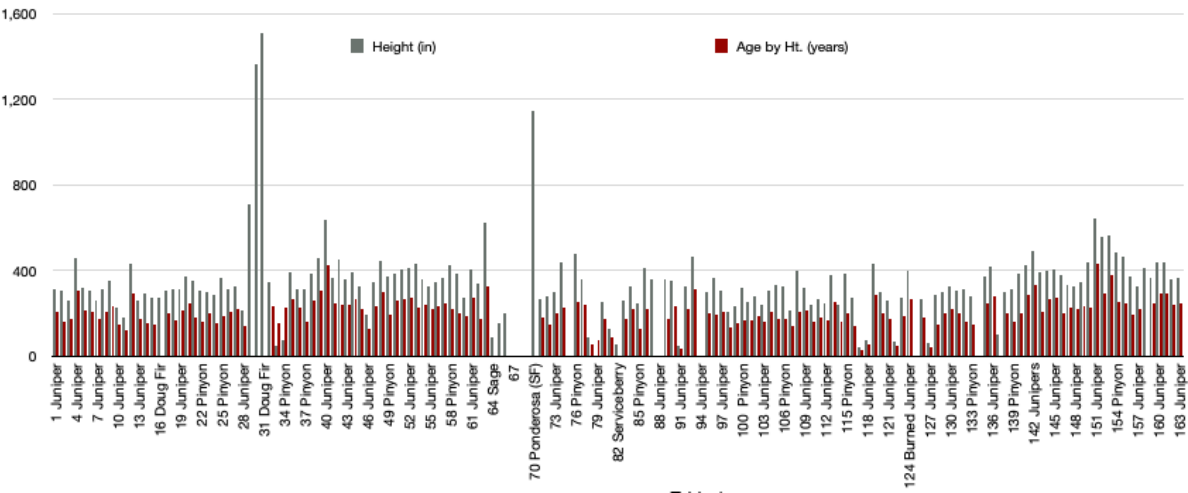
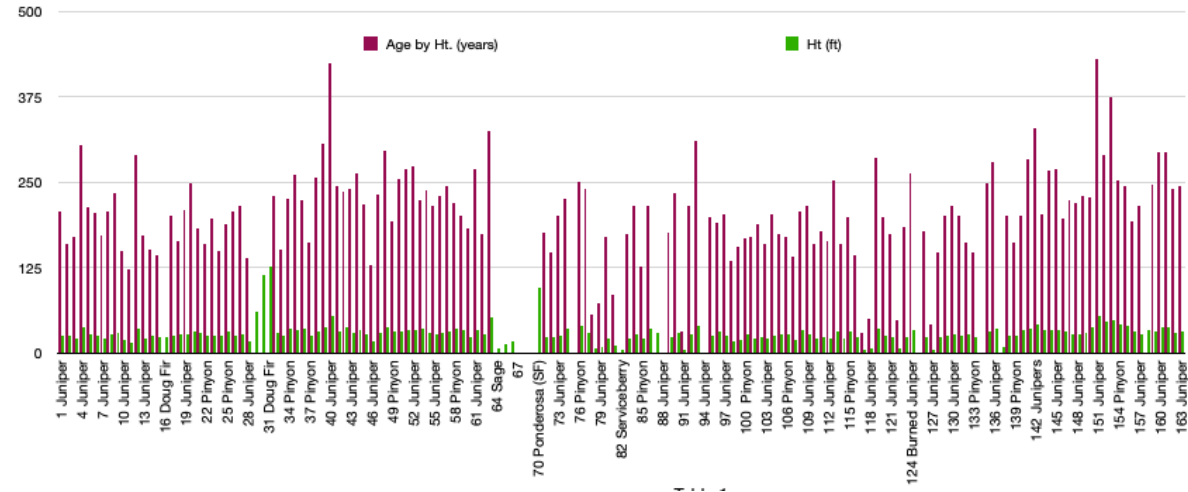


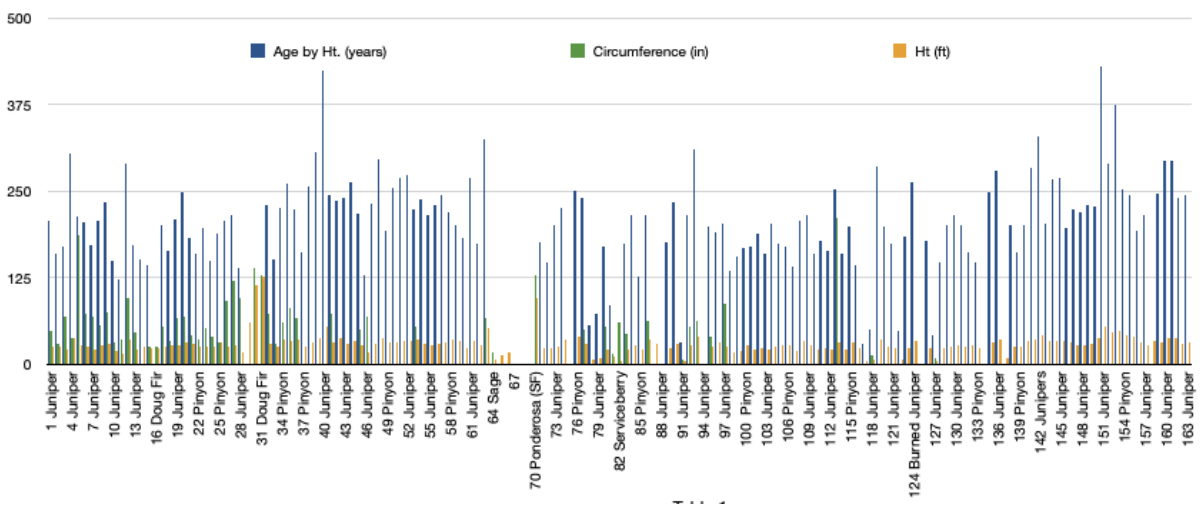
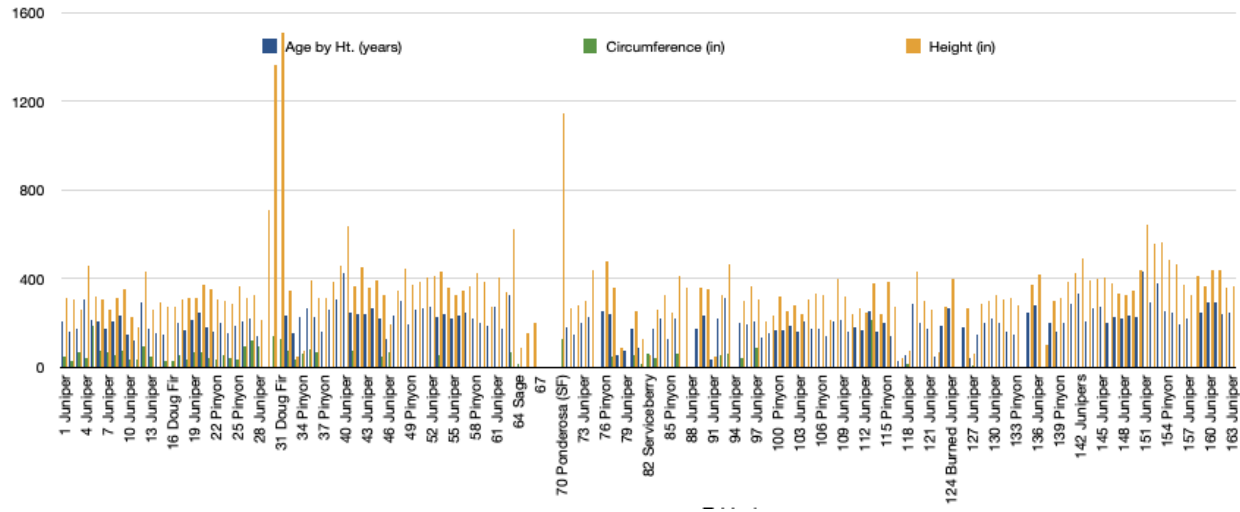
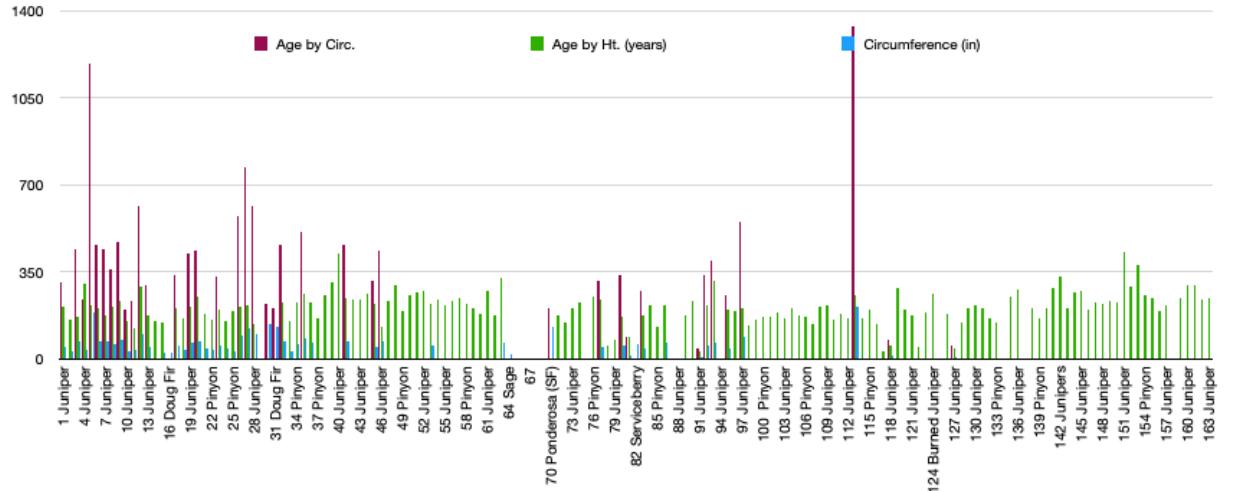
Cultural use of both Pinyon and Juniper are commonly found as building materials in the ancient dwellings. Also both are food and medicine for many animals including humans. Decoctions were made of bark, roots, branches, berries, leaves, and seeds that were used to treat the lungs, skin, arthritis, and much more. A special use of the bark by the ancient dwellers was to light the eternal fires in the kivas and for sacred ceremonies.

This year as I collected data on the 175 trees, which was only limited to the number of days available during my season in the park. I also identified at least 80 plants that were growing near, under and around these trees. The following charts are created from the data collected with the GLOBE Observer app which is uploaded to the NASA global database and accessible to anyone around the world.

Of the 175 trees documented, 7 were burned trees to find the average age of the forest during the last wildfire twenty years ago. The age of these burned trees ranged between 202-263 years. As for the living trees, four were old growth Douglas Fir found on the Petroglyph Pt trail with an average age of 220 years. Data on 100 Juniper trees living averaged 202 years of age based on height with the oldest at 430 years, however based on circumference the average age was 430 with the oldest tree being 1,338 years old. For the Pinyons, 50 were identified for data collection looking for the tallest trees since they grow straighter with a continuous stem. The average age for these Pinyons is 192 years with the oldest being 326 years old. The following charts are a visual play with the data:







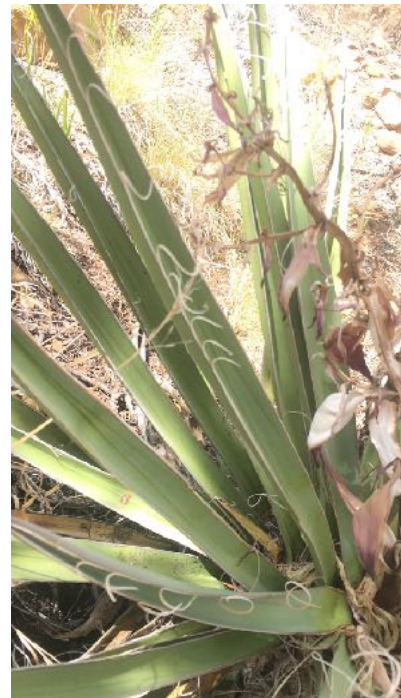
## Unusual Suspects

This part of the Field Report is the fun part, the part that is theoretical, the part where one tries to make story as if in the minds of other is not impossible, but rather anthropogenic, or perhaps formless, invisible relationship. First to introduce the characters at play in the story I mentioned above:

**The Yucca**, (*Yucca baccata*) The banana yucca is a common desert species native to southwestern United States, and into northwestern Mexico. According to the USDA the banana yucca is found in California, Nevada, Utah, Colorado, Arizona, New Mexico, and Texas, as well as in western Louisiana. It is found in Chihuahua, Coahuila, and Sonora, Mexico and is reported to occur in southern Australia. This yucca is commonly found in Pinyon-Juniper forests both widespread and isolated in Sky Island biogeographic regions, along with Gambel oak and Serviceberry. In Mesa Verde the yucca is found in association with particular plants in areas with diverse burn histories including serviceberry, bitterbrush and fenderbush.

The yucca can grow very large, up to 30' tall and produce procumbent stems and rhizomatous stems with roots sprouting both aerial and earth bound that are long lived and create a complex net beneath the soil surface. The yucca reproduces through its rhizomes and root structures and less from seed. However seed dispersal requires participation with vertebrates like rabbits and wood rats. Large white flowers bloom each spring on a central panicle that grows more than 3' tall. Once pollinated, large fruit emerges that look like long cucumbers or squash full of seeds. The plant has adapted to drought and fire with long term water storage in the thick leaves and base of the plant. Banana yucca adapted to drought, developed a crassulacean acid metabolism (CAM), allowing carbohydrate stores, built up in the summer and early spring, to assist during the reproductive period in late spring. And with the storage of carbohydrates, there will be sugar loving insects and animals ready to exchange these sweet nectars. The sugar is what fuels the fungi networks in the rhizomes beneath, as they scavenge the soil for nitrogen and phosphorus just as they do amongst the forest roots.

The Range of Tolerance for banana yucca is in open dry grasslands and in shady woodlands, on slopes in a variety of soils ranging in varying pH levels 8-8.7. Elevation ranges are between 2,000 and 8,000 feet (1,000m - 2,500m) commonly, and in areas defined by biannual rains in winter and summer ranging from 11-18" annually. The yucca is quick to recover in burned areas. Usually found within a year after a wildfire growing from the rhizome network beneath a Juniper woodland. In an area where a Pinyon-Juniper forest has been burned, it will begin to recover within 30 years. It is the yucca that is intertwined with the lateral roots of the junipers holding the soil ecosystem together allowing it to return.



The banana yucca is important to wildlife over its broad rangelands. Many such animals include javelina, mule deer, elk, cow, horses, bighorn sheep, antelope, birds, wood rats, rabbits, ants and a variety of insects. It is the stem, flowers and fruit that are high in fiber, protein and calcium while the flower stalks are high in phosphorous making the banana yucca highly nutritious both to human and animal alike. They also provide homes for many birds like quail, and as I observed a favorite for wintering pack rat nests.

The **Pack Rat** (wood rat) who is very plentiful at Mesa Verde, also likes to get inside one's truck at night, and sometimes chews wires of the NPS vehicles. The wood rats are intelligent and curious creatures. In the scientific community, pack rats and other rodents play an important role in preserving history. Paleobotanists and climatologists have studied the ecosystems of the past by analyzing plants and seeds, sticks and bones in rat nests, tracking ice age climates and changing flora across the American Southwest. The pack rat is very advantageous in creating relationship with other species and has a flair quite unique to the animal world. Similar to the Bower bird who creates giant nests with selective colored and flashy objects, the pack rat will return to nests for hundreds of years, sealing the integrity of the nest (home) with crystallizing urine to harden the architecture. And like the bower bird, has a penchant for shiny and colorful objects like marbles and buttons.

I played a little game with one this summer. Leaving objects for the rat to see what he/she preferred. She didn't take any objects I left in exchange for a bid to stay out of my truck, but after leaving a few cheerios, and their disappearance I assumed it was food he wanted. So I left a few nuts, and I was thrilled that he stayed out of the truck, until after a week of exchange I discovered she had put all of the morsels inside of the air filter box in my truck! So I stopped and he stopped. A rather good deal was made.



Pack rats will make their nests in cliff dwellings, just as the ancient humans made theirs at Mesa Verde. I have found them between boulders, in natural holes of the sandstone walls, and in particular for this field report, on top of yucca plants. Waiting until spring bloom and summer fruiting is over, and after the horses deposit their grass saturated dung on top of the yucca plant, it is the pack rat who winterizes the final large nest made of juniper bark and found sticks in the woodland. And it is the pack rat and the ground squirrels who carry cheekfuls of berries,



out onto the grassland, far away from the living trees, to lay them to safe keeping within their nest, composting and incubating under the horse dung resting onto of the yucca, that will produce at least one future tree under its leaves

### **The Insects, Ants and other decomposers**

Wasps, bees, ants, cicadas, and even midges all have their place at Mesa Verde and their timing is in synch with a pattern that I have just begun to understand. Each plant has its blooming time, some in spring, some in summer, some in Fall and even some at the edge of winter. With each plant there is a par-



ticular bug perfectly adapted to it. Perhaps the rabbitbrush is the most colorful and brilliant provider for bees, moths, butterflies and orange pumpkin shaped Spiny Tachinid Flies (hedgehog fly).

They all have their time, and the characters arrive all based upon the seasonal changes in plants and trees. The rabbitbrush may be the queen adapter however, even after 6 months of no rain, it still blooms providing sustenance to all that depend on its multi-colored showy blooms. And for the banana yucca, the nocturnal *Pronuba*



*moth* which has adapted to be specific to banana yucca can remain in diapause for up to 30 years, emerging only when climatic cues are optimal for development. A photo capture of a rare stray *P. Burnsius albescens* whose presence this year may be a tell tale environmental sign. Even the desert tarantula (*Aphonopelma chalcodes*) -- aka western desert tarantula, who mates for life, whose males come out in the thousands in October, crossing roads with their brown "furry"

butts to the amazement and horror of some visitors at the park. They cross pathways on their long journey, sometimes up to 50 miles to find that one true love.





**Horses**, everybody loves horses! They are the thrill of spotting wildlife at Mesa Verde. Especially when new foals are born in the spring and they stay around Wetherill Mesa kiosk. These horses have all been born in the park, but there has been a long disagreement whether they should stay. First let me start with stating as an Environmental Scientist, and an Archaeologist, timelines, historical, pre-historical are all human creations of division. Native and Exotic, or Invasive are all terms used to define what stays and what goes away. These are arbitrary timelines. What these do in fact is create the ideas of conservation and preservation without the allowance of adaptation. I will leave those ideas here and try my best to give a little history of the horses. Going beyond the boundaries of the National Park which was created in 1906 there were animals in a broader biogeographic region even calling the entire area of North America its homeland. Bison and Bighorn sheep were once part of MVNP, but successfully killed off in the 1800s and are now extinct. Yet longer ago great diversity of animals roamed this area pre-human dwellings and it is the human artifacts left behind like the Atlatls and Clovis spear points that tell us so. There were camels and lions and ancient horses that browsed North America. I have worked on a site in Louisiana when an oil drilling rig on Lake Peigneur punctured a tunnel to an adjacent salt mine and successfully drained the lake and the flowing river backwards into the 2,000' mine shaft pulling with it barges and ships and luckily, no humans in the process. What was uncovered by the eroded soil on the banks of the lake were mastodon and ancient horse bones. Yes, ancient horses larger, more robust than the Spanish horse that we know now as mustangs and stock horses, but before their arrival with the Spanish, there were horses here on this landscape.

During the reintroduction of horse in the Desert Southwest, in the 1600s, it was the Ute that became known as the Horse People. Horses were part of this landscape for hundreds and thousands of years. When Mesa Verde NP was established the Ute took their horses with them, and therefore there were no wild horses living within the park boundary, not until domesticated stock horses were brought in for trail concessionaires in the early park days. It was then that these horses used for trail riding were let go into the park to live a wild life. Today there are 75 or so wild horses within the park boundaries and a few ute strays that call this place home. To-

day they are called “Trespass Feral Horses” but this Field Report is not about the current political situation with keeping or removing the horses, but rather a nature, biological key to understanding their part in regenerating the burned forests which I discovered while looking for where the new trees were growing.

During my time on the mesa this year 2021, the horses still remained, in their family groups, birthing new foals, and to the love of the people, still endearing the wildness that people come to the National Parks for. It is David Attenborough who states that of all the animals on this planet, a small amount of the 6.5 million land animals alive on this planet today, only 4% are wild. Wildness, one must ask, what is it that we seek or fear of it? Daily, guiding 1200 people on tours, people thanked me for being of service, for taking care of the wild, for protecting the legacy that came long before our modern world, and there is reverence to that, to be good stewards and keep that going forward for another thousand years.

### **How it all came together**

My observations at the park this year, amazed me. It was a very welcome surprise, knowing that there is something deeper and wilder than humans can contain or reconstruct that will in turn regenerate the future. Nature has all the potential, even in the smallest seed, it has everything it needs to become a large and old tree, and perhaps there are relationships above and beyond that seed, that tree, that horse, that rat, that are all working together. We just have to pause long enough to see it. I have seen it, clearly, the horses are communicating with the yucca, they are working with the pack rats who are also working with the yucca, how they are doing it is unknown. Is it chemical signatures, is it vibration, is it through smell or feeling, taste, seeing, or all of the above. In this case, these unusual suspects as I call them, have come together all without the plan of humans. Who is the key here? Like at Yellowstone NP when wolves were reintroduced, the ecosystem became whole again and healthy. Is the yucca the maestro, conducting the symphony of flowers, fruit, insects, moths, rats, horses? In time with the sun, through the seasons’ changes, bringing this cast of characters together? But what about the trees, growing silently within the cover of the yucca for years before being spotted by a human eye? Could they be the key? Could this root network between the trees and yucca be interconnected in their rhizomes, roots, mycorrhiza sending chemical and neural messages in order to work together to regrow the burned forests? Trees share water and nutrients through the networks, and also use



them to communicate. They send alarm about drought and disease, or insect attacks, and other trees and plants, perhaps even animals alter their behavior when they receive these messages. Mycorrhizal networks, a symbiotic relationship exists in the soil beneath our feet. The sugar, carbohydrates is what fuels the fungi, as they scavenge the soil for nitrogen, phosphorus and other mineral nutrients, which are then absorbed and consumed by the trees. Perhaps the signals are coming from the fungi and they are the key to these unusual suspects? Peter Wohlleben, the author of "The Heartbeat of the trees" is delighted by my question, he says he seems to agree.

## Communication

The term '*elan vital*' coined by a French Philosopher Henri Bergson in 1907 in his book Creative Evolution, is defined as:

**: the vital force or impulse of life** especially : a creative principle to be immanent in all organisms and responsible for evolution.

There are ways in the biological world where creatures such as ants communicate, not by voice, or by sight like humans, but by leaving pheromone trails, as E.O Wilson states. He made it his life study to understand the social structure of ants and much more. He found that the very smell of terpenoids emitted from the ants, direct the entire colony to work together, to know where to go, to escape in fear, it is a communication channel of chemicals. Some terpenoids, such as taxol and mono-terpenoids, are also found in the phloem of trees. The very release of terpenes and terpenoids in the air of a conifer forest actually induces our bodies to manufacture more Natural Killer Cells which in turn make us stronger, healthier by boosting immunity. Forest bathing as the Japanese call it, is all about the smell of the forest. The chemical world is more connected than we could ever imagine. It is the trees that heal us, that connect us with nature.

After observing the "unusual suspects" I mentioned above working with the yucca plants, I wondered how they were "talking" with each other. Could it be chemical? Can the chemical world also create relationships of varying species to work together? Sure, examples of bees and flowers both in need of the other, both evolving to work together. But is there more than chemical communication? Yes, there are heartbeats in trees, electromagnetic frequencies that make spiders landing on trees have "goose bumps." There are vibrations that are sent and received across oceans, plants that lean to sunlight and shy aware from harsh behavior. There are plants that change the sweetness of their berries if a predator eats more than its fill. There are signals in the roots of trees that call in the forest to keep alive a stump that has no branches, no leaves, but is still fully alive through the root connections of the mother tree. An amazing world indeed, the question now, for this field report, can communication cross species to entice those without roots to make things happen for those that are stuck in the ground?

I think about a crab cactus that I have had for more than 20 years, traveling shotgun often, she blooms more than once a year, but always for my birthday. Coincidence? Traveling in the truck, she gets to see the world, meanwhile maintaining her roots in the pot. It is a science experiment, grow a tree in a pot, measure the soil, year after year, the soil volume stays the same, but yet



your tree has grown taller, beyond you in every way. How? from the air, same as your breath. I imagine how a plant that is root bound to the soil receives messages, life in the moving wind, through the clouds, in the jet stream moving around it. A 1,000 year old tree will never get to feel NYC if it is in Arizona, but in a mobile truck on wheels the plant can travel the world as long as its human is giving water and correcting the temperatures so its not so hot and not so cold. A relationship, both of us, dependent on the other, has that crab cactus reeled in her human to give her a ride in the cosmos? I wonder with excitement. Sometimes, clever things reveal themselves.

At Mesa Verde, horses are highly sensitive and they are conscious of the changes in their surroundings, the plants adjust to changing climate patterns, rats plan generations of architecture in harmony with the trees that live equally a thousand years together. If we have the right devices we can capture the "voice" of a plant sending out ultrasonic "squeals" or through a video catching its lean into light, or the wilting of a tree's branches every few hours to then lift them up every 3-4 hours in synch with its heartbeat. In isolation we can observe, through technology we can capture moments, but patterns of relationship across species, especially between plant and animal, is not a common study, but so much needed.

### **Methods of Communication - Chemistry**

E.O. Wilson was a big influence in my teaching after I discovered his book "On Human Nature." He gave my feeling of aloneness as a scientist, a teacher of environmental sustainability, a familiar voice. Wilson tried to explain human nature and sociobiology through his work with ants. His "Letters to A Young Scientist" resurfaced for me just recently and sparked a kindredness in my trying to explain relationships observed in nature that could not speak out and tell me direct. It was in his research on ants that he discovered that they use pheromones, acrid smelling terpenoids as warning signals, as directions and information in how to keep the colony functioning together. Beyond surviving, this understanding of gene evolution and cultural evolution may be a way to understand how the ants have continued to pass on this chemical communication process for millions of years. May we call that Memory? Each organism on earth has a unique way that they solve a problem. Each organism is ideally suited for an environment and if there is an external factor that makes change to that environment, the organism has to adapt or die. Everything is in constant adaptation, it is just a matter of time, however cycles and patterns for everything in nature is on differing timescales. In order to heuristically uncover new information, we have to see diversity, and at least ensure it remains in the natural world so we can learn from it.

If one species comes to an end, then there is another occupying a different niche that will likely carry on. In the case of the horse and the yucca at Mesa Verde, it made me think about how long the yucca plant has existed on the mesa and how short of a time these horses have been there. If the yucca is recruiting the horses to be their legs so to speak, to ensure they are fertilized, then who were their legs before the horses? Was it the Big horned sheep? or the Bison? Grazers, movers across the landscape eating grass, but were the other animals pooping on the yucca like the horses do? or is this a new adaptation recently adopted? The elk and deer on the mesa eat grass, but they are not pooping on the yucca.

Some trees have been noted to recognize saliva of particular animals, A study from the German Centre for Integrative Biodiversity Research shows that trees know the taste of deer saliva. In our case at Mesa Verde, have the yucca chosen the horse instead?

Does the horse know that if she poops on the yucca, then it will ensure new flowers in the spring? If the horse loves the flowers and waits for them to bloom in the spring, then the yucca knows to keep the flowers tasty, if they are sweet then the horses will come. Maybe in gratitude the horses return the gesture with giving it nitrogen through the grass. Is this a chemical transfer of communication? Evolution has provided adaptation of particular birds such as a hummingbird and the trumpet flower, to fit together perfectly. However, evolution takes a long while. How then can a short-term relationship like the one between the yucca and the horse come into being so quickly?

### **EMF and vibrations**

The world is full of electromagnetic frequencies, some humans hear, some they feel. Other species have higher and lower ranges like whales echoing 7-10 hz and cellphones at 5G for us humans. In the world of trees, we look at the smallest of the small (spiders) and how they communicate with trees. It has been noted that some spiders, with their hairy legs and receptors called *trichobothria* are sensitive to electromagnetic currents. The spiders are so sensitive that when a tree sends its currents up its vascular system, the spider's hairy legs develop sensations that raise the hair. To communicate through the network, trees send chemical, hormonal and slow-pulsing electrical signals. Edward Farmer at the University of Lausanne in Switzerland has been studying electrical pulses in trees, and he has identified a voltage-based signaling system that appears similar to a central nervous system in animals. "When a tree is injured, it sends electrical signals like wounded human tissue." (Larocque) Perhaps spiders, insects, and other animals speak tree language in electromagnetic signals?

A study from researcher Erica Morley at the University of Bristol reveals that spiders are sensitive to electrical fields like those all around us in the earth's atmosphere. She found that the electrical fields could be detected by the tiny hairs on the spiders' legs and encouraged the behavior identified as "ballooning," the act of flying. In another study published in [Science](#) a few years ago about how spiders can fly across the ocean without wings! How do they do it? Through science experiments it was discovered that spiders have been seen to do what they call a take-off dance, tiptoeing. Lifting everything higher to the tip of their toes, as if ready to jump, preparing for the ride, along static electricity.

### **Trees have heartbeats**

The human heartbeat is directly connected to the electromagnetic frequencies of earth. W.O. Schumann discovered Schumann Resonance in 1952. He observed that the global electromagnetic resonance at 7.83hz is kept relatively constant on the surface of the planet by 2,000 lightning strikers per second between the ionosphere and the Earth's surface. This consistent electrical pulse at nearly 60 beats per minute and it is the human heartbeat that is synched to this global pulse. No mistake that this subtle pulse conducts on the water planet, and the ancient Chinese

with thousands of years of observation, use the bottom of the feet walking on the earth as a way to recharge the body. Why not then if the earth has a heartbeat, humans have a heartbeat, that trees do not? Wohlleben's latest book *The Heartbeat of Trees* tells us that "Trees can "hear" water flowing deep within the ground and they display a consistent vascular movement resembling a heartbeat as they pump their sap at regular intervals, once every three or four hours.....Trees possess memory, and can pass those memories on epigenetically to their offspring." Therefore the forests of Mesa Verde, do possess memory, speak to each other, and to various other plants and animals, why not could they ensure their own regeneration through the help of allies? Plants do reflect animal sounds to communicate with them. Convergent echo reflectors in several plant species attract mutualistic bats for instance. Reflectors serve as signals or guiding posts and there is growing evidence for acoustic communication in plant-animal interactions. What then is the song between the horse and the yucca? or can we hear the symphony between all of the allies working together?

## **Conclusions**

During this year 2021, I observed what I call "Unusual Suspects" working together to regenerate a burned forest. Unusual to me because I was the alien, a visitor amongst millions coming in and out of this Sky Island made up of multiple ecosystems co-existing within the Mesa Verde National Park boundaries. Together this biogeographic area is adapting to climate warming, and before that adapted to the last Ice Age and beyond. Memory continues forward through the trees that pass information epigenetically, through their senses to the world around them. The allies in this story - yucca, pack rat, juniper and horse have made connections and are regrowing the forest ecosystem and are helping to regenerate this burned landscape. Wildfires will continue just as the lightening that caused them will too with climate warming. At Mesa Verde, the winter snows have reduced from 5' to just 1' and without the seeping water from the snows things will remain dry. My research this year added 175 identified Pinyon and Juniper trees into the NASA GLOBE database which enables anyone anywhere to learn about the Mesa Verde trees. This Field Report jumped in deeper in observing over time how unlikely allies are helping to regrow a burned forest. The evidence challenges old systems of belief in how to treat burned forests and offers a deeper understanding of how nature communicates in order to become a healthy viable forest again.

I am thankful and grateful to the NPS, to Mesa Verde National Park for offering me a place to be inspired, to learn from, to become a better scientist and listener to nature.



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*Abstract: Acoustic communication is widespread and well-studied in animals but has been neglected in other organisms such as plants. However, there is growing evidence for acoustic communication in plant-animal interactions. While knowledge about active acoustic signaling in plants (i.e. active sound production) is still in its infancy, research on passive acoustic signaling (i.e. reflection of animal sounds) revealed that bat-dependent plants have adapted to the bats' echolocation systems by providing acoustic reflectors to attract their animal partners. Understanding the proximate mechanisms and ultimate causes of acoustic communication will shed light on an underestimated dimension of information transfer between plants and animals.*

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*A heartbeat every three to four hours is, unfortunately, too slow for even the most sensitive person to feel when they hug a tree. But there is one last possible way to connect with trees: our voices. Can plants hear? I can answer without hesitation in the affirmative. This was tested years ago with Arabidopsis, a genus of rockcress beloved of scientists. Beloved because it grows well, it reproduces rapidly, and it's easy to keep track of its*

*genes. Scientists discovered that the roots of Arabidopsis oriented themselves toward clicks in the frequency of 200Hz and then grew in that direction.*

*Arabidopsis also seems to react to the nibbling of caterpillars, an ominous sound to plants of all species. Researchers at the University of Missouri put caterpillars on samples of the plants. The vibrations caused by the caterpillars munching were enough to shake the plants' stems, and the researchers used laser beams to record the vibrations. When researchers then played these vibrations to plants that were not being eaten, they produced particularly large quantities of defensive chemicals when they were later attacked. Wind and other sounds with the same frequency did not elicit a reaction. Arabidopsis, then, can hear, and this makes perfect sense. Thanks to acoustic warnings, it is able to recognise danger some distance away, so it can make appropriate preparations to defend itself. What is particularly important here is that the plants ignore noises that pose no threat to them. These noises probably include human voices. What a shame.*

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*Plants Use Chemical Signaling*

*So remember, organic chemistry is behind all of this communication. A small compound can allow plants or insects to create scents. These scents can enable them to communicate. A compound can seem sweet and inviting to one animal, while another compound can be used to make animals leave the plant alone. Plants can't move from place to place, but they can use these organic chemicals to "talk" to other plants, and also to animals! Amazing, isn't it?*

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