NORTH DAVIS
PREPARATORY ACADEMY
ZIONS NATIONAL PARK
CAMPOUT
2019

The 2019 Travel Commitments

- **I will be a positive example representing myself, family, school, state and country.**
- **I will obey the instructions of the chaperone(s).**
- **I will follow the behavior policies of NDPA, the laws of Utah, and the United States of America.**
- **I will always use the "Buddy System" and my chaperones will know my whereabouts at all times.**
- **I will not create or cause a safety issue for myself or others.**
- **I will be in NDPA uniform or designated dress each day.**
- **I will keep my appearance clean and appropriate each day.**
- **I will be on time for all scheduled activities and events.**
- **I will NOT be out of my tent following bed check.**
- **I will be kind, courteous, respectful, and help others enjoy their time with me.**
- **I will report any infraction made by myself or that of another student to an NDPA chaperone.**

I understand that failure to abide by the above rules may cause injury to myself or others and may cause the trip chaperones to contact my parent(s), issue a school suspension, or arrange for immediate transport back home at my family's expense.

Student Signature:_____ Date:_____

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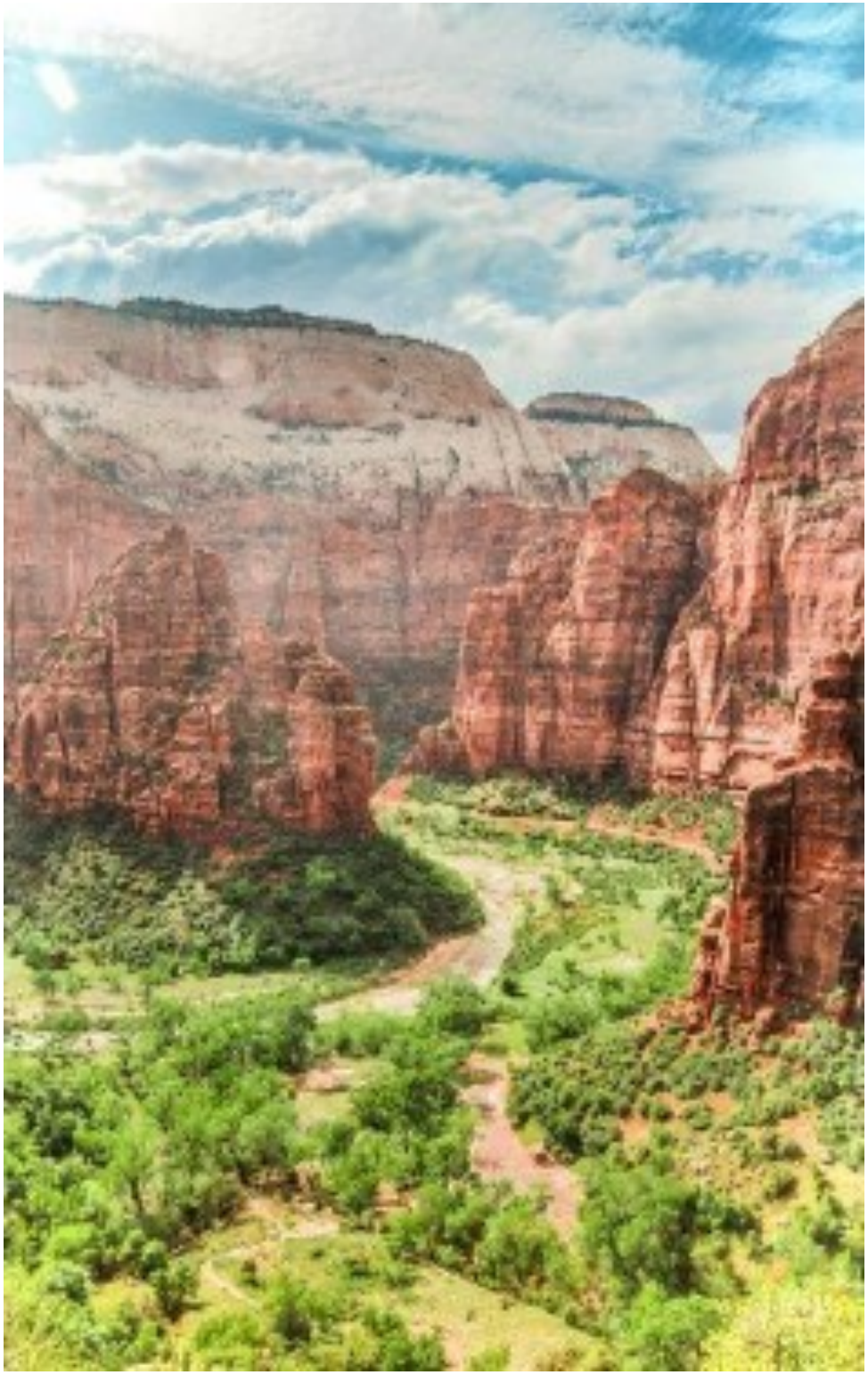
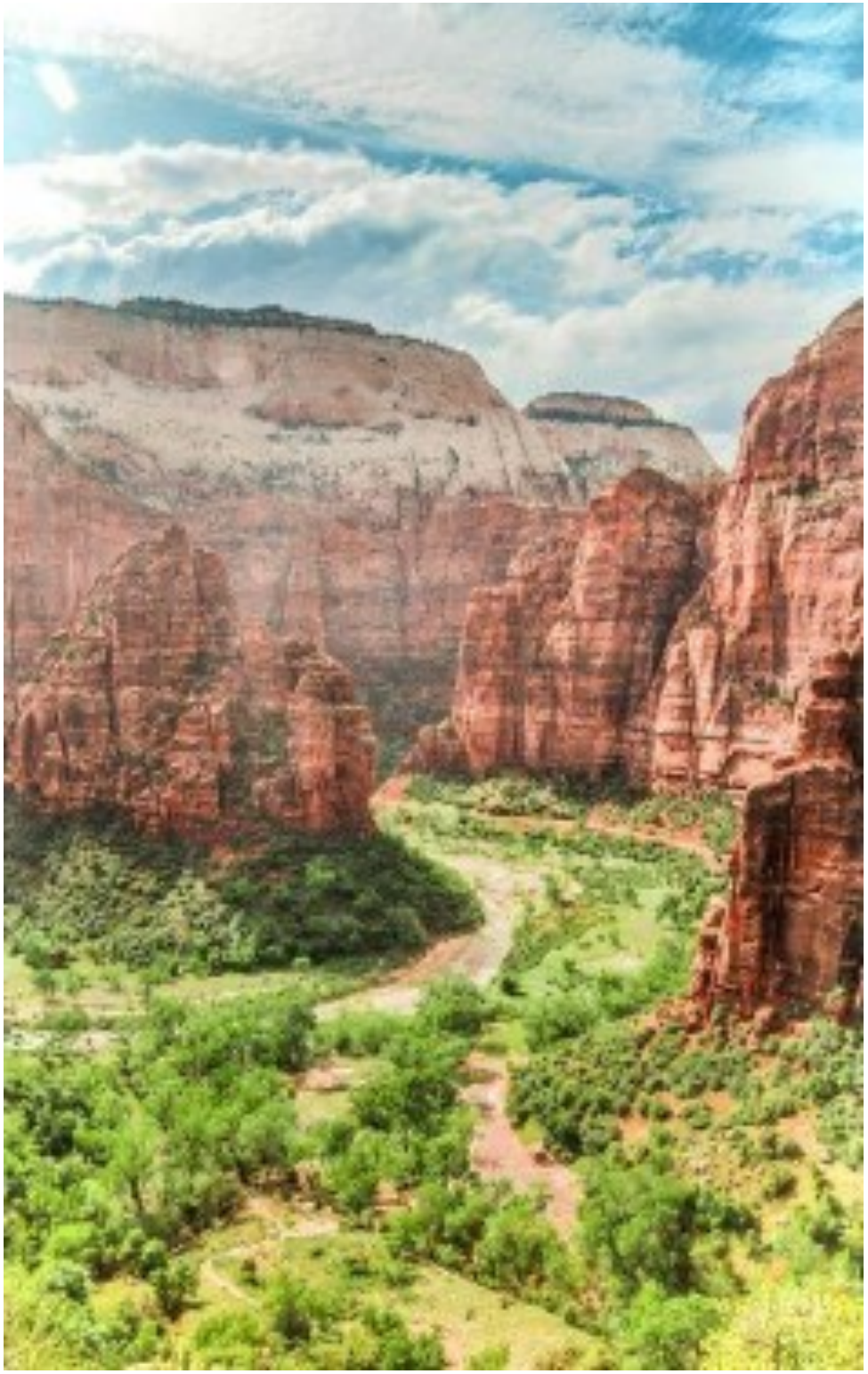

CONTACT NUMBERS

NAME	Contact #
SEÑORA RHONDA ADAMS 	
	
	
	

NAME
Zion National Park 1 Zion Park Blvd State Route 9 Springdale, UT 84767 (435) 772– 3256
Springdale Police Dept. (435) 634-5730 (Dispatch)

CAMPGROUND INFORMATION

Watchman Campground Site E-0001	Toilets, drinking water and picnic tables are provided at this facility. Group sites are also tent-only and can ac-commodate 30 people.

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Equipment List:

All items not listed as optional are required

Camping Equipment:	⇒ Swimsuit (conservative)
⇒ Sleeping mat	⇒ Towel
⇒ Sleeping bag	⇒ Toothbrush/toothpaste
⇒ Pillow	⇒ Bath soap
⇒ Towel	⇒ Deodorant
⇒ Foldable camping chair	⇒ Feminine products
⇒ Flashlight/headlamp	⇒ Brush/comb
⇒ Whistle on neck string	⇒ Hiking shoes
⇒ 1000ml camelback w/backpack	⇒ Sandals/flip flops
⇒ Bowl	**Miscellaneous:**
⇒ Plate	⇒ Baby wipes
⇒ Spoon/Fork/Knife	⇒ Sunscreen
⇒ Cup or small water bottle	⇒ Bug spray
Clothing/Toiletries:	⇒ Hat
⇒ 3 pairs of socks	⇒ Sunglasses
⇒ 1 pair shorts	⇒ Pack of Tissues
⇒ 1 pair long pants/sweats	⇒ Hand sanitizer
⇒ 3-4 T-shirts	⇒ 3 1-gallon zip bags
⇒ 1 hoodie/sweatshirt	⇒ 3 small zip bags
⇒ 4 pairs undergarments	⇒
⇒ Sleeping pants/shirt	⇒
⇒ Raincoat	⇒

Remember that this is a camping trip with many other people. Your bags should be as condensed as possible with minimal space. Also, less space, less stuff to keep track of.

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10

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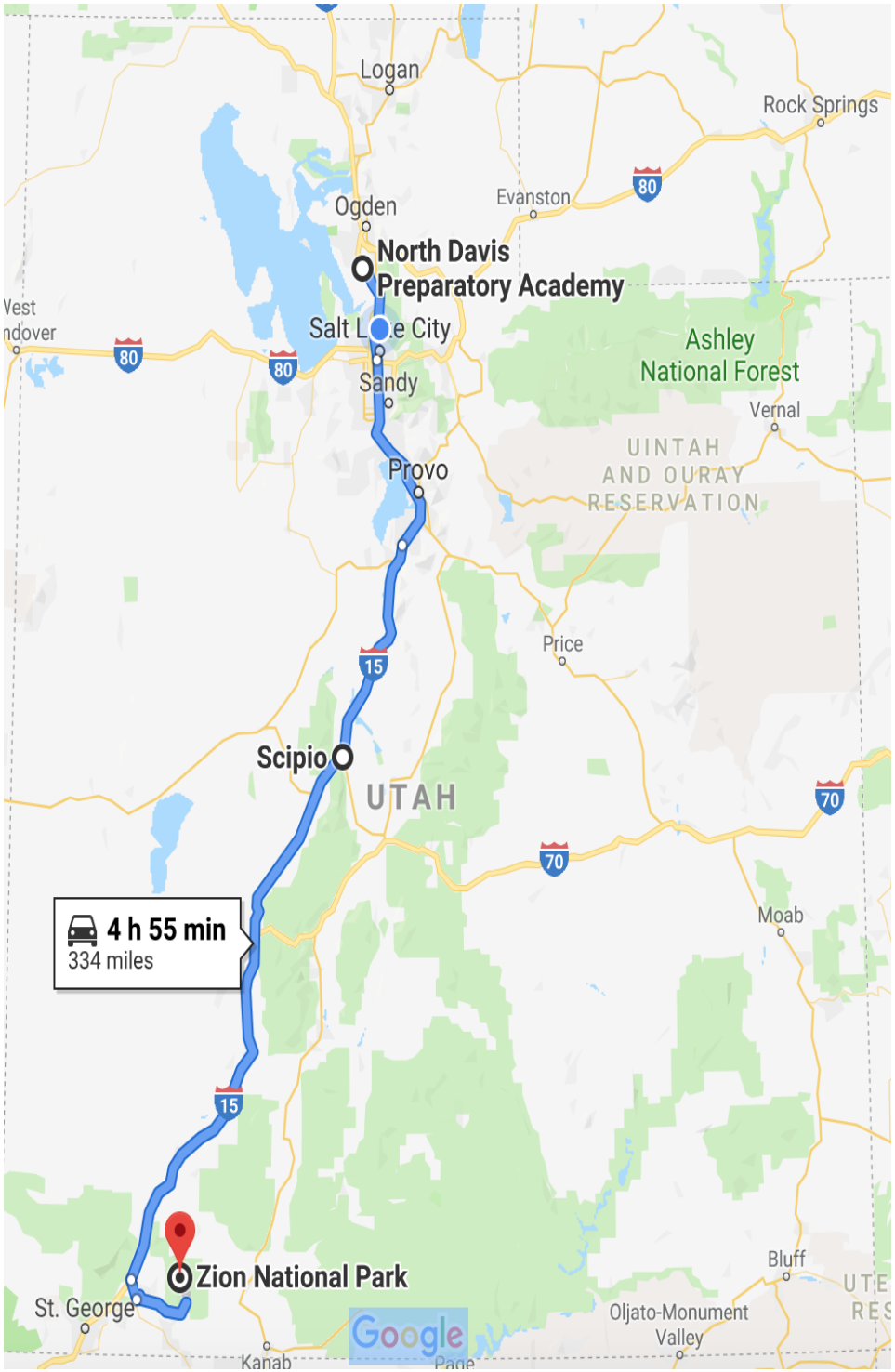

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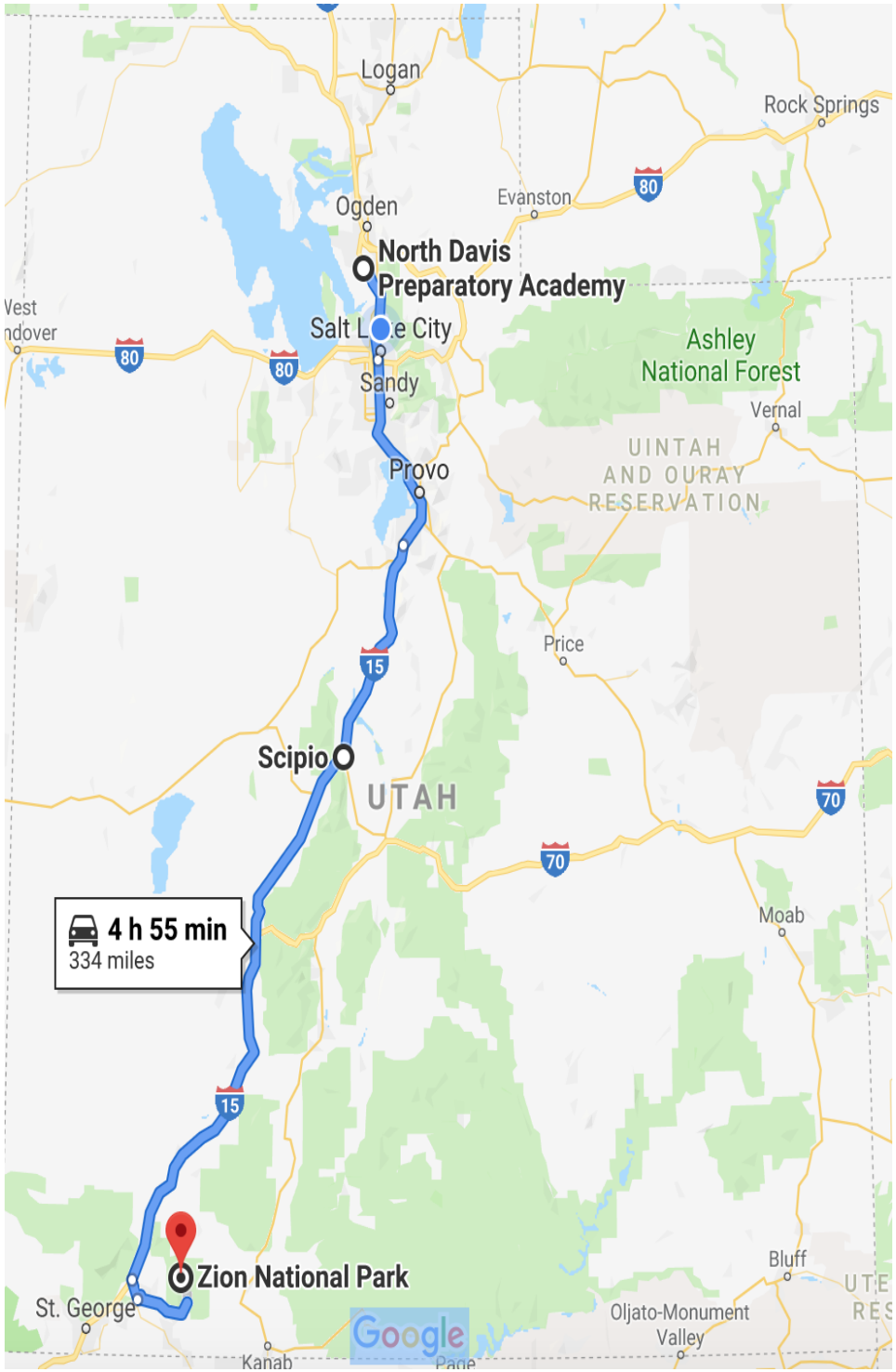

Día 1 - Viernes, 17 de Mayo 2019

Day 1 - Friday, May 17, 2019

•Always use the buddy system. Notify your chaperone of your plans and who is with you. NO EXCEPTIONS!

•Drink lots of liquid.

TIME:	EVENT:
8:00 am	Arrive at NDPA for check in -Equipment sign off by chaperones -Load gear into pre-arranged vehicles
9:00 am	Depart NDPA
11:15 am	Arrive Scipio, UT (bathroom breaks, fuel, eat lunch packed from home)
11:45 am	Depart Scipio, UT
2:30 pm	Arrive at Watchman Campground, Zion National Park, UT Group Site E007
2:30-4:00	Set up Base Camp -Tents • Gear unpacked and day pack ready at campfire site • -Safety Training Brief (using shuttle system, whistle protocol, hygiene in park, etc.)
4:15 pm	Walk to Visitor's Center (using buddy system, complete pages in book for Visitor's Center)
5:45 pm	Walk back to Base Camp
5:00 pm - 6:30 pm	Dinner -Ready-made meal of choice -Cleanup
6:30 pm	Activity -Stories by the Firelight -Hosted by your NDPA chaperones

Check In Procedures:

- Equipment sign-off by chaperones
- Load gear into pre-arranged vehicles
- Get ready made pre-ordered meals and put into packs

Camp Set Up Procedures:

- Tents set up
- Gear unpacked and ready with day pack at campfire site
- Safety Training Briefing
  - ◊ Using Shuttle System
  - ◊ Whistle protocol
  - ◊ Hygiene in park
- 2 Chaperones will go to store for breakfast and lunches

Watchman Program:

Discover what makes Zion such a special place. 45 minute evening program addresses a myriad of topics including the geology, people, and animals of the park.

Noticias:

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9:15 pm	Return to Basecamp -Fireside stories. (in book and from chaperones)
10:00 pm	Lights out. -Personal hygiene, stow gear for the ngiht -Dress warm, temp gets down to below 50 degrees at night

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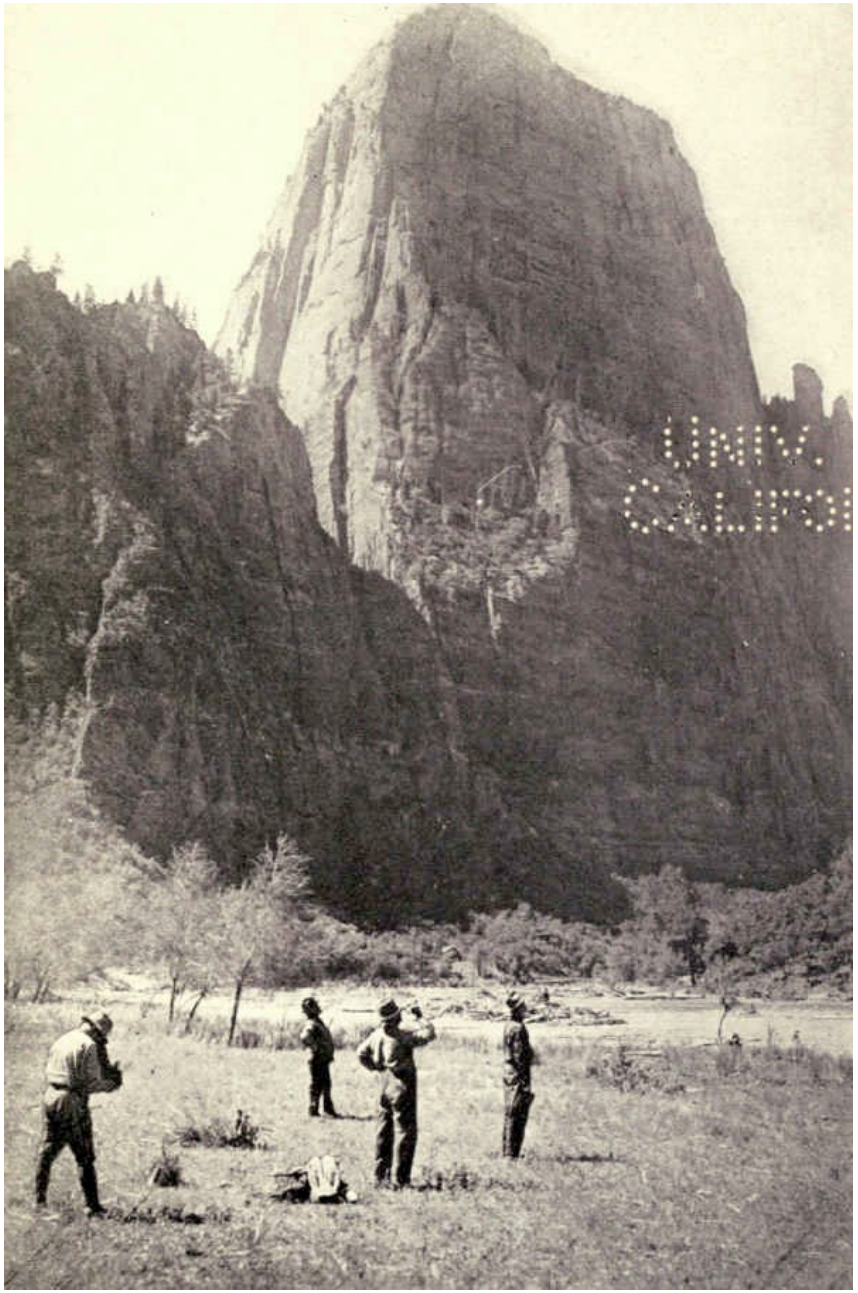

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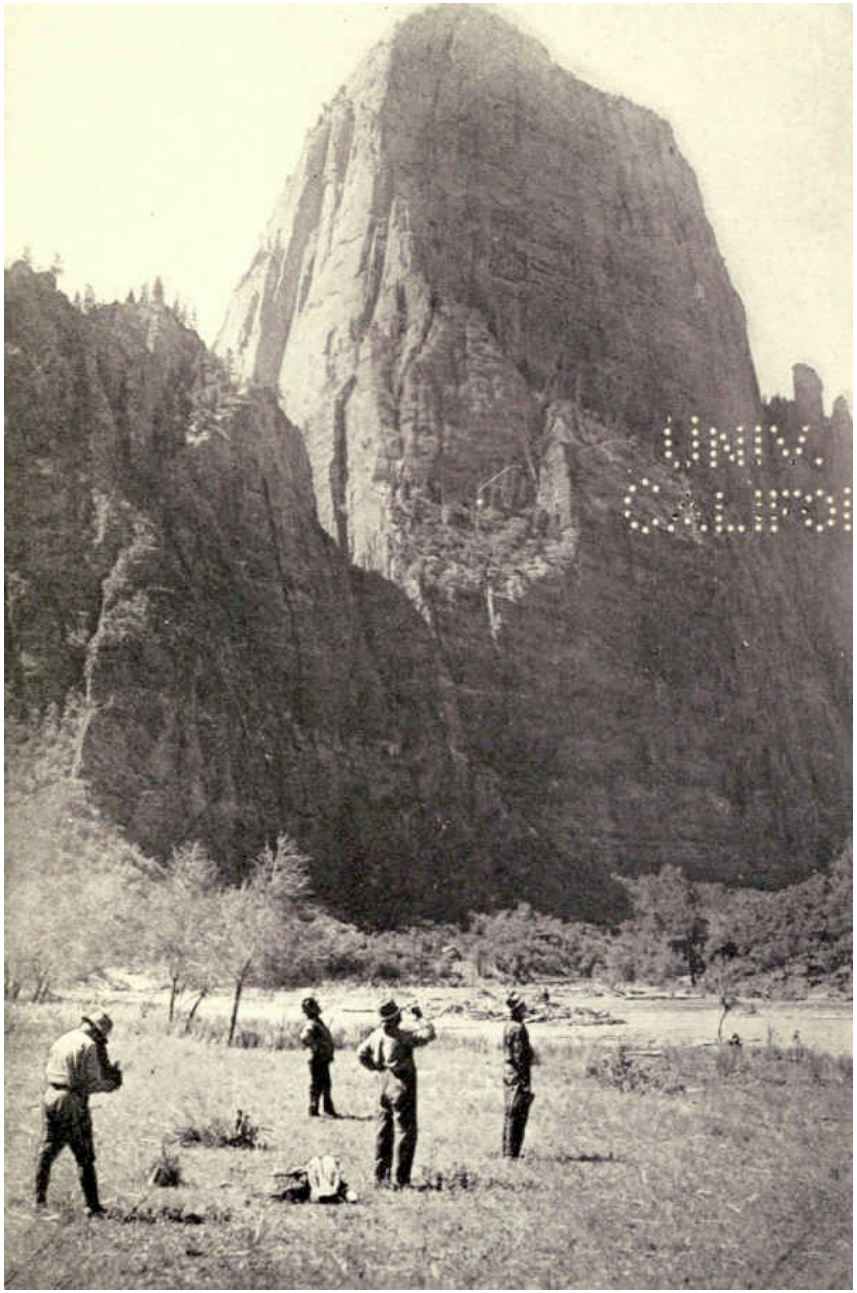

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Zion Park Details

Zion National Park, the first national park in Utah, was designated as a national monument on July 31, 1909, in order to preserve the beautiful canyon. It was then renamed and designated a National Park in 1919. Similarly, Arches National Park was first made a national monument on April 12, 1929, to preserve its unique geologic formations and rich cultural history, and was then designated as a national park in 1971. These two areas remained largely inaccessible for many years due to the lack of adequate road systems. However, projects like the Zion Canyon Tunnel, which was cut through solid sandstone in 1930, and a federally mandated highway system established throughout Utah in the 1960s, the public was able to access the parks more easily by automobile. Both Zion and Arches National Parks are very popular with drivers and hikers who come to see the spectacular vistas and natural features the parks contain.

Because of the early protected status of places like National Parks, they have been left largely unaffected by mining and agriculture practices. Today, thousands of people come to these national parks, as well as Utah's other parks and recreation areas, to appreciate the natural scenery and to participate in the many recreation opportunities. During difficult economic times, however, national parks see a decrease in visitation. This could be the result of high gas prices and reduced incomes, which tends to keep people closer to home. However, several Utah parks broke visitation records in 2008, and National Parks overall set visitation records in 2014, thus creating a concern of its own. As there is little fear that these protected areas are in danger of development, there is a growing concern that these beloved areas will simply be "loved to death".

Reflection: What are your thoughts about what you just read? What do you think the phrase "loved to death" could mean?

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You learn sooner or later to find an equilibrium within yourself; otherwise, you move.

Desert as teacher.

Desert as Mirage.

Desert as illusion, largely our own.

What you come to see on the surface is not what you come to know.

Emptiness in the desert is the fullness of space, a fullness of space that eliminates time. The desert is time, exposed time, geologic time.

One needs time in the desert to see.

End of Day 1: Fireside Stories

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When traveling to southern Utah for the first time, it is fair to ask, if the redrocks were cut would they bleed. And when traveling to Utah's desert for the second or third time, it is fair to assume that they do, that the blood of the rocks gives life to the country. And then after having made enough pilgrimages to the slickrock to warrant sufficient separation for society's oughts and shoulds, look again for the novice you once were, who asked if sandstone bleeds. Pull out your pocketknife, open the blade, and run it across your burnished arm. If you draw blood, you are human. If you draw wet sand that dries quickly, then you will know you have become part of the desert. Not until then can you claim ownership.

This is Coyote's country – a landscape of the imagination, where nothing is as it appears. The buttes, mesas, and redrock spires beckon you to see them as something other: a cathedral, a tabletop, bear's ears, or nuns. Windows and arches ask you to recall what is no longer there, to taste the wind for the sandstone it carries. These astonishing formations invite a new mythology for desert goers, one that acknowledges the power of story and ritual yet lies within the integrity of our own cultures. The stories rooted in experience become beads to trade. It is the story, always the story that precedes and follows the journey.

Just when you believe in your own sense of place, plan on getting lost. It's not your fault – blame it on Coyote. The terror of the country you thought you knew bares gifts of humility. The landscape that makes you vulnerable also makes you strong. This is the bedrock of southern Utah's beauty: its chameleon nature according to light and weather and season encourages us to make peace with our own contradictory nature. The trickster quality of the canyons is Coyote's cachet.

When the Navajo speak of Coyote, they do so hesitantly, looking over their shoulders, checking the time of year so they won't be heard. They know his stories are told only after the first frost and never after the last thaw. Their culture has been informed by Coyote. He is profane and sacred, a bumbler and a hero. He straddles the canyon walls with wild oats in his belly. And they know him by name – Ma'ii, the one never to be taken for granted. They understand his fickle nature, how he seduces fools into believing their own myths, that they matter to the life of the desert.

Coyote knows rocks care nothing for those who wander through them; yet he also knows that those same individuals who care for the rocks will find openings – large openings – that become passageways into the unseen world, where music is heard through doves' wings and wisdom is gleaned from the tails of lizards. Coyote is always nearby but remains hidden. He is an ally because he cares enough to stay wary. He teaches us how to survive.

Coyote Clan

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Coyote's howl above the canyon says the desert may not depend on his life, but his life depends on the desert. We would do well to listen. The canyons of southern Utah are giving birth to a Coyote Clan – hundreds, maybe even thousands, of individuals who are quietly subversive on behalf of the land. And they are infiltrating our neighborhoods in the most respectable ways, with their long, bushy tails tucked discreetly inside their pants or beneath their skirts.

Members of the Clan are not easily identified, but there are clues. You can see it in their eyes. They are joyful and they are fierce. They can cry louder and laugh harder than anyone on the planet. And they have enormous range.

The Coyote Clan is a raucous bunch: they have drunk from desert potholes and belched forth toads. They tell stories with such virtuosity that you'll swear you have been in the presence of preachers.

The Coyote Clan is also serene. They can float on their backs down the length of any river or lose entire afternoons in the contemplation of stone. Members of the Clan court risk and will dance on slickrock as flash floods erode the ground beneath their feet. It doesn't matter. They understand the earth re-creates itself day after day.

This adventure is dedicated to the Coyote Clan, to give them strength when they are away from the slickrock, to jar their memories that beauty is not found in the excessive, but in what is lean and spare and subtle. How do we inhabit the canyons inside a divided heart? One body. Two bodies. Three.

What types of things do you think a member of the Coyote Clan should do?

1) _____

2) _____

3) _____

4) _____

5) _____

What types of things does a Coyote not do?

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I strike a match and light the shreds of kindling I have cut with my knife. Juniper. I fan the incense toward me. The smoke rises, curls, coils around my face. It feels good to be in the desert again. Home-where I can pause, remain silent. There is nothing to explain. I break twigs and lean them against each other in the formation of a teepee. More smoke. On hands and knees in red sand, I blow at its base, blow again, add a handful of dried cotton wood leaves, blow, they ignite, flames engulf the triangle.

I sit back on my haunches, pleased that the fire is growing in the desert, in me, so that I love. It is fate that determines the territory of the heart. I add more sticks, blow; the first flares in darkness. The wood opens. Flames rise, flicker. My eyes blur. I hold every detail of love in my body, nothing forgotten, put more sticks on the fire. It surges sputters, and purrs. The fire holds me captive, charismatic flames wave me closer. I add two more sticks like bodies to love. They are consumed instantly. The first shifts, then settles with new intensity; it shifts again, adjusts. The wood pops like vertebrae. The silver bark of juniper burns black, turns white. A spark breathes. I crouch down and blow on embers. They flare and quiver. I blow again. They become rubies. I reach into the coals, believing, and burn my fingers, blister their tips, pull back in pain and bury my hands in the sand. The fire wanes. I cannot bear its absence. I lower my head and blow. The fire ignites. My longing returns. When we want everything to change we call on fire.

I fetch more wood. Bones of pinon and juniper lie on the desert floor. Even in darkness I see them illumined by the moon. I gather them in my arms. This time they are larger. I must break them over my knee and feed the fire once again. The fire is aroused. The flames reach higher. I stand before them with my arms raised, my hands surrender and come down to caress the heat and mold it into faces I love. Do I dare to feel the white heat of my heart as a prayer? What is moldering inside me? And how is it that pleasure exists between such beauty and violence? Feed the fire. No. Yes. My fingers touch the blaze of bodies in flames.

The fire explodes. Flames become blue tongues curling around each other. My eyes close. I step forward. My legs open to the heat, the tingling return of heat, inside, outside, shadows dance on the sandstone, my ghostly lover. I allow myself to be ravished. My generosity becomes my humiliation. The hair between my legs is singed. My left hand shields my face from the fire. Fingers open. It is a shuttered scape. Fingers clench. I hold a fist before flames, loyal and disloyal at once. Above me, free-tailed bats circle the flames like moths. Moths frighten me. I hate their addiction to light. But bats delight in darkness with their ears wide open. What do they hear that I am missing? Gifted in the location of echoes, they listen twice to all that is spoken in the desert. They are the dark angels who register our longings and pinpoint the cries lodged within our throats. Heat. More heat. My face flushes red. The fire's hands are circling. I sit inches away from something that tomorrow will not exist. The blue-eyed coals I gaze into will disappear. Ashes. Ashes. Death is the natural conclusion of love.

But tonight it remains alive and I know in the shock of my heart that love is as transitory as fire. The warmth I feel, the glow of my body and the force of my interior heat, is enough to keep me here. It is our nature to be aroused-not once, but again and again. Where do we find the strength not to be pulled apart by our passions?

Fire
By Terry Tempest Williams

I strike a match and light the shreds of kindling I have cut with my knife. Juniper. I fan the incense toward me. The smoke rises, curls, coils around my face. It feels good to be in the desert again. Home-where I can pause, remain silent. There is nothing to explain. I break twigs and lean them against each other in the formation of a teepee. More smoke. On hands and knees in red sand, I blow at its base, blow again, add a handful of dried cotton wood leaves, blow, they ignite, flames engulf the triangle.

I sit back on my haunches, pleased that the fire is growing in the desert, in me, so that I love. It is fate that determines the territory of the heart. I add more sticks, blow; the first flares in darkness. The wood opens. Flames rise, flicker. My eyes blur. I hold every detail of love in my body, nothing forgotten, put more sticks on the fire. It surges sputters, and purrs. The fire holds me captive, charismatic flames wave me closer. I add two more sticks like bodies to love. They are consumed instantly. The first shifts, then settles with new intensity; it shifts again, adjusts. The wood pops like vertebrae. The silver bark of juniper burns black, turns white. A spark breathes. I crouch down and blow on embers. They flare and quiver. I blow again. They become rubies. I reach into the coals, believing, and burn my fingers, blister their tips, pull back in pain and bury my hands in the sand. The fire wanes. I cannot bear its absence. I lower my head and blow. The fire ignites. My longing returns. When we want everything to change we call on fire.

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Beyond the junipers and pinons of this starless night, I face the deep stare of darkness. This wildness cannot be protected or preserved. There is little forgiveness here. Experience is the talisman I hold for courage. It is the desert that persuades me toward love, to step outside and defy custom one more time.

The fire now bares the last testament to trees. I blow into the religious caverns of wood and watch them burn brightly.

As you listened to and read this story, did some of you notice parts about fire you had never noticed before? If you said yes then you are already on the path. The path to seeing. Some for the first time ever. Seeing the beauty that is Zion. Learning. Learning the history of the land. Learning the creation of the land. Learning yourself, with the land. Through a series of trials, tribulations, and just plain hard work, you will exit this adventure a better person than when you began.

In these pages you will record accounts of your adventures, things you have learned, observations you have experienced, and reflections of your journey.

After all the stories are shared by your chaperones this evening use the pages that follow to write a short journal entry reflecting on one of the stories. Do any of them ring home to you? If so, why? Did any of them put a vivid picture in your mind? Did any of them remind you of a story you have heard fireside?

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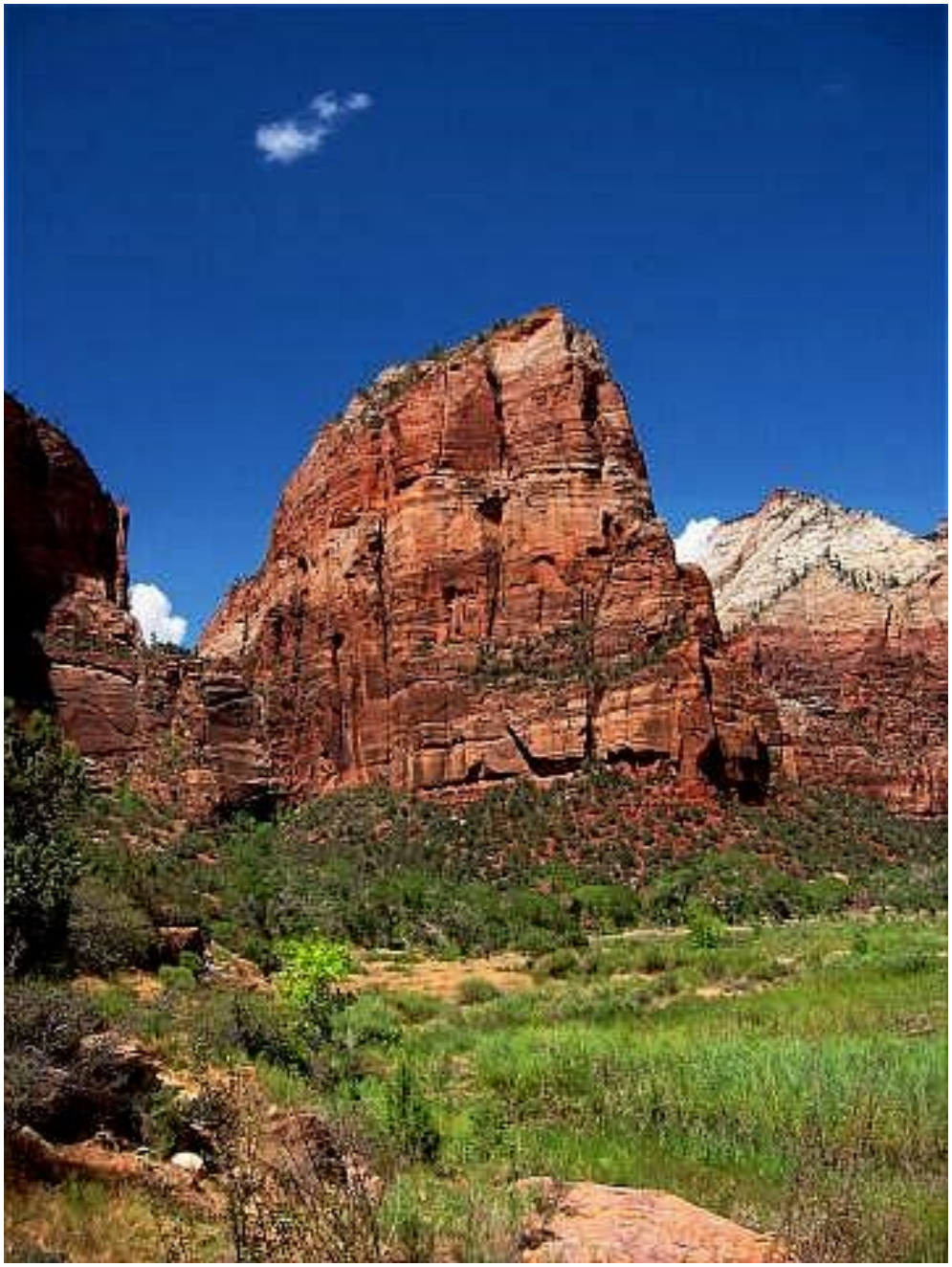
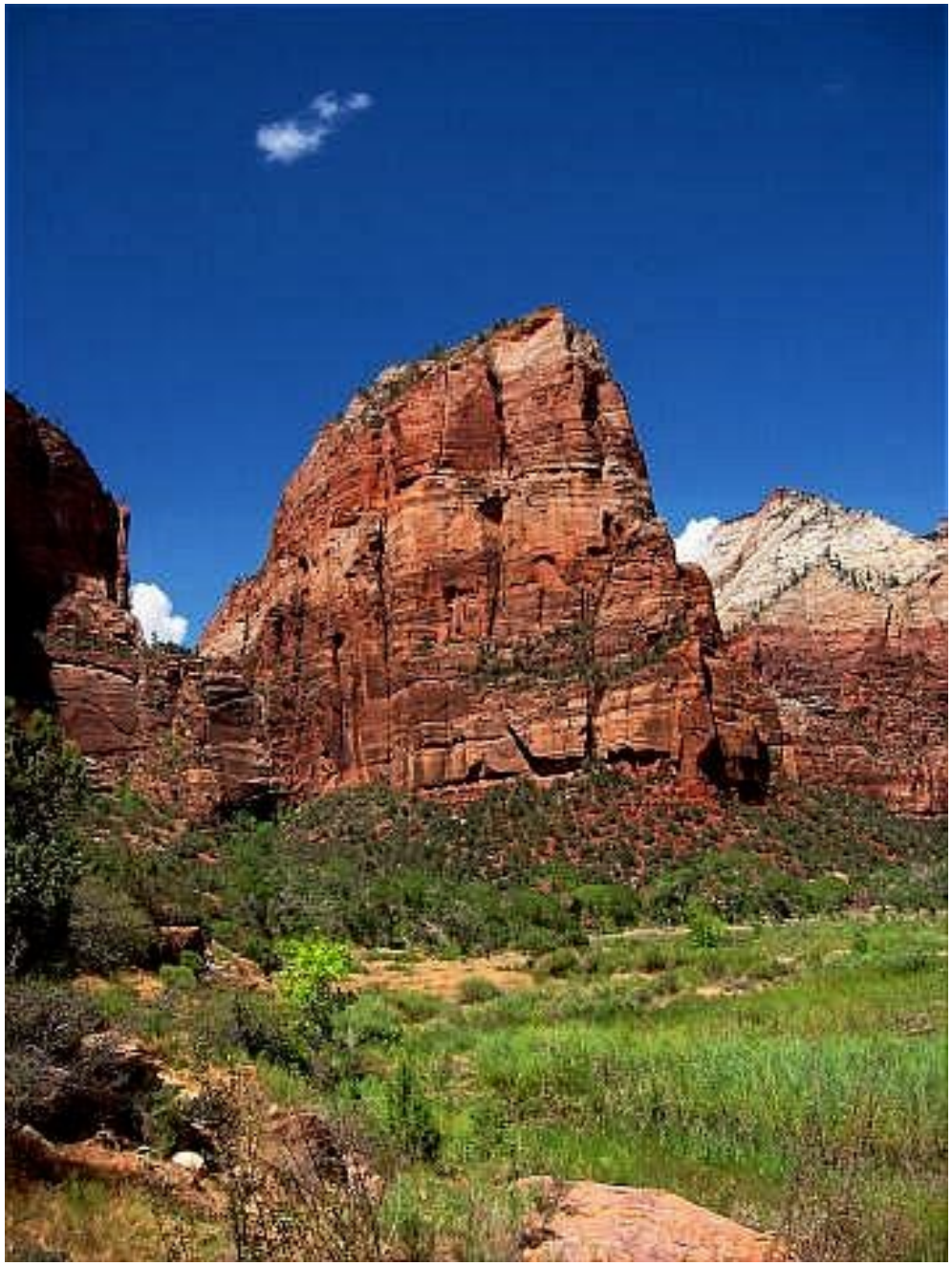


Angels Landing Zion National



Angels Landing Zion National

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Día 2 – Sábado, 18 de Mayo de 2019

Day 2 - Saturday, May 18, 2019

TIME:	EVENT:
6:00 am	Up and at 'em!  • Menu TBD • Brush teeth/Wash faces • Pack Lunch (sandwiches) Special meal TBD
7:00 am	Walk to visitor's center
7:30 am	Board shuttle at Visitor's Center for Grotto Shuttle Stop 6 • Take short walk across road to trail head
8:00 am	Arrive at the Grotto Shuttle Stop 6 • Begin hike to Angels Landing (4 hour hike for slowest hikers) • Parent hiker will hike part-way but will remain at top but not on the point • Students do not have to go to point, getting to the top is the goal
12:00 pm	Return to Zion lodge (Shuttle Stop 6) • Lunch • Tour gift shop, bathrooms, refill water bottles
1:00 pm	Board shuttle to Museum
1:15 pm	Arrive at Museum • View amphitheater (group photo) • View movie and complete book section about Museum stop • Gift shop

TIME:	EVENT:
2:15 pm	Board shuttle to stop 7 (Echo Canyon/Weeping Rock)
2:35 pm	Arrive at Shuttle Stop 7 (Weeping rock) Duration 3 hours
5:35 pm	Return to shuttle stop and board shuttle to return to Visitor's Center
6:00 pm	Arrive at Visitor's Center • Walk back to base camp
6:15 pm	Dinner(Ready-made meals)
7:15 pm	Campfire and activities • Full moon festivities • Learn about the moon with Ms. Adams • Attend a moonlight hike with Mr. Garcia
10:00 pm	Lights Out! (brush teeth, stow gear, dress warm) • Complete assignments for the day!

TOMORROW—Buckskin Gulch!

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Noticias:

About Our Moon

A Quick Reference Guide to Help Adults Become Lunar Rock Stars

Why does our Moon shine?

Just like the planets, our Moon does not make its own light. It "shines" because it reflects the Sun's light. Our Moon is much closer to us than the Sun or other planets, so it appears much brighter to people on Earth. It is the brightest object in our night sky (when it is visible at night). Around the time of the full Moon, the Moon can help us to see at night!

How big is our Moon?

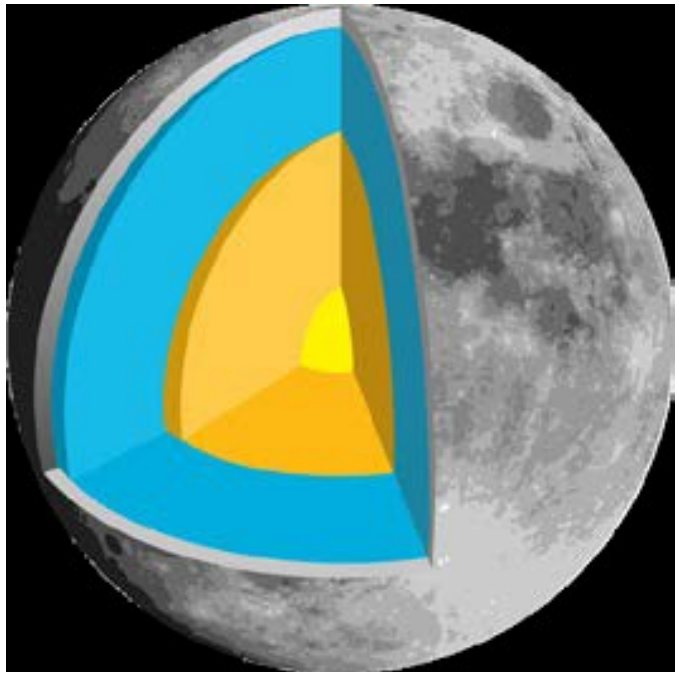
Our Moon is about 2,100 miles across (about 3500 kilometers). This is about the distance from New York City to Albuquerque, New Mexico!

How far away is our Moon?

Our Moon is just about 250,000 miles from Earth (about 380,000 kilometers). If our Earth were the size of a basketball, our Moon would be the size of a tennis ball. At that scale, they would be about 24 feet apart!

How old is our Moon?

Our Moon is about 4 and a half billion years old (that's a lot of birthdays!). It is just a little bit younger than the Earth and the rest of the solar system.



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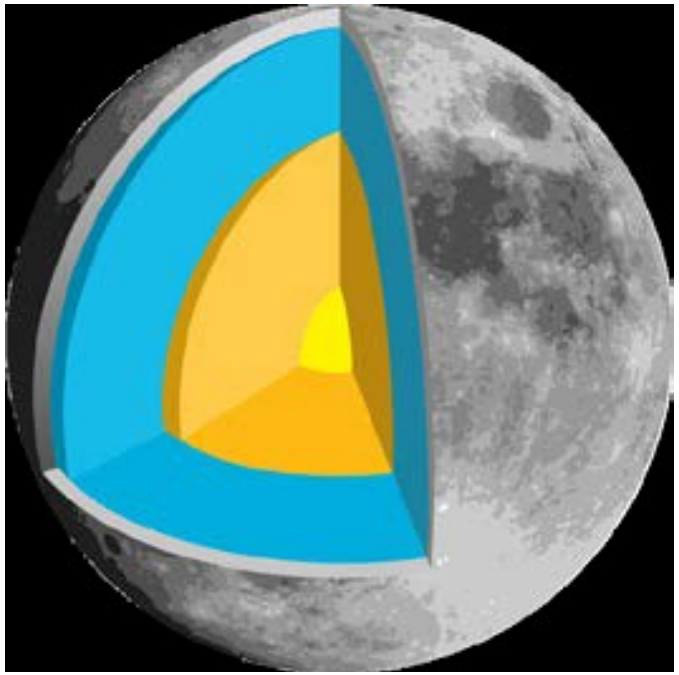

What are the bright and dark areas on our Moon?

The lighter areas you see are called the Lunar Highlands. They are the oldest, roughest, most cratered part of the Moon. The rocks of the highlands formed when the Moon was young and hot (from all those bits slamming into each other to make the Moon). The Moon was so hot that at least part of it melted, forming an ocean of magma across the Moon's surface. This ocean cooled and solidified into the Moon's rocky crust. Rocks collected from the Lunar Highlands are between about 4 and 4 ½ billion years old! The darker, circular areas you can see are called the Maria (pronounced "mar-ee-ah"). "Maria" is the Latin word for "seas;" these areas looked like seas to early astronomers. The circular basins formed when really big asteroids hit the Moon. Much later, after all the really big impacts had finished in our solar system, magma from deep inside the Moon made its way to the surface and flowed through cracks. The runny lava filled the low basins and cooled, forming a smooth dark rock surface in the big basins.

Why does the Moon have so many craters and the Earth doesn't?

Over time, asteroids and comets have run into the Moon and the Earth, and everything in our solar system. But the Moon's surface has been very quiet for a long time. There are no more volcano eruptions on the Moon. The Moon does not have any atmosphere or flowing water – so there are no streams or wind to wear the craters down. Every object that hits the Moon leaves a crater that does not get erased. The Apollo astronauts' footprints are still there!

Earth is very active. Wind and water and glaciers wear down the land – and any craters on it. Earth also recycles its outer layer through plate tectonic activity; new crust is being created and old crust is being destroyed. Craters get erased very quickly on Earth.

What is inside of the Moon?

Cheese! No, not really! The Moon, like Earth, has three main layers, its inner core, middle mantle, and outer crust. The Moon has a very small metallic core at its center that probably is mostly iron with a little nickel and sulfur. This is the yellow at the center of the picture. The core is about 300 miles across (500 kilometers). For many years, the evidence suggested that our small Moon had cooled completely and the inner core was solid. Recent evidence suggests the core may be molten still! The mantle, the middle layer of the Moon, is a dense rocky layer. It is about 620 miles thick (1000 kilometers). The orange and blue layers in the picture are the mantle.

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Why do we only see one side of the Moon?

The Moon spins on its axis (just like Earth does). It also orbits Earth. It takes the same amount of time to spin on its axis as it does to go around Earth once. Because of this, we always see the same side of the Moon – the near side. We never see the far side (not the dark side!) of the Moon from Earth.

Why does the shape of the Moon change?

Actually, the shape of our Moon does not change – it's always a sphere! However, the shape of the part that is bright does appear to change! The "amount" of Moon that we see as we look from Earth changes in a cycle that repeats about once a month (29.5 days). The relative positions of our Sun, Earth, and Moon, cause these changes.

As our Moon orbits around Earth, the side facing the Sun is always illuminated, just like Earth's daylight side is illuminated by the Sun.

What we see from Earth, however, is a different story. Starting with the dark new Moon, we see the light part of the Moon "grow" from a sliver to a half to a full Moon — and then the illuminated part decreases, becoming thinner until there is no visible Moon in the sky and we are at the new Moon part of the cycle again.

We have a "new Moon" when our Moon's orbit around Earth moves it between Earth and the Sun. From Earth, the Moon's surface looks dark because the illuminated side is facing away from Earth. As our Moon continues its orbit counterclockwise around Earth (viewed from above the north pole), more and more of the illuminated part of the Moon becomes visible to us, until it reaches the "full Moon" stage. A full Moon occurs when the Moon has moved in its orbit so that Earth is "between" the Moon and the Sun.

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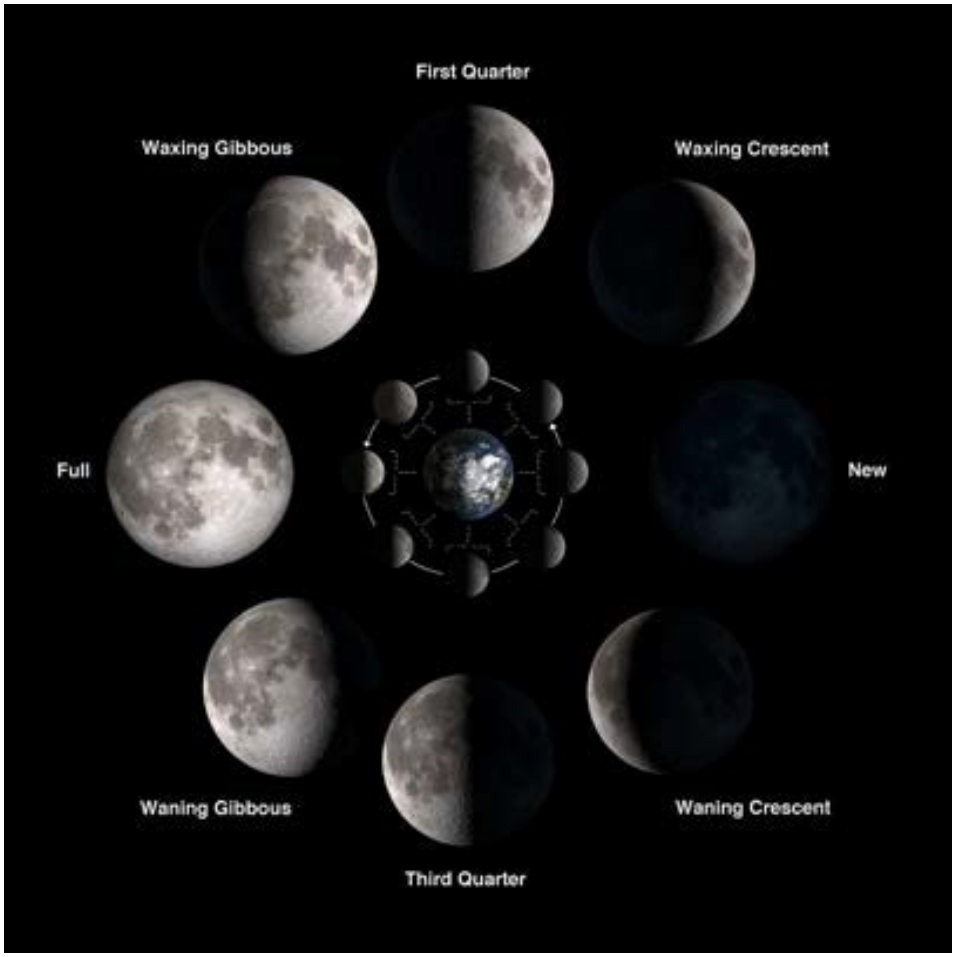
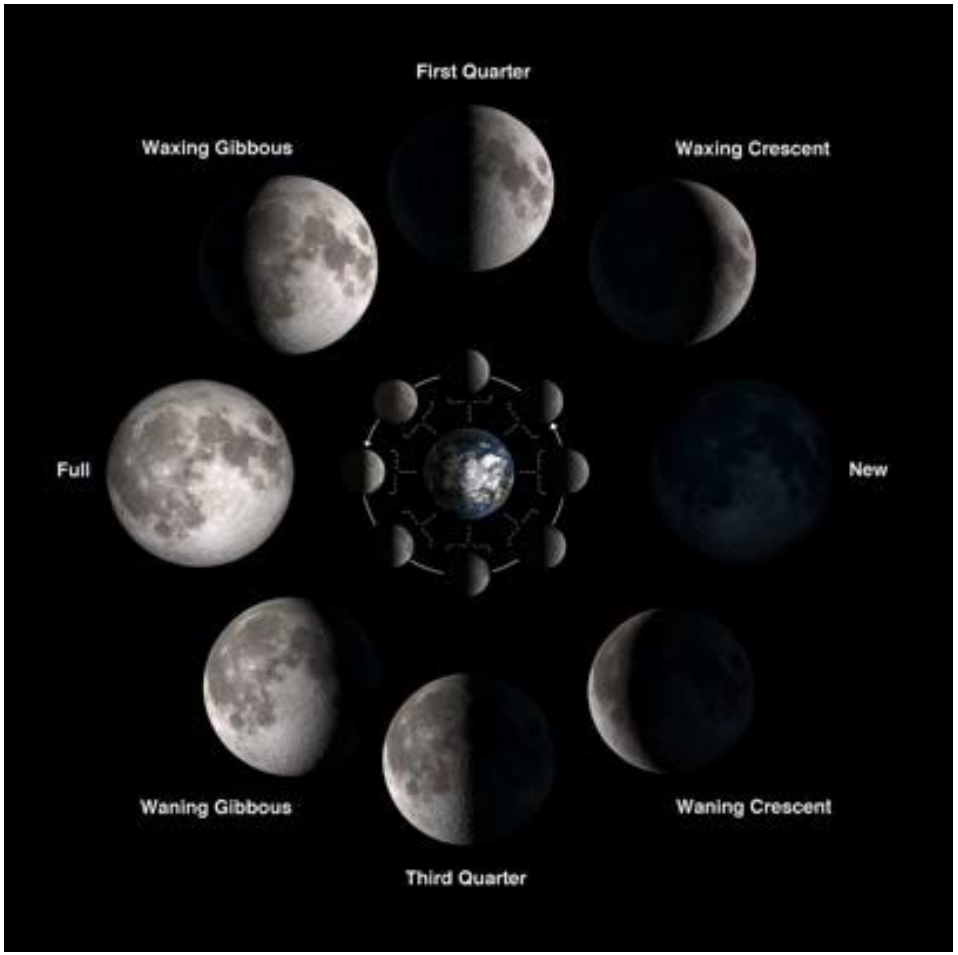


Between the new and full Moon, the amount of Moon we see grows — or waxes from its right side toward its left side. As it passes the full Moon stage, the amount of illumination decreases — or wanes — from right to left. Finally, the Moon returns to its position between the Earth and the Sun, and on Earth we observe the new Moon again.

What would it be like to walk on the Moon?

Well, for starters, the Moon is smaller (has less mass) and therefore has less gravity than Earth. When you walk on the Moon, you are not "pulled back as hard" to the surface as when you walk on Earth. If you were on the Moon, you would weigh about 1/6th of what you weigh now. In this reduced gravity you could jump higher and lift things that were too heavy for you on Earth. Perhaps the Moon will be the site of future Olympics?



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You will need a spacesuit to provide water, air to breathe, and to maintain your temperature. The Moon has no atmosphere or liquid water. It is very hot when you are in the Sun and very cold when you are in the dark. Temperatures range from 225 degrees F above zero down to 240 degrees F below zero (105 degrees C to -150 degrees C)!

The Moon actually has water, hidden as ice in deep craters at the Moon's poles. Because the Moon is not tilted on its axis, deep craters at its polar regions do not get exposed to incoming sunlight, and they stay cold. The ice may have been delivered by comets smashing into the Moon!

All of those comets and asteroid impacts have really broken up the lunar landscape! The surface of the Moon is covered with about two inches of very fine dust – in some places it is much deeper.

What if I don't know the answer to a question that someone asks?

Not having an answer is a great opportunity to enable the questioner to delve deeper. Just say you don't know, and invite them to find out the answer online, in their library, or through another local expert. Shoot, you can even ask them to share the answer back with you! If it is a family member, this is a fantastic opportunity for you to research the answer together so that you can learn more together.

How did our Moon form?

Using evidence from Moon rocks collected by the Apollo astronauts, and observations of our Moon's orbit, scientists think that our Moon formed just after Earth formed. They think that a giant asteroid – about half the size of Earth – crashed into Earth. The asteroid broke apart. Some of it became a part of the Earth and some of it (and some of Earth, too) was knocked into orbit around Earth. Earth may have looked a little like Saturn does today – surrounded by a band or rings made of bits of debris. Eventually these rocky bits orbiting Earth clumped together, forming our Moon. This scientific hypothesis of our Moon's formation, called "the Giant Impact Hypothesis," best explains the scientific evidence at this time. As with all hypotheses, scientists studying the Moon will continue to gather and interpret scientific evidence and measure it against the Giant Impact Hypothesis. Scientists may modify the hypothesis in the future based on new evidence. Science is a very exciting field – our understanding of our world, solar system, and universe gets refined as new discoveries are made!

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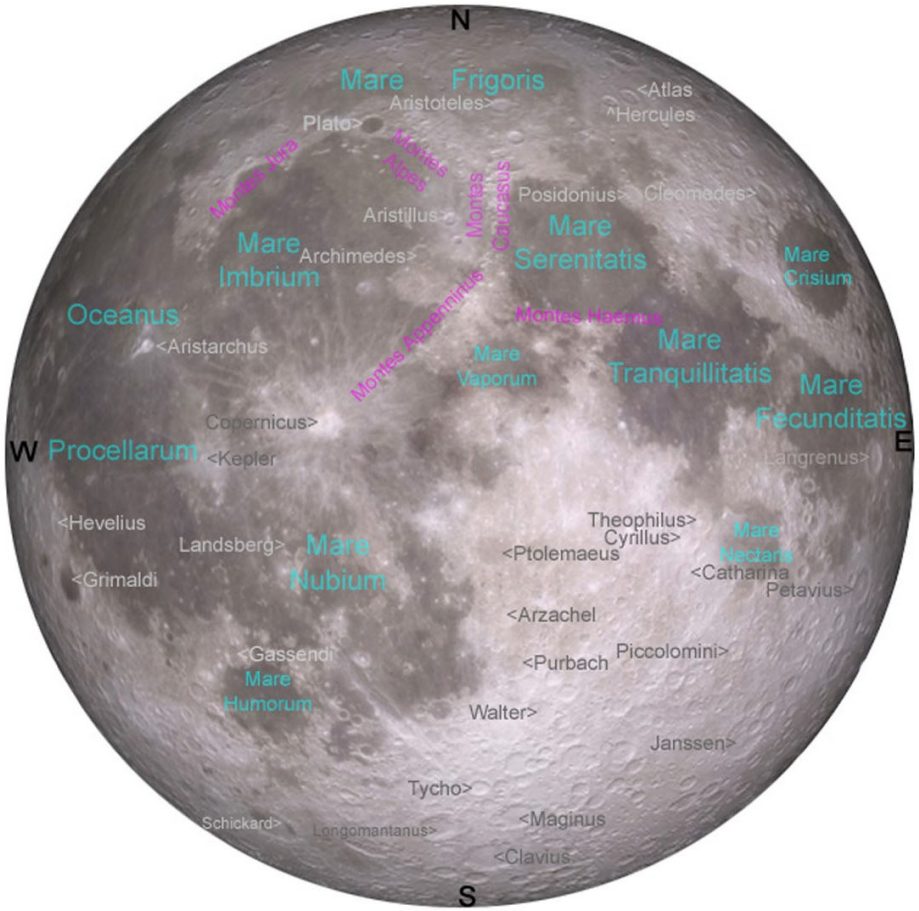
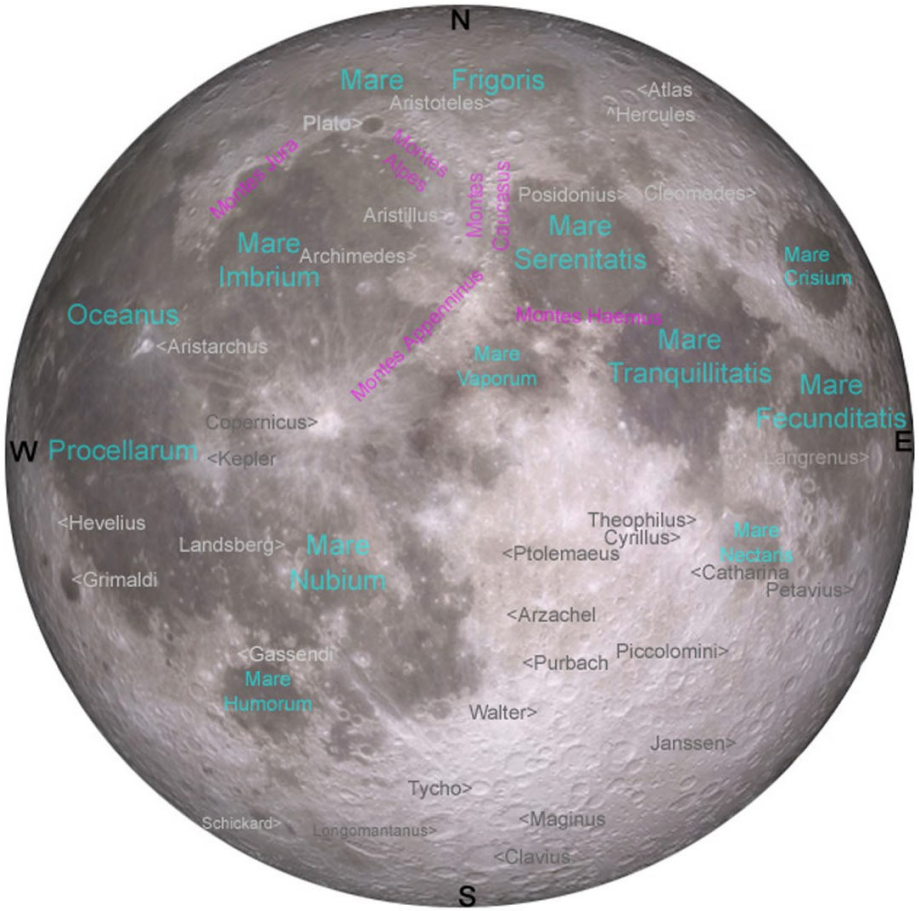
Waxing Crescent
First Quarter
Waxing Gibbous
Full Moon
Waning Gibbous
Last Quarter
Waning Crescent



Moon Notes:



Moon Notes:

31

Día 3 – Domingo, 19 de Mayo de 2019

Day 3 - Sunday, May 19, 2019

TIME:	EVENT:
7:00 am	Up and at 'em! • Breakfast (yogart, fruit, granola • Hygiene, clean tents, etc.
8:00 am	Load up Vans to head to Buckskin Gulch • Be sure to have lunch, snacks, and a full water bottle • Chaperones will have extra water bottles and snacks at the van for the trip back to Zion • Students read info on Buck Skin Gulch in camping books to become familiar with the hike
10:30 am	Arrive at Wire Pass Trail Head • Get gear ready • Eat snack
11:00 am	Buckskin Gulch hike • Mr. Garcia will be our tour guide on this amazing walk through the largest slot canyon in Utah
1:00 pm	Lunch Break
1:30 pm	Return to vans • This slot canyon is over 15 miles long. We will only hike for a certain amount of time than retrace our path back to the vans
3:30 pm 32	Arrive back at Vans • Refresh water, write reflection, snacks

Noticias:

Be sure to read up on Buckskin gulch before arriving at trail head. Information can be found on the next page.

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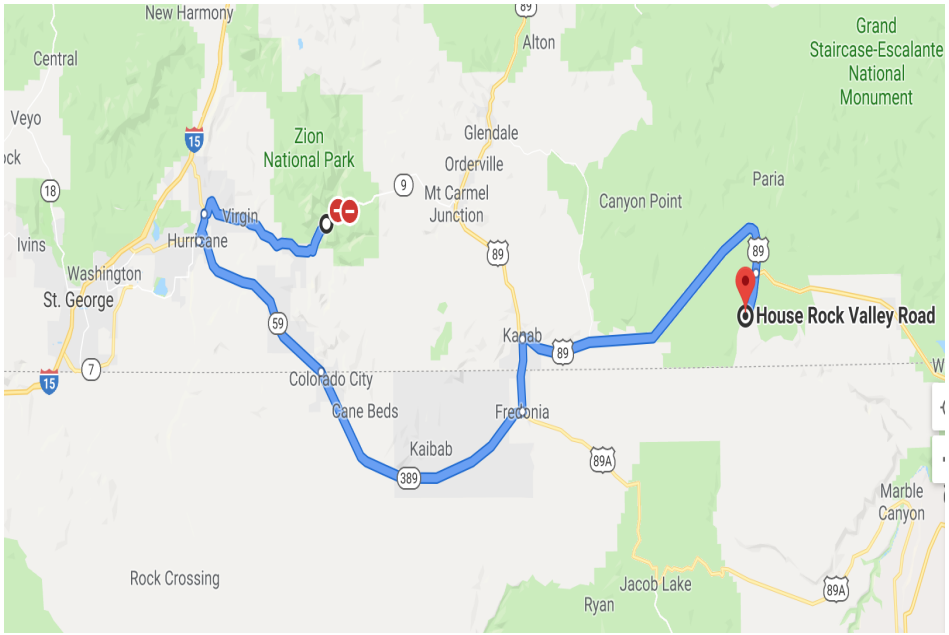
Day 3 - Sunday, May 19, 2019

TIME:	EVENT:
6:00 pm	Arrive base camp • Clean up equipment form the day, wash hands and face • Dinner (Ready-made meal of choice and clean up) • Organize gear, pack non-essentials for trip home tomorrow
7:30 pm	Activity with Ms. Adams and Mr. Garcia using head lamps and camping books for species identification • Archeology trail

Noticias:



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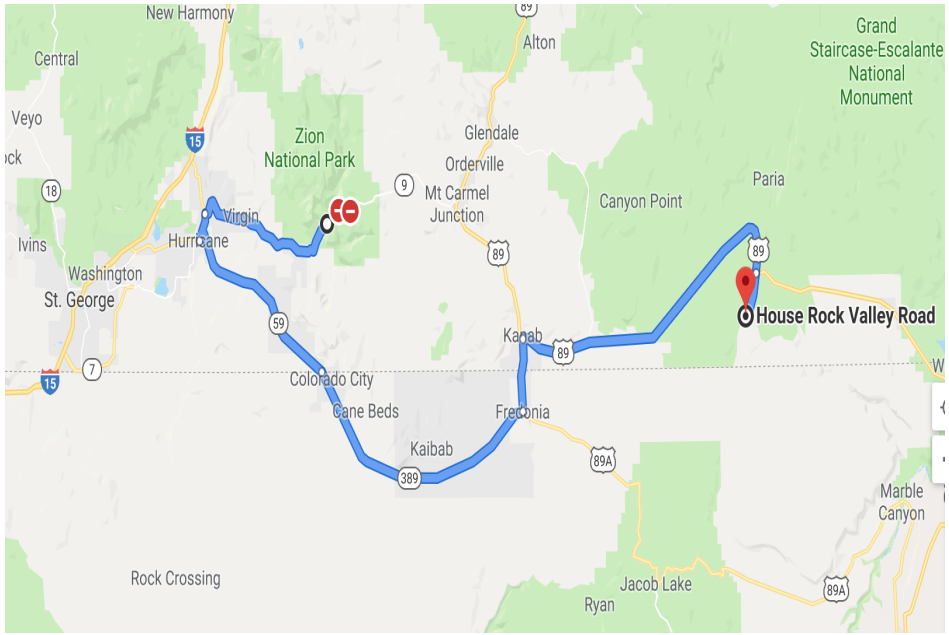

Buckskin Gulch is the longest and deepest slot canyon in the Southwest, and while others are narrower, prettier or more challenging to explore, the length and variety of the terrain in the gulch make it the best overall. The canyon is narrow for 12 miles; the cliffs become steadily higher downstream, reaching a height of 500 feet above the streambed at the end, where Buckskin Gulch meets the Paria River which also flows through a deep canyon for several miles either side of the confluence.

The walls of both canyons are rather dark, and the great depth means that the sun rarely illuminates the narrow passages fully, and Buckskin lacks the pretty patterns of light and color as are found in, for example, Water Holes Canyon. Still, the walls of the gulch do show the characteristic swirls and curves worn by countless millennia of floods, and they are eroded into innumerable eerie rock formations which, given a vivid imagination and the right kind of light, can resemble all kinds of distorted creatures and strange objects.

Buckskin Gulch (named on some maps as Kaibab Gulch, or The Dive) is a tributary of the Paria River that drains an area around the Vermilion Cliffs in far south Utah and joins the Paria exactly at the Utah/Arizona border, 20 miles from Lees Ferry next to the Colorado River. Three trailheads give access to the gulch; Middle, Wire Pass and Buckskin. The **Middle Trail** leads to the canyon about half way, but involves a 5 mile trip on bad roads and a climb down the cliff walls. The other two entry points are more popular, and are both reached along a reasonable quality dirt track - fine for 2WD cars - that heads due south from US 89 near milepost 26, 4 miles east of the turn off to the Paria ghost town.

After 4.5 miles, a signpost points to the **Buckskin Trailhead**, where the gulch is unremarkable - wide and meandering, filled with soft sand, and remains similar in appearance for several miles downstream. Most people prefer the **Wire Pass Trailhead**, 4 miles further south since it affords quicker access to the deep, scenic parts of the canyon. Only about 2 miles of the narrows are bypassed, and the start of the route is along the Wire Pass side canyon that is also quite narrow and interesting. Again there is a signpost, with a carpark, self-pay fee point and a good area for free camping a short distance along a side-track opposite.

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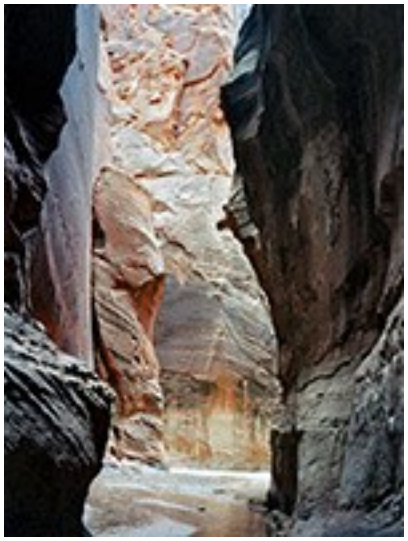
This has nice views of the enclosing hills and the start of Wire Pass, with interesting cacti all around. There are also scattered specimens of petrified wood in various nearby locations, which have bands of the same colorful clayish soils (the Chinle Formation) that are found in the Petrified Forest National Park. The hills are part of the Coyote Buttes region - an extensive area of eroded sandstone cliffs and mounds which includes **The Wave**, an oft-photographed formation of curving rock layers framing a depression in the cliffs. Permits for The Wave are quite difficult to acquire, as the BLM allow only 20 people per day to visit. Again there is a signpost, with a carpark, self-pay fee point and a good area for free camping a short distance along a side-track opposite.

The Gulch has some open, shallower sections, but averages less than 10 feet wide for most of its length. There are always some residual pools of water and mud; the extent depends on how recently the canyon has flooded. Occasionally swimming will be necessary but normally the pools are just 2-3 feet deep and a few yards long.

The water is permanently cold and muddy, and the canyon is certainly not a place to take expensive footwear. The walking surface is roughly half sand - sometimes hard and damp but mostly soft and dry - and half stones or boulders, so progress is more difficult than might be expected as the terrain is largely flat. There are some places where the floor drops a few feet but none of the sheer dryfalls found in some other slot canyons.



Length: (to the Paria confluence) 13.5 miles from Wire Pass, 16.5 miles from Buckskin, 6.8 miles from Middle

Difficulty: Moderate; few major obstacles apart from long muddy pools, but the full hike is long and tiring. High flash flood danger

Management: BLM - part of Paria Canyon-Vermilion Cliffs Wilderness

Rocks: Navajo sandstone

Season: Late spring to fall, though not for several days after recent rains

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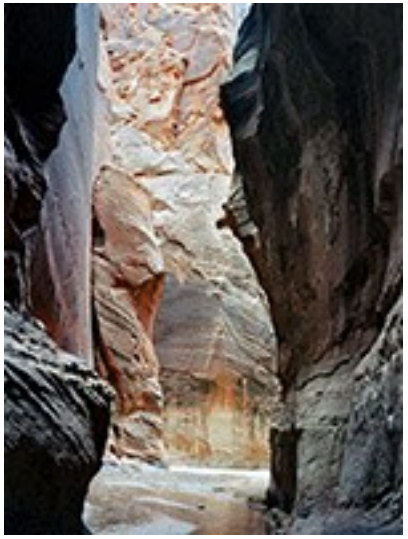

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Día 4 - Lunes, 20 de Mayo de 2019

Day 4 - Monday, May 20, 2019

TIME:	EVENT:
8:00 am	Up and at 'em!
8:15 am - 9:00 am	Breakfast • Yogurt, fruit, granola Brush teeth/Wash faces
9:00 am - 10:00 am	Pack gear into bags/ vehicles Chaperones sign off gear check (in books) Check/clean area (better than we found it) Last minute bathroom breaks Pack sack lunches for trip home
10:00 am	Depart for NDPA (students will contact parents when we get on the road)
12:30 pm	Arrive Scipio, UT (bathroom breaks, fuel)
12:45 pm	Depart Scipio, UT
3:15 pm	Arrive NDPA Unload and head home!

Noticias:

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36

The primary goal of taking this group to Zion National Park is to promote stewardship of Utah's natural world. In doing so, the NDPA chaperones naturalists will train and inspire its participants to not only become better stewards themselves, but also to help inspire others to their own roles as stewards of the land. Becoming a better steward can involve physically managing land more sustainably, but for most of us, it usually includes developing an appreciation for and curiosity about Utah's natural world, considering how our use of resources in our daily lives affects this natural world, and making informed decisions to live in a more sustainable way.

Goals of NDPA Naturalists:

- To inspire people to have a lifelong commitment to explore and learn about Utah's natural world, as well as share those experiences and that knowledge with others
- To promote an increased awareness of and stewardship for Utah's natural systems
- To develop a growing population of well-trained naturalists in Utah
- To disseminate relevant science-based information and effective interpretive techniques
- To connect professional and volunteer naturalists to organizations that need them.

What is a naturalist, and what is their role or responsibility? Each NDPA Naturalist day begins with a discussion that is an opportunity for participants to shape the idea of what it means to be a naturalist. There are many tools that aid a naturalist. Perhaps the greatest tools are our five senses, for it is with these senses that we observe nature. Many naturalists use other tools to capture a particular moment in nature in order to revisit it again.

Getting to Know Desert Ecosystems

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These tools might include writing in journals, taking photographs, painting landscapes, or even collecting and identifying parts of nature to possibly learn more about at a later time using reference materials. Each one of us has interests and abilities that are brought out and enhanced by using these tools. During your time here you will be using various tools to record what you experience during your time. You will be expected to participate and record your ideas, thoughts, inspirations and observations. Through this the hope is to help you become better connected to the land, and proud to be a steward of the beauty that is in the natural world.

Geology of Deserts

Sandstone Layers During the Pennsylvanian Period (286-320 million years ago), a landlocked sea, which eventually evaporated, deposited vast amounts of salts in southeastern Utah over a span of 4 million years. Salt deposition was so high that, in some areas, the salt is 5,000 feet thick, creating what is known as the Paradox Formation. Then, over millions of years, the earth's environment changed; sea levels dropped, rivers criss-crossed the land, mudflats covered the area, and the salt deposits were buried by sand.

White sands blew in from the west and formed large sand dunes. Concurrently, red mud and sediment was deposited by rain and snow runoff from the Uncompahgre Mountains to the east. Much of the deposited debris from these events was cemented together, forming layer upon layer of sedimentary rock (i.e., rock that is formed by deposition and consolidation of mineral and organic material and cemented by precipitates in groundwater) over millions more years. Each layer of rock contains patterns and fossils that reveal its depositional environment. For example, the red and white layers of some sandstones occur when floods of iron-rich debris from nearby mountains periodically flooded coastal dunes of white sand. The Paradox Formation has played a large role in shaping the landscape of southeast Utah. When conditions are right, the weight of overlying rock causes the salt deposits in the Paradox Formation to liquefy and flow through channels that offer the least resistance. This underground movement can have drastic effects on the surface, causing rock layers to crack, uplift, sink, or collapse under the stress.

As you venture through the park you will see evidence of these formations. The diagram on the next page has been provided to aid you in identifying these aspects.

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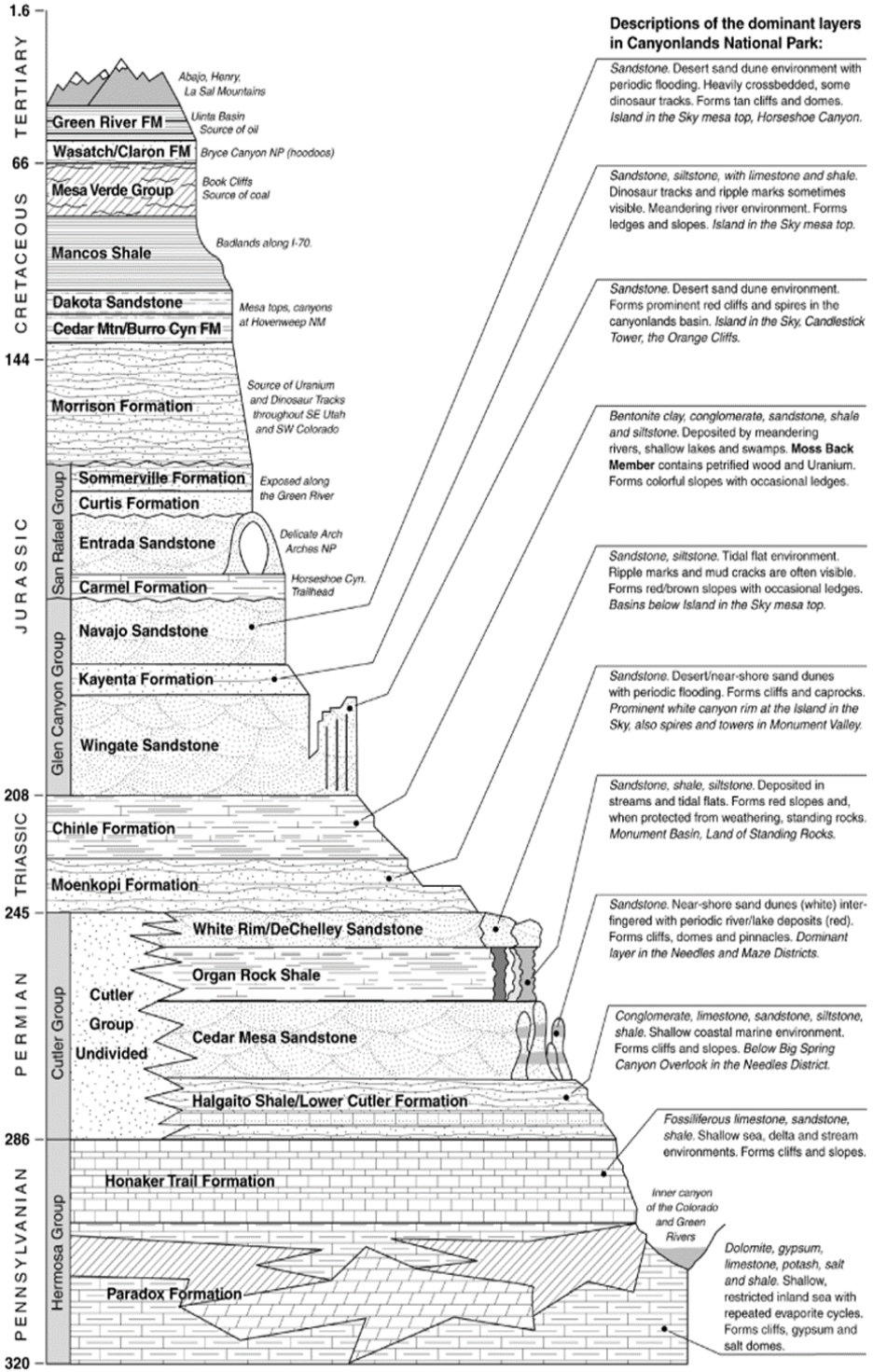
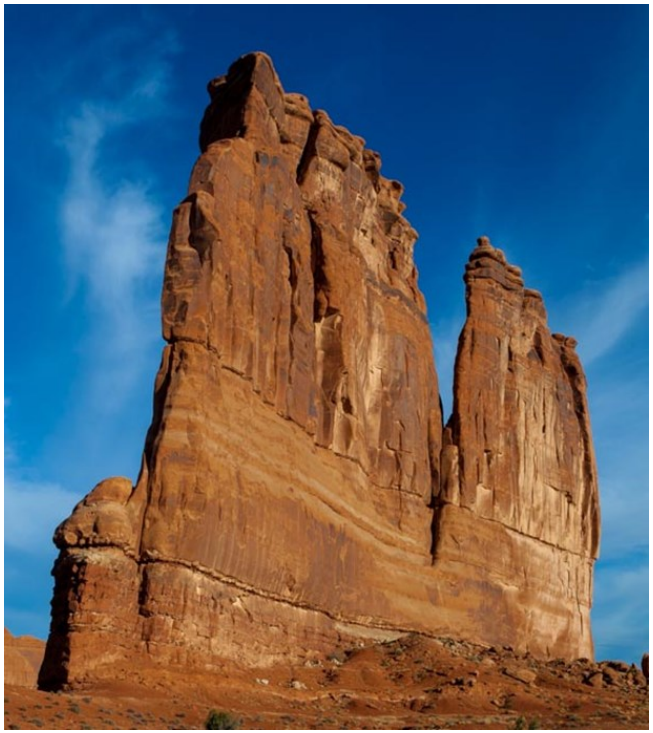


1.6
TERTIARY
Abajo, Henry, La Sal Mountains
Green River FM
Uinta Basin Source of oil
Wasatch/Claron FM
Bryce Canyon NP (hoodoos)
66
CRETACEOUS
Mesa Verde Group
Book Cliffs Source of coal
Badlands along I-70.
Mancos Shale
Dakota Sandstone
Mesa tops, canyons at Hovenweep NM
Cedar Mtn/Burro Cyn FM
144
Morrison Formation
Source of Uranium and Dinosaur Tracks throughout SE Utah and SW Colorado
JURASSIC
San Rafael Group
Sommerville Formation
Exposed along the Green River
Curtis Formation
Entrada Sandstone
Delicate Arch Arches NP
Carmel Formation
Horseshoe Cyn. Trailhead
Glen Canyon Group
Navajo Sandstone
Kayenta Formation
Wingate Sandstone
208
TRIASSIC
Chinle Formation
Moenkopi Formation
245
PERMIAN
Cutler Group
White Rim/DeChelley Sandstone
Organ Rock Shale
Cutler Group Undivided
Cedar Mesa Sandstone
Halgaito Shale/Lower Cutler Formation
286
PENNSYLVANIAN
Hermosa Group
Honaker Trail Formation
Inner canyon of the Colorado and Green Rivers
Paradox Formation
320
GEOLOGIC PERIOD
Millions of Years Ago
Descriptions of the dominant layers in Canyonlands National Park:
Sandstone. Desert sand dune environment with periodic flooding. Heavily crossbedded, some dinosaur tracks. Forms tan cliffs and domes. Island in the Sky mesa top, Horseshoe Canyon.
Sandstone, siltstone, with limestone and shale. Dinosaur tracks and ripple marks sometimes visible. Meandering river environment. Forms ledges and slopes. Island in the Sky mesa top.
Sandstone. Desert sand dune environment. Forms prominent red cliffs and spires in the canyonlands basin. Island in the Sky, Candlestick Tower, the Orange Cliffs.
Bentonite clay, conglomerate, sandstone, shale and siltstone. Deposited by meandering rivers, shallow lakes and swamps. Moss Back Member contains petrified wood and Uranium. Forms colorful slopes with occasional ledges.
Sandstone, siltstone. Tidal flat environment. Ripple marks and mud cracks are often visible. Forms red/brown slopes with occasional ledges. Basins below Island in the Sky mesa top.
Sandstone. Desert/near-shore sand dunes with periodic flooding. Forms cliffs and caprocks. Prominent white canyon rim at the Island in the Sky, also spires and towers in Monument Valley.
Sandstone, shale, siltstone. Deposited in streams and tidal flats. Forms red slopes and, when protected from weathering, standing rocks. Monument Basin, Land of Standing Rocks.
Sandstone. Near-shore sand dunes (white) interfingered with periodic river/lake deposits (red). Forms cliffs, domes and pinnacles. Dominant layer in the Needles and Maze Districts.
Conglomerate, limestone, sandstone, siltstone, shale. Shallow coastal marine environment. Forms cliffs and slopes. Below Big Spring Canyon Overlook in the Needles District.
Fossiliferous limestone, sandstone, shale. Shallow sea, delta and stream environments. Forms cliffs and slopes.
Dolomite, gypsum, limestone, potash, salt and shale. Shallow, restricted inland sea with repeated evaporite cycles. Forms cliffs, gypsum and salt domes.

39

The vast amount of **arches**, **windows**, and **natural bridges** in southeastern Utah are also a result of the Paradox Formation. Because the salt layer of the Paradox Formation is unstable under pressure, the salt bed below Arches National Park began to flow, causing the overlying rock to buckle and shift. Fault lines deep within the earth also contributed to this surface instability. Not only were sections of rock thrust upward into domes or collapsed into valleys, but vertical cracks were formed in the overlying rock, which contributed to the development of arches.

As this underground movement of salt shaped the landscape, erosion continued to strip away younger rock layers on the surface. Water seeped into cracks and joints washing away loose debris and eroding the cemented particles of sandstone, leaving a series of free-standing fins (elongated pillars of standing rock) such as the Courthouse Towers in Arches National Park. During winter months, the expansion of forming ice puts pressure on the rock breaking off pieces and sometimes creating openings, or arches. Only fins with the right combination of balance and hardness (resistance to erosion) evolve into an arch.



The enormous free-standing fin of Courthouse Towers

Arches, Windows, and Natural Bridges

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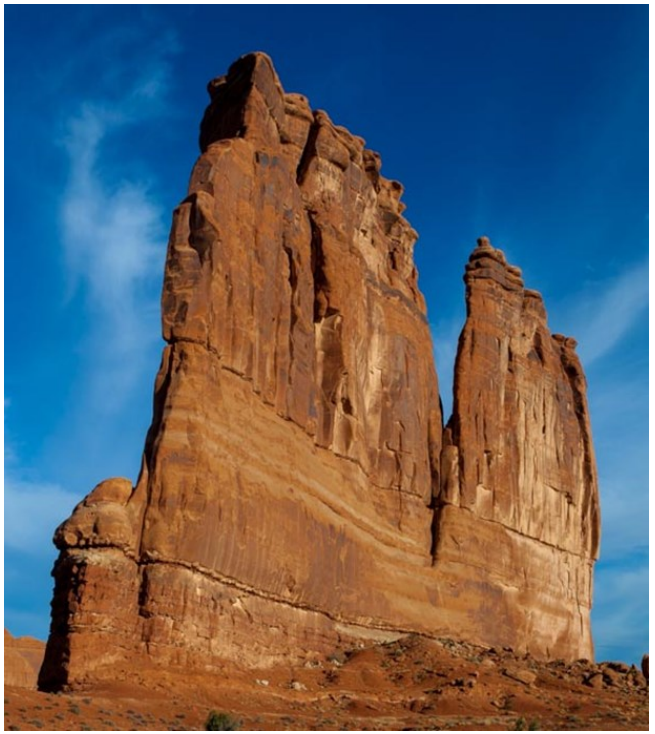

The enormous free-standing fin of Courthouse Towers

40

There are over 2,000 catalogued arches within Arches National Park. These formations range in size from very small, with 3-foot openings, to very large, like Landscape Arch, with 306 feet from base to base. Other formations in the area include **spires**, **fins**, and **balanced rocks**, which complement the arches, thus creating a remarkable assortment of land-forms in a relatively small area.

The different stages or sandstone arch formation.

Plateaus, Mesas, Buttes, and Spires

Uplifting forces beneath the surface of the earth formed plateaus, which are relatively large, level expanses of land that rise 1,500 feet or more above the surrounding area and have at least one steep side. Surges of magma beneath the earth's crust cause the crust to elevate but not break, creating a raised section of land. Geologists believe that this is how the Colorado Plateau was created. Another way plateaus are created is through continued lava flow through cracks in the earth's crust creating large land forms of volcanic rock, and the Columbia Plateau in the northwest U.S. is an example of this.

A mesa (right), butte (far left), and spire (left) in southern Utah.

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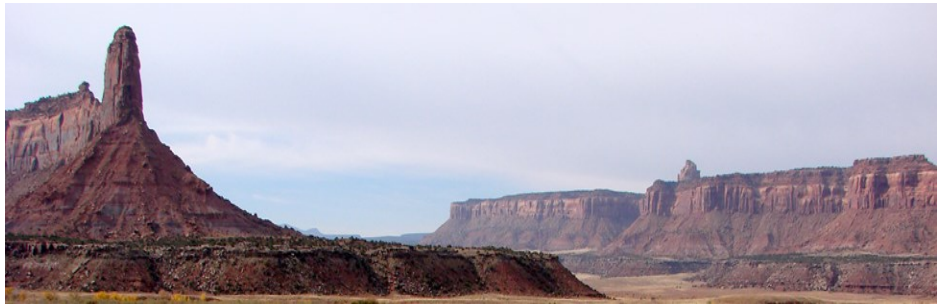

A mesa (right), butte (far left), and spire (left) in southern Utah.

Mesas, buttes, and spires were once plateaus and have been eroded over millions of years by the slow process of erosion. The top layer of these formations is a hardened layer of rock that is resistant to erosion. This top layer, called the cap rock, is usually not sedimentary rock, but cooled and hardened lava that had spread out across the landscape. Beneath this flat protective cap are horizontal layers of softer sedimentary rock formed by the deposition and compression of sediment. Each layer of sedimentary rock has a varying degree of resistance to erosion, which gives mesas and buttes their unique shape. Over time, running water erodes the exposed sides of the softer layers of rock on the plateau, creating mesas and even smaller buttes. The base of these landforms is gently sloped, differing with the near-vertical sides leading down from the cap rock. This base is formed by rock material that has been eroded off the sides and carried downward. Mesas are generally wider than they are tall, and buttes taller than they are wide. Spires, the iconic remnants of greatly eroded buttes, stand as tall, slender towers or pinnacles of rock. Eventually spires will erode away, which is the final fate of all plateaus

Soils

Desert soils are poorly developed because of relatively low nutrient levels and plant productivity. This means that there is little or no organic material (material from once living organisms, such as plants or animals) for microorganisms to convert into organic soil. Although lacking in organic matter, desert soils have a high content of mineral particles. Because of the low organic matter and high mineral content, these soils have a low water-holding capacity; therefore, desert soils do not retain much moisture and are dry for most of the year. Additionally, the high level of evaporation of water from desert soils brings dissolved salts to the surface, sometimes in large quantities. This process can create large areas, called saltpans, where vegetation growth is minimal or nonexistent. However, in some cold deserts, the soil has better drainage due to alluvial fans (cone shaped landforms at the base of slopes and are composed of loose material carried there by water), where the salts have been leached, or drained, out of the soil.

Another important aspect of desert soil development is the process of soil compaction by natural elements. For example, rainfall and baking sunlight cause desert soils on the ground to compact or become cemented together.

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Biological soil crusts, sometimes referred to as **cryptobiotic** or **cryptogamic crusts**, are perhaps the most important communities in Utah's deserts. They are formed primarily by living organisms called **cyanobacteria**. Algae, lichens, mosses, microfungi, and other forms of bacteria also contribute to the formation of these soils. When wet, cyanobacteria and fungi grow and move through the soil and bind soil particles together by a swelling action that forces them to shed a sheath layer. This repeated action of leaving behind dead cell sheaths creates a complex network of empty material that maintains soil structure. Through this process, an otherwise unstable surface becomes very resistant to wind and water erosion.

Well established biological soil crusts are found throughout the Great Basin and Colorado Plateau, covering almost all soil spaces not occupied by vascular plants; comprising 70 percent or more of the living groundcover in these desert ecosystems. Biological soil crusts are characterized by their marked increase in surface topography, often referred to as pinnacles, and are usually darker than the surrounding soil due to the density and dark color of the cyanobacteria, lichens, and mosses creating them. Soil crusts can increase in thickness about 1 millimeter a year and aboveground crust thickness can reach up to 10 centimeters.

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Not only do soil crusts bind together desert soil, but they also serve several other functions for desert ecosystems. The ability to intercept and store water, nutrients, and organic matter that might otherwise be unavailable to plants is improved by the space and surface roughness created by soil crusts. Nitrogen fixation is another significant capability of cyanobacteria. Vascular plants are unable to utilize nitrogen gas as it occurs in the atmosphere; however, cyanobacteria are able to convert atmospheric nitrogen to a form plants can use. In desert ecosystems where nitrogen levels are low and often limiting to plant productivity, cyanobacteria play a crucial role in maintaining sufficient nitrogen levels for improved soil fertility.

While soil crusts are well adapted to desert environments, they are poorly adapted to compaction. Disturbances to soil surfaces in desert environments, such as livestock grazing and recreational activities (e.g., hiking, biking, and off-road driving) can greatly compact the soil, crushing the microorganisms responsible for holding the soil particles together. When the loss of cryptobiotic soil organisms is severe, runoff can increase by half, and the rate of soil loss can increase by six times without apparent damage to surrounding vegetation. With impacts such as these, it takes soil crusts anywhere from six to 250 years to fully recover, depending on the amount of available precipitation. With the destruction of biological soil crusts comes reduced soil nutrients and organic matter, and, ultimately, the collapse of the plant communities and entire desert ecosystem.

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Rocky Outcrops, Cliffs, and Sand Dunes

Abundance in Utah

Utah is well known for its vast canyon country that encompasses the southern half of the state. The Colorado Plateau is a prime example of a collection of steep, rocky canyons and dispersed, varied vegetation types. Several protected areas with these characteristics are Zion National Park, with its cacti, various grasses, ferns, wildflowers, and deciduous and evergreen trees; Bryce Canyon National Park, with is various evergreen trees, and abundant wildflowers; Arches National Park, with its various prickly pear cacti, bunchgrasses, abundant lichens and mosses, and its mixed pinyon-juniper stands; and Coral Pink Sand Dunes State Park, with its vast rolling salmon-colored dunes surrounded by sandstone cliffs and coniferous forests.

Structure As a result of the layers upon layers of sedimentary rock and the uplift of the area known as the Colorado Plateau, towering rocky cliffs were formed in this region. These rocky outcrops themselves are often only able to support little vegetation besides grasses, wildflowers, and small shrubs and forbs. However, these structures are surrounded by vast expanses of dispersed shrublands and woodlands. Pinyon pine and Utah juniper are the most prevalent woodland types; however, other native and introduced(*) species, such as Russian olive*, tamarisk*, and Fremont cottonwood, can be found in riparian areas where water is plentiful. Shrublands consist mainly of shadscale, greasewood, and sagebrush; however, other vegetation, such as rabbitbrush and creosote bush, are often common.

Ecology-Utah's desert environments provide critical and valuable habitat not only many species of plant life, but for a wide variety of animal life as well. The steep, rocky canyons and cliffs, as in Capital Reef and Canyonlands National Parks, provide desert bighorn sheep with the ultimate desert home. Also found in these areas are many species of lizards, and the canyon mouse, which utilize the space under rocks and upon the slickrock. Desert tortoises dig their burrows in the loose sand of these desert areas, spending up to 95% of their life underground. The antlion, a lacewing larva, digs a shallow cone-shaped pit in the loose sand and waits for an ant or other unlucky insect to slip and fall in, becoming the antlion's dinner

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There are also several desert plant and animal species that are **endemic** (restricted to only one place) to Utah's deserts. For example, the giant four-winged saltbush grows nowhere else in the world except in the sand dunes at Little Sahara Recreation Area in central Utah. This species has special adaptations like rapid root growth, huge size, and stems that develop roots that enable it to survive in such a harsh environment. The Coral Pink Sand Dunes tiger beetle only occurs in southern Utah at Coral Pink Sand Dunes State Park. This beetle lives in sand dune habitat and is threatened by all-terrain-vehicle use and therefore it is a candidate for listing as a threatened or endangered species under the Endangered Species Act. There are also several different species of hydrophytes (plants that grow in saturated soils), such as orchids and monkeyflower, only found in hanging gardens on cliffs in Utah's deserts.

A native grassland on the Colorado Plateau

Grasslands

Abundance in Utah -Grasslands occur in Utah below 6,000 feet in cool-temperate regions in the Great Basin and Colorado Plateau. Two types of native grasslands historically existed in abundance in Utah: tall-grass plains grasslands, dominated by blue grama grass, and short-grass prairie grasslands, dominated by galleta grass and Indian rice grass. Both types of grasslands integrated downslope with semi-arid scrub communities and upslope with pinyon-juniper woodlands. Beginning in the late 1800s, with the coming of the railroad and the cattle industry, Utah's grasslands were heavily grazed and many were unintentionally converted to shrublands as a result of fire suppression.

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Salt Desert Shrublands

Abundance in Utah -Saltbush shrublands are widespread in Utah's lowlands where precipitation is less than 10 inches annually. Different species of saltbush flourish in dry, saline soils, making them abundant on playas (inland desert drainage basin filled with alkaline salts washed down by rainwater from surrounding highlands) and badlands (area of barren gullies and mesa tops) in the Great Basin, Uinta Basin, and Colorado Plateau regions. Some areas where saltbushes prefer to grow have such high concentrations of salt in the soil that the surface is white. Soil salinity reduces the moisture availability for vegetation, to which these salt tolerant plants have adapted well.

Structure-Saltbush shrublands occur in widely scattered groups of plants, giving it a feeling of patchiness. These areas generally have shrub growth that covers less than 20 percent of the ground. The vegetation comprising these shrublands generally grows less than 18 inches tall, even in deep soils. It is because of soil salinity and low precipitation that the plant cover in these areas is less than in grasslands or shrubland ecosystems.

Composition-Salt desert shrublands, often found in association with a playa, provide a complex environment for vegetation to grow in; however, several species, primarily shadscale, are found to flourish in the saline clay conditions. Shadscale, greasewood, four-winged saltbush, and winterfat are some of the plants that have adapted to this environment. These shrublands are often intermittently flooded; subsequent evaporation draws salts up from the soil to the surface, often creating salt crusts. Soil substrates are often alkaline, calcareous, and medium to fine textured. Saltgrass can be found growing through the cracks of salt crusts, with sparse shrubs on the boundaries of the crusts. Shadscale typically grows on outskirts of the playas, growing only during spring months, while greasewood grows in the bottomlands of the playa during midsummer. Playas sparsely covered with these shrubs provide valuable habitat for migratory shorebirds, especially on the fringes of the Great Salt Lake.

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A salt desert shrubland in the Great Basin

Ecology

Saltbush shrublands are very dry with hot summers and cold winters. These areas receive less than 10 inches of precipitation annually; however, playas, where salt desert shrublands often occur, are water catchment basins for the surrounding highlands. Accumulation of water causes salts to build up as well. Then as water evaporates, the salts are drawn up from the soil and left behind creating a hard crust, which leads to increased runoff, as well as increased soil aridity. Because of these factors, the vegetation that grows in saltbush shrublands generally only grows in mounds of soil that have not been fully encrusted by salts. High soil salinity, low nutrient availability, low precipitation, with hot summers and cold winters, cause primary productivity in saltbush shrublands to be low. In addition, there is often low species diversity in plant and animal life. The animals that make their home in saltbush shrublands are mainly rodents and birds, with only the horned lark seen in abundance. Additionally, pronghorn are the only large ungulate taking advantage of this marginal habitat.

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Cool Desert Shrublands

Abundance in Utah-Sagebrush shrublands are found throughout the Intermountain West and are widespread in Utah. Sagebrush communities generally occur in broad basins between foothills and mountain ranges at 4,500 to 10,000 feet. This shrub community is usually found on flat to rolling hilltops that appear to be a monoculture of sagebrush.
Structure-Sagebrush shrublands create a moderately dense shrub layer usually 3-5 feet in height, with ground cover as high as 50%. The well-drained slopes are filled with sagebrush, while mixed bunchgrasses and various forbs are found underneath the shrub layer. Sagebrush generally grows evenly across the land, creating a dominant and uniform shrub layer throughout the community; however, stands can differ extensively in the composition of understory plants.

Typical cool desert shrubland

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Considered one of the west's largest and most distinct ecosystems, sagebrush shrublands occur in well-drained clay soils that are deep and non-saline. These shrublands are dominated by big sagebrush, and other *Artemisia* species such as black sagebrush. Blackbrush is another plant that can occur in pure stands in shallower soils than are needed for sagebrush to grow, and is common in southern Utah. Soil type determines which species will flourish in a certain area; furthermore, greasewood and/or saltbush species may occasionally be present in some sagebrush communities where the soil is poorly drained. The understory of sagebrush shrublands is comprised of various bunchgrasses and forbs, such as Indian ricegrass, blue grama grass, Idaho fescue, and bluebunch wheatgrass, that may contribute less than 25 percent of the vegetation cover. In addition, species of rabbitbrush may co-dominate disturbed sagebrush shrubland communities.

The uniform structure of a sagebrush community

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The uniform structure of a sagebrush community

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Ecology

Sagebrush shrublands have adapted to multiple climate types, hence being found at nearly every elevation from 4,000 to 10,000 feet in the Intermountain West. This shrub community can withstand cold winters and hot, dry summers. It grows in areas that are extremely arid, to those classified as semi-arid and is often the climax community at higher elevations. Native sagebrush shrublands encompass about 165,000,000 acres of land in the western U.S. That is a lot of sagebrush considering there is low plant species diversity within sagebrush shrublands. Sagebrush communities support a broad diversity of mammals, reptiles, and birds, with the presence of sage grouse as an indicator of a healthy sagebrush ecosystem.

Warm Desert Shrublands

Abundance in Utah-Creosote bush shrublands are located in the southwestern corner of Utah, within the Mojave Basin and Range. This desert shrub occurs in the low-lying desert areas of the state, typically below 3,500 feet in elevation. Creosote bush shrublands become well established on hot, dry slopes, rocky outcrops, bajadas (plains of sedimentary deposits), sand dunes, and in arroyos (steep-sided dry gulches). Some colonies of this hearty shrub are 11,000 years old, which is largely due to the excellent adaptations creosote bush has to its desert home. The presence of this shrubland ecosystem is a true indicator of a hot desert.

Structure

Creosote bush shrublands are open and sparse with a large quantity of bare soil between plants, which helps prevent the spread of fire. The bare areas are often covered with spring ephemerals (short-lived plants that leave no permanent evidence of being there); however, it is becoming more common for these bare areas to be invaded by non-native grasses like cheatgrass and red brome. Creosote bush is a low to medium height shrub that forms clonal rings that can extend for miles and can be thousands of years old; however, this shrubland is relatively diverse. The uplands are composed of taller perennials, like the Joshua tree, while the lowlands consist of very short annuals.

Composition-Warm desert shrublands are primarily dominated by creosote bush, but the presence of other small evergreen and perennial shrubs is very common. This shrubland ecosystem may contain species of plants from various families;

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including bursage, box thorn, encelia, and globemallow. There is also a diverse array of succulents present in the creosote bush shrubland ecosystem; including hedgehog cactus, several species of cholla, prickly-pear cacti, Joshua tree, and other yucca species. These desert plants flourish in calcareous, sandy, alluvial soils. Creosote bush shrublands are also home to ephemeral wild flowers, which, in wet years, create an incredible sight, while not even appearing during dry years.

The unique Joshua trees of the Mojave Desert.

Ecology-Creosote bush shrublands occur in areas where temperatures are variable and extreme. Located in the southwest corner of Utah, the mean annual temperature is around 60°F. Summer daytime temperatures can reach 115°F, while winter temperatures can be as low as 5°F. Annual precipitation in these shrublands is 6 inches, which is mostly received during isolated summer thunderstorms. As this precipitation is collected into the lowland areas and evaporated, a hard crust on the surface, or just underneath, called caliche (a layer of clay or sand containing minerals, such as calcium carbonate, and salts), is created. This soil type is also referred to as desert pavement. This hard layer of soil is one cause, along with low soil oxygen and nutrients, for primary production in creosote bush shrublands to be low.

Desert plants have the tendency to grow from the centers of **fertile islands**, where the majority of nutrients and biological processes occur; as a result in some areas creosote bush may stand alone with no other associated plants for miles. Desert washes tend to have higher productivity rates and greater species richness because the presence of water and nutrients carried there by rain events. Creosote bush shrublands in Utah provide valuable habitat for a diverse array of wildlife. Small mammals, non-game birds, desert tortoises, jackrabbits, and pronghorn eat the seeds and leaves of the vegetation; while snakes, lizards, roadrunners, and coyotes prey on many of these, as well as insects. Reptiles are especially diverse in this community, having unique adaptations for this harsh environment.

including bursage, box thorn, encelia, and globemallow. There is also a diverse array of succulents present in the creosote bush shrubland ecosystem; including hedgehog cactus, several species of cholla, prickly-pear cacti, Joshua tree, and other yucca species. These desert plants flourish in calcareous, sandy, alluvial soils. Creosote bush shrublands are also home to ephemeral wild flowers, which, in wet years, create an incredible sight, while not even appearing during dry years.

The unique Joshua trees of the Mojave Desert.

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Pinyon-Juniper Woodlands

Abundance in Utah-Pinyon-juniper woodlands cover 30 percent of Utah and are abundant throughout the desert ecosystems. This community occurs on dry mountains and foothills and is especially prevalent on the Colorado Plateau. Located on dry slopes, mesas, plateaus, and ridges at elevations between 2,700 and 11,000 feet, pinyon-juniper woodlands are most common between 5,000 and 8,000 feet. Juniper trees are more tolerant of drought and cold, while pinyons prefer more moisture. As a result, temperature and precipitation govern distribution of pinyon-juniper stands, often causing junipers to be dominant in lower elevations and pinyons dominant at higher elevations. However, mid-elevations receive a good mix of pinyon and juniper.

Pinyon-juniper woodlands of the higher elevation desert

Structure-Pinyon-juniper woodlands have been referred to as pygmy woodlands because both pinyon and juniper are generally less than 20 feet tall. Although juniper dominates lower elevations, it often reappears on rocky ridge tops where they have wedged their roots into narrow rock crevices and persisted for centuries (e.g., Jardine Juniper in Logan Canyon is 3,200 years old). Pinyon-juniper woodlands consist of several different types of pinyon and juniper trees with the interspaces filled with various shrub species, including sagebrush. Historically, pinyon-juniper woodlands had an open canopy, which allowed for more abundant herbaceous vegetation to persist. Recently, pinyon-juniper stands have increased in density, which has prevented the growth of understory vegetation.

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Composition Pinyon-juniper woodlands consist mainly of pinyon pine and Utah juniper trees. The U.S. Forest Service has distinguished 32 pinyon and 23 juniper plant species. The Colorado pinyon pine is the most common species on the Colorado Plateau, the single leaf pinyon is the most common in the Central Basin and Range, and the Utah juniper is the most common juniper. Eleven different species of pinyon pine co-dominate with 17 different species of juniper in this woodland community. Several other common species include one-seed juniper, Rocky Mountain juniper, and alligator juniper. Plant diversity, however is moderate since the understory layers are dominated by shrubs and can even be absent if the tree canopy is dense. Understory species in pinyon-juniper woodlands include big sagebrush, blackbrush, stansbury cliffrose, blue gramma grass, and James' galleta grass.

Ecology Pinyon-juniper woodlands are susceptible to limited distribution if severe climatic events occur during the growing season. Frosts and droughts tend to limit these woodlands to narrow altitudinal belts on mountainsides. A wide variety of soils support pinyon-juniper communities, from rocky to sandy, clay loams and annual precipitation ranges from 10 to 15 inches. The trees in these communities have adapted well to changing conditions and are generally both drought and cold tolerant. Pinyon tends to form more closed-canopy stands, which demonstrates a more forest-like dynamic and species composition, including a significant shrub component. On the other hand, juniper tends to grow in a scattered, open pattern with no significant shrub component, with the exception of areas that have been overgrazed and big sagebrush has invaded and become well established.

Pinyon-juniper woodlands serve as valuable cover and habitat for many species of wildlife. Mule deer eat the needles of the trees, while birds, small mammals, and rodents collect and eat their seeds and bark. The dead trees in this ecosystem also serve as important habitat for animals, including insects. Pinyon-juniper woodlands provide cover for desert bighorn sheep and 70 different species of birds, such as the pinyon jay and Clark's nutcracker that nest, breed, and are critical in dispersing the seeds for generation of new trees.

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Desert Ecology

Food Webs-While all food webs begin with the sun, life in the desert begins with the plants, bacteria, and lichens that photosynthesize. **Photosynthesis** is the process of converting the sun's energy, water, and carbon dioxide into carbohydrates that are stored within plant tissue, and oxygen. This form of potential energy is stored for the plants' survival and growth. Some of the carbohydrates get used by the plant for its own growth and reproduction through a process called **respiration**. The produced organic material, called biomass, is then available to herbivores and omnivores that rely on it as an energy source for survival. In the desert, you may see scattered plants across the surface of the land. While it may not look like much plant productivity, it is only 40% of the total plant biomass of the desert ecosystem. The remaining 60% is located underground, in the form of roots or rhizomes (stems producing roots to develop into new plants) or soil microbes, and is unavailable to most herbivores. Because of this, primary production, the maximum amount of plant material produced each year, is often only measured above ground. Because climatic factors and the availability of nutrients control net primary production, desert ecosystems are generally low producers of total biomass. The relative lack of water and nutrients limits plant growth in deserts. On average, desert scrub ecosystems produce only 7% of the energy found in a temperate broad-leaf forest each year. **Net primary productivity**, measured as total energy production minus that used for plant respiration, provides the food for desert animals (i.e., the **consumers**) and gives them the nutrients and energy they need to survive. Animals directly consume the energy by eating the plant, or indirectly consume it by eating the animal that ate the plant.

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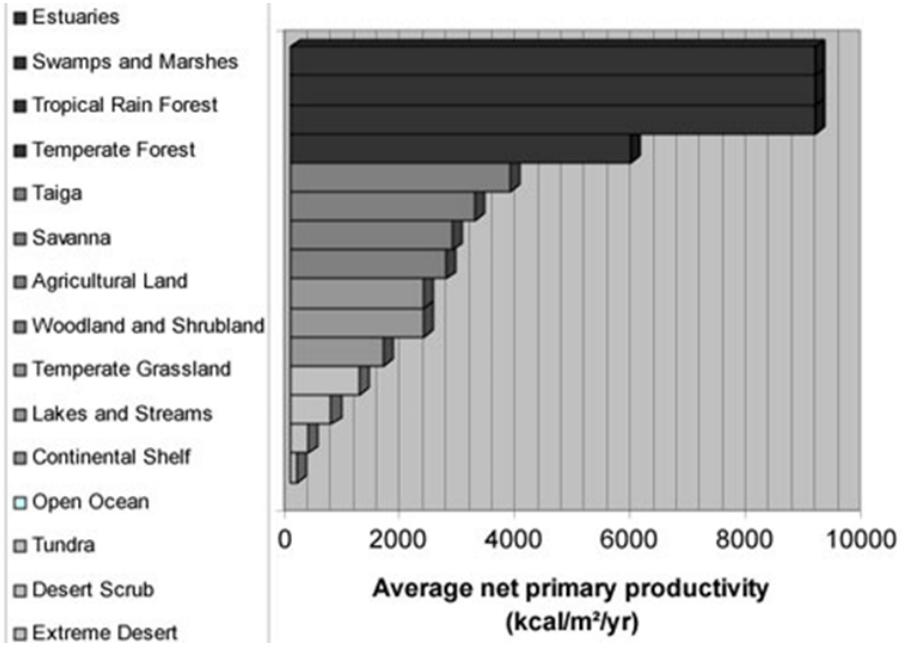
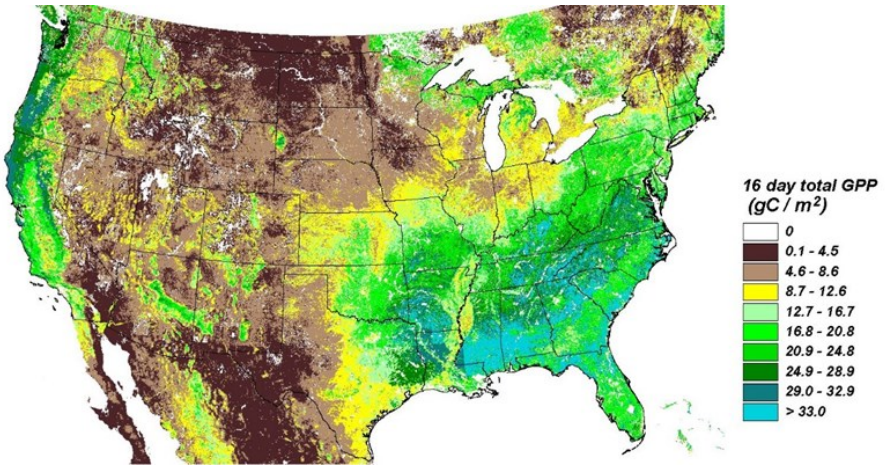
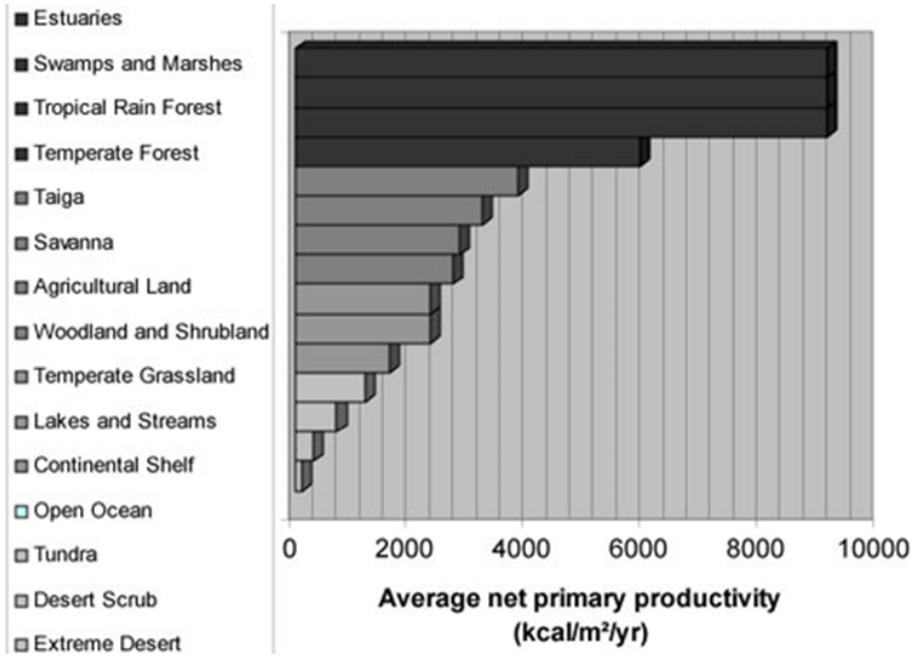


Compared to other major biomes, primary productivity is low in deserts



Across the U.S., primary productivity is lowest in the dry Intermountain West and at high altitude mountain ranges.



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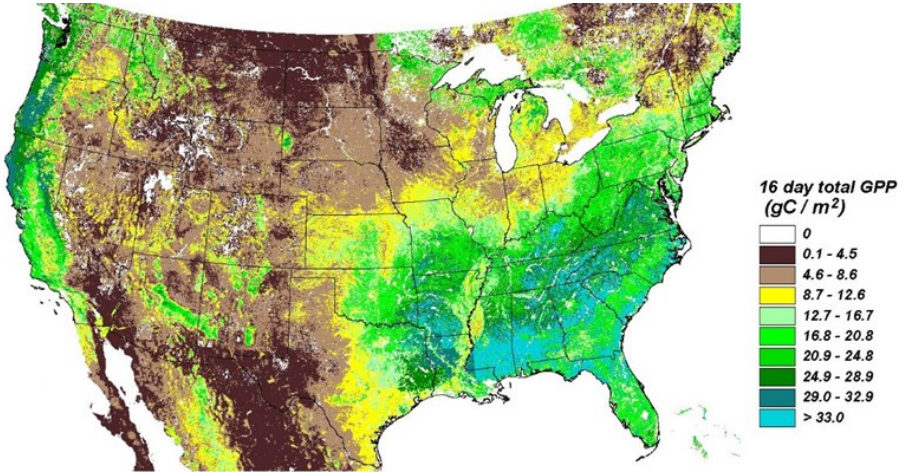

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The plants and bacteria that photosynthesize are known as **producers** and make up the first trophic level of a food web (the networks of feeding links between organisms). The amount of energy produced by plants is limited by the availability of sunlight, nutritional resources, and water. The second trophic level is comprised of **primary consumers** that receive the energy that has been stored within the plant tissue. The third trophic level contains **secondary consumers**, which are animals that eat the primary consumers. This brings us to the last trophic levels, which contain **tertiary consumers**. The members of this level are often large predators. These carnivores eat other carnivores; for example, in desert ecosystems, this level of predator is a hawk that eats a snake. The final, but very important group, in a food web is the **decomposers**. Each organism in any trophic level excretes waste or eventually dies, leaving behind organic material. Fungi and bacteria break down this remaining organic material, releasing energy in the form of simple chemical compounds. These nutrients can be dissolved in water and absorbed into plant roots; thus, allowing plants to grow and the food web to begin all over again.

The energy transferred from one **trophic level** to the next is only about 10% of the total energy of the previous level. This occurs, in part, because portions of organisms that don't get consumed (e.g., beaks, shells, and bones) required energy to be created, but that energy is not available to the subsequent consumer. More importantly, though, is that the vast majority of energy consumed by an organism is devoted to growth and daily metabolic needs. Because of this, ecological systems need to produce a large amount of organisms at the lowest level of the food web (i.e., the producers) in order to sustain relatively few of tertiary consumers at the top. Since deserts produce relatively minimal biomass, the bottom trophic level of producers supports an especially low number of consumers at the top trophic level.

One key aspect of food web structure is complexity, which refers to the number of links to other organisms that are consumed. The complexity of a food web greatly reflects the stability of the ecosystem. It shows how dependent organisms are on each other and how complex and dynamic the ecosystem is.

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For example, animals may forage for different food items at different times based on availability. Desert herbivores eat a wide variety of plants during the course of their lives, or even during a single year. Largely a result of low plant availability, they will eat almost anything they can find, and are referred to as **generalists**. Animals may also migrate to different areas within the ecosystem, thus causing many variations in the food web. Because many desert consumers are generalists, energy passes through many routes, resulting in highly complex food webs compared to those in many other ecosystems. If one species in a desert food web disappears, it is likely that the ecosystem will remain stable because most consumers can shift to other foods. Biologists studying food web complexity hope to predict how ecosystems are likely to respond to changes imposed from outside forces, such as climate change or disturbance.

Biodiversity

Biologists will often calculate the biodiversity of an ecosystem, or the total number of species, to assist in determining the health of an ecosystem. Generally, the higher the diversity, the healthier the ecosystem. But, this does not always hold true. For example, a wetland with a high density of cattails, insects, and birds may be very productive, but may have low numbers of other plants and animals thus giving the wetland low overall biodiversity. Species diversity is a function of many different factors. As we move closer to the Equator, that is, further south in North America, species diversity generally increases due to increased primary productivity (primarily due to increased average annual temperature, precipitation, and nutrients). However, this does not always hold true. As it turns out, variety in habitat structure is more important than level of primary productivity. The greater variety in structure, whether it is topography, vegetation, or microclimate, the greater the species diversity. Because of this increased diversity in structure, there are more habitats or niches available. Of course, suitability of the physical conditions also matters. Even though deserts have, in general, lower net primary productivity, diversity is relatively high, primarily due to habitat diversity.

Accurately determining the biodiversity of an ecosystem not only requires counting the number of species, or species diversity; it also requires calculating the ecological diversity and genetic diversity of an ecosystem. Ecological diversity refers to the differences between ecological processes, habitats, and communities between and within ecosystems. Grassland ecosystems of America are similar, but not identical to, the pampas of South American, because of the different organisms and climate in both areas.

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Genetic diversity represents the different genes within all the members of a population of a particular organism. Diversity in gene pools is important because the loss of genes can result in poor reproductive rates and susceptibility to diseases. Genetic diversity can be lost through random environmental changes or specific events. Sometimes a number of individuals will occupy a new area and become isolated from the larger population. This is called a **founder event**, much like the pioneers settling in Utah. Founder events can result in a significant loss in genetic diversity over time if no new genetic material (i.e., immigrating individuals) is introduced. If a founding population remains small and genetically isolated, it can result in a **genetic bottleneck** where genetic diversity continues to be lost through the lack of immigrating individuals and increased population size.

Considering that plant productivity is relatively low in deserts, it is not necessarily true that plant species diversity would also be low. In some cases, this is true, such as in the polar regions, but not necessarily. If you take a closer look at North America, in particular Utah, you'll see that diversity of vascular plants is actually relatively moderate.

Farther up the desert food web, vertebrate diversity is surprisingly high. Deserts and xeric shrublands have relatively high species diversity, third only to moist tropical forests and tropical grasslands, savannas, and shrublands. The generalist nature of desert consumers allows for vertebrate diversity to flourish.

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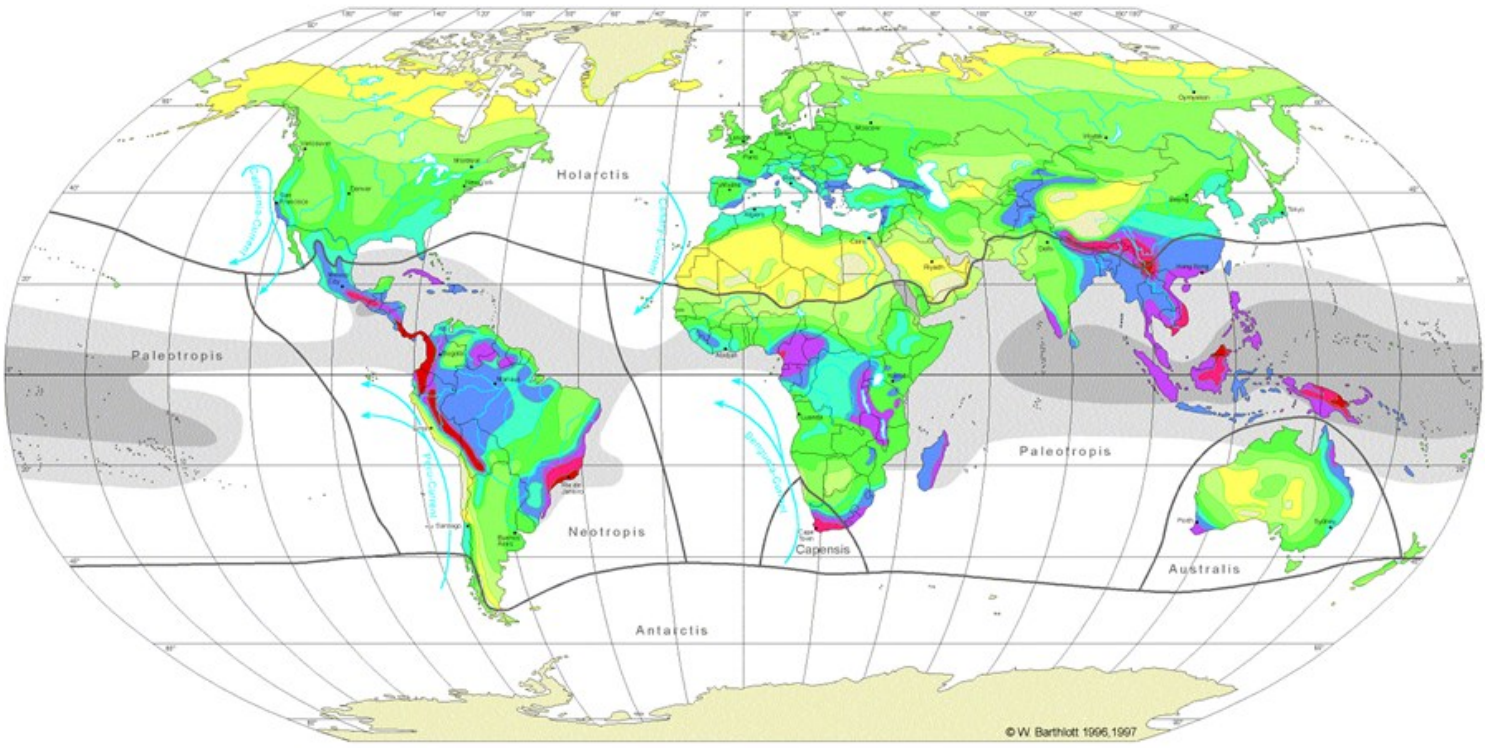
GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



Robinson Projection
Standard Parallels 38°N und 38°S
Scale 1: 130000000

Diversity Zones (DZ): Number of species per 10.000km²

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- DZ 4 (500 - 1000)
- DZ 5 (1000 - 1500)
- DZ 6 (1500 - 2000)
- DZ 7 (2000 - 3000)
- DZ 8 (3000 - 4000)
- DZ 9 (4000 - 5000)
- DZ 10 (≥5000)

Capensis floristic regions

sea surface temperature
- >29°C
- >27°C

cold currents

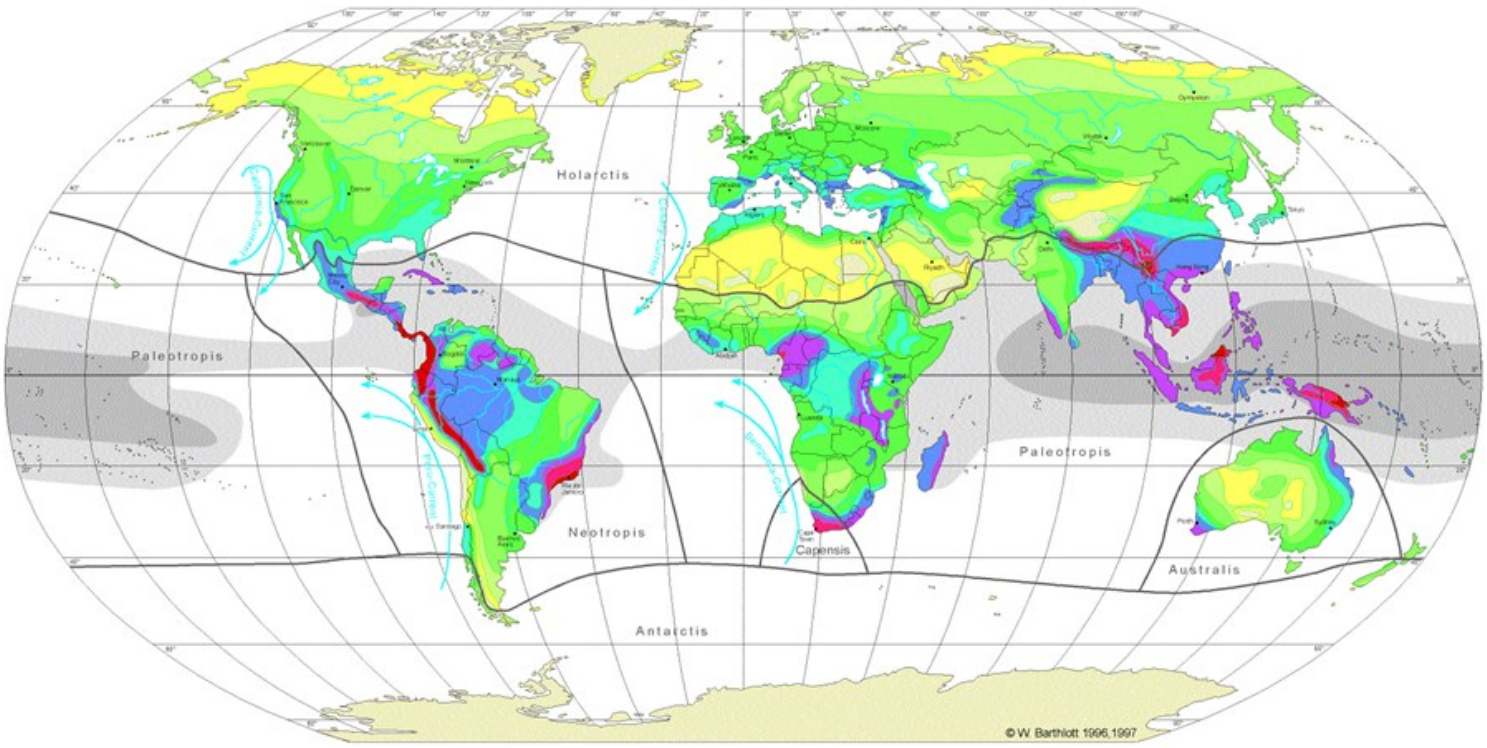
W. Barthlott, N. Biedinger, G. Braun
F. Feig, G.Kier, W. Lauer & J. Mutke 1997
modified after
W. Barthlott, W. Lauer & A. Placke1996
Department of Botany and Geography
University of Bonn
German Aerospace Research Establishment, Cologne

Cartography: M. Gref
Department of Geography
University of Bonn

61

Regional vascular plant diversity across the globe

GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



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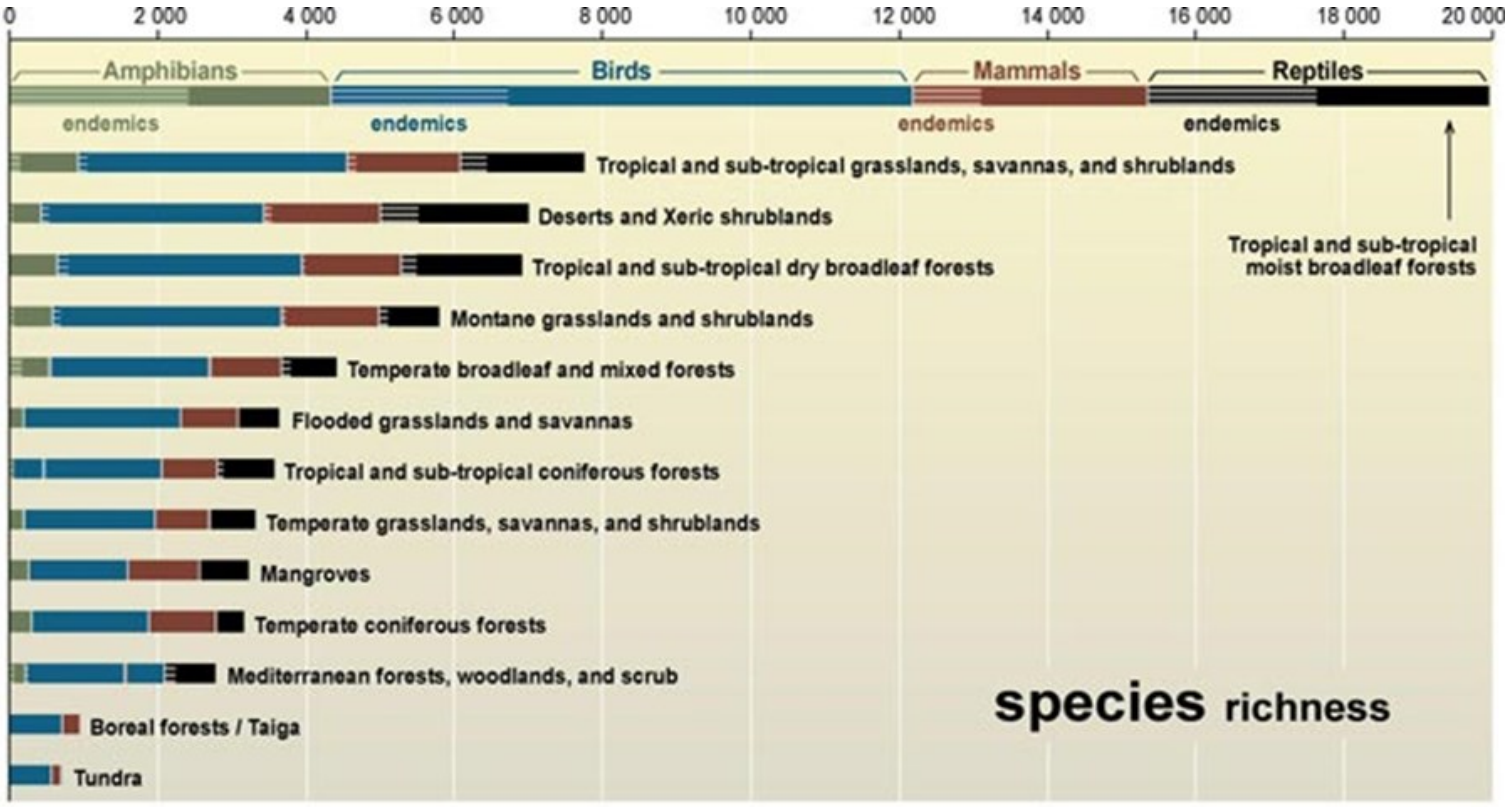

Vertebrate species diversity is paricularly high in deserts.

0
2 000
4 000
6 000
8 000
10 000
12 000
14 000
16 000
18 000
20 000
Amphibians
Birds
Mammals
Reptiles
endemics
endemics
endemics
endemics
Tropical and sub-tropical grasslands, savannas, and shrublands
Deserts and Xeric shrublands
Tropical and sub-tropical dry broadleaf forests
Montane grasslands and shrublands
Temperate broadleaf and mixed forests
Flooded grasslands and savannas
Tropical and sub-tropical coniferous forests
Temperate grasslands, savannas, and shrublands
Mangroves
Temperate coniferous forests
Mediterranean forests, woodlands, and scrub
Boreal forests / Taiga
Tundra
Tropical and sub-tropical moist broadleaf forests
species richness

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62

Plant Adaptations to Desert Ecosystems

Organisms that make deserts their home have developed adaptations to harsh environmental conditions. There are three types of adaptations for survival in the desert: morphological, physiological, and behavioral. Morphological adaptations are related to the physical shape of the plant or animal. For animals, this could include long, slender legs for keeping its body off the hot soil, and for plants, the waxy coating on its leaves helps conserve water. Physiological adaptations involve the actual metabolic or chemical attributes that help an individual survive in its particular environment. For both plants and animals, this could include dormancy during periods of low water or food availability. Behavioral adaptations involve changes in the way an animal acts. Animals conscientiously alter their behavior to adjust to changing environmental conditions (e.g., moving into the shade when they get too hot).

Water Storage in Leaves

Because precipitation comes in infrequent, brief bursts to Utah's deserts, plants must be able to absorb large quantities of water in a very short period of time and be able to store it for long periods of time. Many of the plants found in the desert are **succulents**, meaning they have thick fleshy leaves, stems, and/or roots that can store water. Succulent plants include agave, aloe, euphorbias (e.g., candelabra tree), and all cacti. These plants are visually striking because they are unlike the plants found in any other region. They have very small leaves, very few leaves, no leaves at all, or spines/thorns which are all adaptations for survival in their harsh environment. Furthermore, many succulent plants have bitter and toxic attributes that are adaptations against being consumed by hungry consumers.

Plant Adaptations to Desert Ecosystems

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Shallow Root Systems

Most succulent plants have fibrous root systems that rarely grow deeper than 4 inches (10 cm) below the soil's surface, with the water-absorbing roots located only ½ inch (1.3 cm). Although the roots are shallow, they extend laterally twice as far as the plant is tall to take advantage of brief rains that only wet the top few inches of the soil and dry out again quickly due to intense sun. Not only are the **fibrous roots** of succulent plants efficient at quickly absorbing water, but they are also very efficient at transporting the water from their roots to other parts where it is needed. The efficiency comes by way of using very little energy to perform these processes; therefore, allowing the plant to reserve energy for survival in its harsh environment .

Waxy Coating on Leaves

One way succulent plants conserve stored water, whether from transpiration or being devoured by animals, is by developing a waxy or oily coating on their leaves. The waxy coating creates a waterproof seal over the leaf when its **stomata** (cells that allow gases such as carbon dioxide, water vapor, and oxygen to move rapidly into and out of the leaf) are closed, protecting it from the drying effect of the sun and wind. These waxes and oils are shiny; thus reflecting sunlight and keeping the temperature of the leaves lower, which reduces the amount of water lost through transpiration. The oils of some succulent plants, like the creosote bush, have a distinct odor that serves the same purpose as thorns in discouraging animals from eating it.

The shiny, waxy leaves of creosote bush

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Extensive Taproot

Another way that desert plants are adapted to collect water is through long **taproots**. Unlike fibrous roots, taproots grow deep into the soil in order to reach available water sources deep within the ground. Phreatophytes (long-rooted plants which have adapted to desert or arid environments) like desert willow, tall sagebrush, and species of mesquite utilize this strategy to keep the plant alive throughout the hot and dry season. Some extensive **phreatophyte** roots have been found to grow hundreds of feet deep to reach a constant water source in order to survive.

Trichomes

Trichomes, hair-like projections found on the stem and leaves of plants, help desert plants reduce temperatures and water loss. They provide shade for the plant, which reduces evaporation by keeping the leaves cooler. Trichomes can sometimes be extremely thick, making desert plants lighter in color. As a result, evaporation rates remain lower and allow the plant to conserve its water stores. On some plants, such as brittlebush, no green can be seen because of the great thickness of its trichomes. Trichomes also help collect and trap water by absorbing morning dew, which creates a moist microclimate around the plant.

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Drought/Winter Dormancy

Drought dormancy refers to a plant's ability to withstand dehydration without dying. Drought-tolerant plants may appear to be dead during the dry seasons, and can even be used as fire kindling, although they are alive. Plants with this adaptation are non-succulent, and can survive for months or years with no new precipitation. Drought-tolerant plants enter into a state of low metabolic activity which allows the plant to conserve its stored water and energy, and survive for long periods of time without rain. After the plant is rehydrated by the soaking rain, it can resume full metabolic activity (within a few days to a week) and begin new growth and maintain it for several weeks. In contrast to succulent plants, drought-tolerant plants can absorb moisture from soils that are very dry. They also continue to photosynthesize with low moisture contents, which would kill other plants.

Shortened Life Cycles

Annual plants (i.e., plants that complete their life cycle in a single season) escape harsh desert conditions by "disappearing" during these periods. Germination and growth of annual seeds depend on rains that are earlier and more plentiful than normal; therefore, they grow and produce seeds within a narrow window of opportunity occurring in the spring or fall. The seeds are dormant with a great resistance to environmental extremes and almost no metabolism. A typical annual seed in the desert consists of a plant embryo and a supply of nutrients to sustain it until conditions are appropriate for germination. The seeds have a thick seed coat that is waterproof, so the seed cannot dehydrate and die. Also in the seed coat are chemicals that inhibit germination until enough water is present to dissolve them and allow the embryo to grow. These factors make these annual seeds well equipped for survival in the desert's harsh conditions for as long as it takes, sometimes for decades, to obtain the right conditions for growth.

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Dropping Leaves

Drought-tolerant plants often drop their leaves during dry seasons. Because most water is lost through transpiration on leaf surfaces, dropping leaves reduces the surface area of the plant; thus reducing transpiration and allowing the plant to conserve water. Living in a desert environment where temperatures are extreme and precipitation minimal, plants may drop their leaves multiple times a year in order to survive. Mesquite, creosote bush, acacia, and ocotillo are all drought-tolerant plants that drop their leaves and enter a dormant state in harsh conditions.

Ocotillo with and without leaves.

These plants have chlorophyll (i.e., green pigment in plant cells that captures light energy required for photosynthesis) in their stems, which makes it possible for them to continue photosynthesizing, albeit at a much slower rate, after dropping their leaves.

Plants using CAM photosynthesis lose about one-tenth the amount of water that plants utilizing standard photosynthesis do. One draw-back to CAM is that the overall rate of photosynthesis is lower than usual, causing CAM plants to grow much slower than others. Another vital attribute of CAM plants is their inactive metabolism during droughts. CAM plants keep their stomata closed during day and night when they become water-stressed. This causes the plant's water store to be sealed inside and gas exchange virtually ceases; however, a low level of respiration is continually performed within the plant, allowing it to keep from going completely dormant

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Members of the Crassulaceae family (i.e., herbs and small shrubs that have succulent leaves, such as stonecrop) have been found to perform a different type of photosynthesis called **crassulacean acid metabolism**, or CAM. This process allows plants to make food during the day without losing water. Normally, during photosynthesis, plants open stomata (i.e., cells that allow gases to move rapidly into and out of the leaf) during the day to let carbon dioxide enter the plant and oxygen to exit. Light energy is required for photosynthesis to occur; however, this energy also causes water vapor in the leaves to rapidly escape via open stomata through transpiration. CAM plants keep their stomata tightly closed during the day and get their carbon dioxide by opening their stomata at night when it is cooler and less water is lost through transpiration. The carbon dioxide collected at night is then stored as malic acid until morning when photosynthesis can take place using the stored carbon dioxide.

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Avoiding Extreme Temperatures

Desert animals are particularly susceptible to the effects of extreme temperatures. Animals receive heat directly through solar radiation, and indirectly through conduction from rocks, soil, and convection from the air. To avoid the harsh environmental conditions, many desert mammals and reptiles are **crepuscular** (i.e., only active at dusk and dawn) or nocturnal (i.e., active at night), only expending their energy during cooler parts of the day. This allows them to conserve the water and energy they receive from the little food that is available to them. Some animals, such as bats, many snakes, most rodents, and some larger mammals like foxes, are strictly **nocturnal**. Still, other animals remain active during the heat of the day. These animals have several strategies like moving rapidly over hot surfaces and escaping to shaded areas as often as possible to rest and maintain a stable body temperature. Some desert animals, like the desert tortoise, avoid the harsh environmental conditions by burrowing below the surface of the ground where temperatures are considerably cooler. Some rodents even plug up the entrances to their burrows to keep the hot air out.

A desert cottontail rests in the shade, with its body against the cool ground

Animal Adaptations to Desert Ecosystems

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A desert tortoise burrow serves as refuge from the desert heat

Collecting Water

When water is scarce, some animals have adapted collection strategies to get the water they need to survive. For example, the desert tortoise gets most of its water from the moisture in the grasses it consumes in the spring. Desert tortoises also dig catchment basins in the soil in order to maximize the utilization of infrequent rainfall. They are often seen sitting near a basin when rain appears to be on the way.

Another animal that has adapted strategies to collect water is the kangaroo rat. This rodent collects dry food and stores it in its cool, underground burrow where the humidity is higher than that of the air above ground. As the rodent hides in the burrow out of the desert heat, the moisture in its breath condenses, and is absorbed by its dry food. This increases the water content of the food from 4 percent to 18 percent; thus, helping the rodent to live indefinitely on a diet of seeds and other dry plant material without ever drinking.

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Body Morphology

Body shape is a morphological adaptation of animals to desert environments. Long legs and toes of the collared lizard limit heat absorption by its body, preventing overheating. The long ears of the black-tailed jackrabbit play a similar function. A jackrabbit's ears have an extensive blood supply near the surface of the skin. In hot weather, their blood vessels dilate to give off heat, which has a cooling effect. In cold weather, its ears lay back along the hare's body and the blood vessels constrict to maintain body warmth

The long legs of the collared lizard keep it elevated from the hot rocks

Body Coloration

Another morphological adaptation to desert environments by animals is cryptic coloration or **camouflage**. Many desert animals have light coloration, which provides several benefits, including protection from solar radiation, defense against predators, communication with members of the same species, attracting mates, deceiving rivals, signaling alarm, and approaching prey. There are at least six different means of camouflage by animals: 1) *general background resemblance*, looks like the surrounding environment; 2) *deceptive resemblance*, looks like something else in the environment; 3) *disruptive coloration*, stripes or shades that confuse predators about the actual location of an animal; 4) *countershading*, top side of the animal is darker than the bottom side; 5) *polymorphism*, the presence of more than one genetically distinct type in a species; and 6) *cryptic behavior and vigilance*.

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These adaptations can make it extremely difficult to spot an animal in its natural habitat, which is essential to desert animals' survival. Not only does camouflage conceal animals from predators, but it allows them to be inconspicuous predators themselves.

Color and texture combine to camouflage a horned lizard

Aestivation is a dormant state that some animals enter into during hot weather or drought to reduce water needs and energy expenditure. Aestivation is characterized by an animal's body temperature becoming near ambient (i.e., directly affected by outside temperature) through the reduction of heart rate and respiration. Desert tortoises, many amphibians, and several species of ground squirrel are well known for their summer slumber. In underground burrows, these animals spend up to 95% of their time, awaiting cooler, wetter conditions. Some amphibians, like the spadefoot toad, spend 10 or 11 months aestivating below ground and revive only when vibrations of falling rain arouses it. Aestivating animals can be fully aroused quickly as the acceleration of breathing increases blood and oxygen to its tissues.

A spadefoot toad emerges from the desert soil

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Winter Dormancy or Hibernation

Hibernation has physiological similarities to aestivation; however, it is usually in response colder temperatures and limited food availability. Animals unable to migrate to warmer environments at the onset of winter begin hibernation with a long period of eager feeding and collecting of food. The food is then turned into a thick layer of body fat to provide energy and warmth during hibernation. The animal goes to sleep in its hibernaculum, and its blood vessels constrict and heartbeat slows allowing its core body temperature to fall to 40°F, restricting its metabolism to generate only 2 percent of the body heat it produces when active. In order for the animal to prevent its blood from clotting, due to a slow heartbeat, changes in the blood plasma are necessary to keep the brain and nervous system functioning and remain in a state that can be aroused with the appropriate stimulus. When time comes for the animal to be aroused, the nervous system causes it to begin shivering violently, which generates heat. This process consumes large amounts of energy, obtained by the stored fat, and takes up to 4 hours or longer to increase heart rate, metabolism, and breathing depending on the size of the animal.

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Evaporative Cooling

Unlike humans, animals cannot turn on the air conditioner and control the temperature of their environment when they get too hot. However, like humans, they do need to keep their bodies from over-heating. Desert animals can cool themselves via evaporation in several ways: 1) **panting**, in which water evaporates from the mouth, nasal passage, and lungs; 2) **gaping**, which allows water to evaporate from membranes in the throat; and 3) **gular flutter**, or rapid movement of moist membranes in the throat to increase evaporation. One drawback for desert animals utilizing these processes is that they lose water, which must be replaced in order to maintain effective heat regulation. This can be a difficult task for desert dwellers where water is scarce during the majority of the year. Desert animals utilizing evaporative cooling strategies include owls, doves, and gallinaceous (i.e., chicken-like) birds. One bird that utilizes a variation of these evaporative cooling strategies is the turkey vulture. The turkey vulture urinates directly onto its own legs and as the urine evaporates the bird stays cool. Another animal using a variation of these strategies is the kangaroo rat, which salivates abundantly and licks its fur. As the saliva evaporates from its fur, the kangaroo rat is cooled.

Obtaining Water from Foods

Because Utah deserts typically receive less than 10 inches of precipitation each year, desert animals are must often obtain their water from other sources. Luckily, desert plants are well adapted to the environment and are able to store water for long periods of time. Succulents, and their seeds, are the main source of water for some herbivores. Just as carnivores feed on the herbivores and energy is passed through each trophic level, water is also passed on in this way. Some desert dwellers are completely reliant on their food source to provide the water they need for survival.

How is it possible to survive by only eating plants and not drinking water? The metabolic processes that break down carbohydrates, fats, and proteins produce water as a by-product, which is known as metabolic water. This process oxidizes these energy-containing substances from the food an organism eats, providing nutrients and water to the animal. For example, the kangaroo rat, which has a diet composed primarily of dry seeds, requires little drinking water since it receives most of its water through metabolism.

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Adapted Urinary Systems

Kidneys are the organs that filter metabolic waste products from the blood. These waste products are carried out in water and excreted in the form of urine (mammals) or uric acid (birds and reptiles). Desert animals have the most efficient kidneys of any other group. Kidney efficiency can be measured by the concentration of urine excreted; the more concentrated the urine, the less water it contains. Thus, highly efficient kidneys conserve water for other uses within the animal's body. The kidneys of a kangaroo rat are the most efficient of all vertebrates by excreting very low amounts of water. In fact, their kidneys are so efficient that kangaroo rats are the only animals that can drink salt water and not be harmed. Like the kangaroo rat, desert tortoises obtain the majority of their water from the plants they consume. Desert tortoises have the capability to hold up to one quart of water within their bladder and can draw upon it for use when needed. Their bladder contents can account for up to 40% of the tortoise's body weight in water.

Conclusion

Now that you have a basic knowledge of desert ecosystems, use these skills to find and identify the species on the following pages. When you find a species, mark which day you saw it. When we return to the school, the one with the most items on their "scavenger hunt" will receive an award and a special honor. Be sure to be on the lookout! Some of them are very hard to see. Happy looking!

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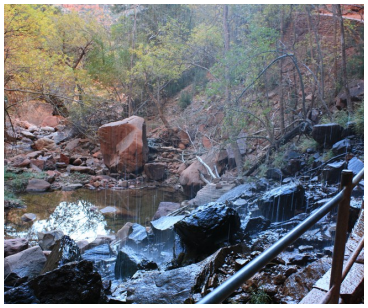
Desert Notes:

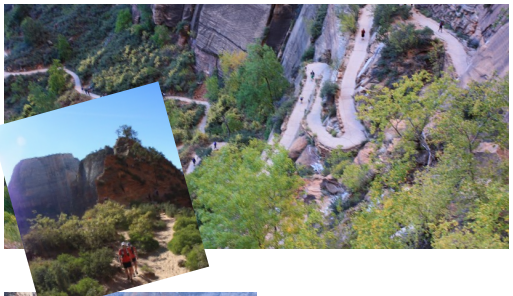
Desert Notes:

I spy with my little eye..... In Zion.....



Emerald Pools

Ampitheater at Sunrise



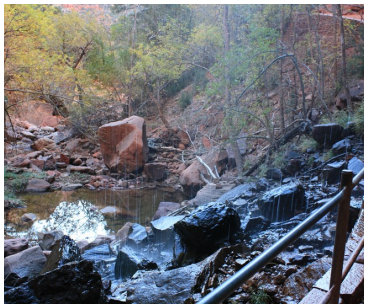
Angel's Landing

Emerald Pools

The Angels Landing Trail is one of the most famous and thrilling hikes in the national park system. It is Zion's pride and joy.

The Narrows

I spy with my little eye..... In Zion.....



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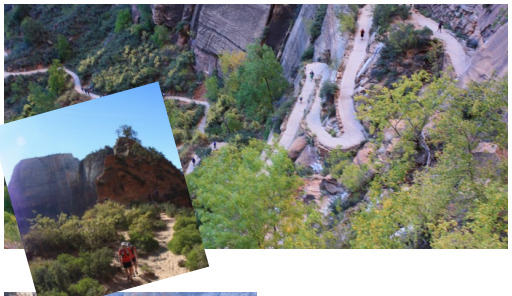

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Scavenger Hunt

Throughout your time in the park, you will have the opportunity to see many birds, flora and fauna, as well as rock formations, that don't exist in other parts of the world. If you happen to see one of the items listed below, please fill out the time of day you viewed each item by putting what day of the week in the appropriate spot. Who over finds the most may win a prize! Good luck and happy hiking!

Birds of Zion

Turkey Vulture:
Nests in a cliff or in a snag at a height of 0 - 20+ feet, in a no nest nest. This species is not a cowbird host. This species is a **carnivore: ground scavenger**.
Time of Day:

Morning	
Afternoon	
Evening	

Black-Capped Chickadee:
A bird almost universally considered "cute" Oversized round head, tiny body, and curiosity about everything, including humans. Has a black cap and bib; white cheeks; gray back, wings, and tail; and whitish underside.
Time of Day:

Morning	
Afternoon	
Evening	

Common Raven:
Nests in a cliff or in a conifer at a height of feet, in a cup nest. This species is not a cowbird host. This species is an **omnivore: ground scavenger**.
Time of Day:

Morning	
Afternoon	
Evening	

Blue-ray Gnatcatcher:
A tiny, long-tailed bird makes insistent calls and is in constant motion. Is found in dense outer foliage, foraging for insects and spiders. Steely blue-gray bird conspicuously flicks its white-edged tail from side to side, scaring up insects and chasing after them.

Morning	
Afternoon	
Evening	

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Morning	
Afternoon	
Evening	

American Robin:
Common sights on lawns across North America, where you often see them tugging earthworms out of the ground. Robins are popular birds for their warm orange breast, cheery song, and early appearance at the end of winter.

Morning	
Afternoon	
Evening	

Western Bluebird:
Deep blue, rusty, and white, males are considerably brighter than the gray-brown, blue-tinged females. Nests in holes in trees or nest boxes and often gathers in small flocks to feed on insects or berries, giving their quiet, chortling calls.

Morning	
Afternoon	
Evening	

Ruby-Crowned Kinglet:
Smaller than a warbler or chickadee, this plain green-gray bird has a white eyeing and a white bar on the wing. Male's brilliant ruby crown patch usually stays hidden unless it's trying to attract a female.
Time of Day:

Morning	
Afternoon	
Evening	

Yellow Warbler:
In summer, the buttery yellow males sing their sweet whistled song from willows, wet thickets, and roadsides. The females and immatures aren't as bright, and lack the male's rich chestnut streaking, but their overall warm yellow tones, unmarked faces, and prominent black eyes help pick them out.

Morning	
Afternoon	
Evening	

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Time of Day:

Morning	
Afternoon	
Evening	

Yellow Warbler:
In summer, the buttery yellow males sing their sweet whistled song from willows, wet thickets, and roadsides. The females and immatures aren't as bright, and lack the male's rich chestnut streaking, but their overall warm yellow tones, unmarked faces, and prominent black eyes help pick them out.

Morning	
Afternoon	
Evening	

Downy Woodpecker:
An often acrobatic forager, this black-and-white woodpecker is at home on tiny branches or balancing on slender plant galls, sycamore seed balls, and suet feeders. Downies and their larger lookalike, the Hairy Woodpecker, are one of the first identification challenges that beginning bird watchers master.

Morning	
Afternoon	
Evening	

Broad-Tailed Hummingbird:
A medium-sized hummingbird of subalpine meadows, males make a loud trilling noise with their wingtips and perform spectacular aerial displays that make them hard to miss. To survive the cold nights in their high-elevation habitats, Broad-tailed Hummingbirds can enter torpor, slowing their heart rate, and dropping their body temperature.

Morning	
Afternoon	
Evening	

Northern Flicker:
Large, brown woodpeckers with black-scalloped plumage. Found mostly on the ground. Shows a flash of color in the wings – yellow if you're in the East, red if you're in the West – and a bright white flash on the rump.

Morning	
Afternoon	
Evening	

White Throated Swift:
Nests in a cliff at a height of feet, in a crevice nest. This species is not a cowbird host. This species is an **insectivore: air screener**.

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Morning	
Afternoon	
Evening	

Black-chinned Hummingbird:
Small green-backed hummingbird of the West, with no brilliant colors on its throat except a thin strip of iridescent purple (in the sun) bordering the black chin. Often perches at the very top of a bare branch.

Morning	
Afternoon	
Evening	

Black-Throated Gray Warbler:
A small warbler of the American West, the Black-throated Gray Warbler is found in pine and mixed oak-pine forests west of the Rocky Mountains.

Morning	
Afternoon	
Evening	

Red-tailed Hawk:
Red-tailed Hawks soar above open fields, slowly turning circles on their broad, rounded wings. Other times you'll see them atop telephone poles, eyes fixed on the ground to catch the movements of a vole or a rabbit, or simply waiting out cold weather before climbing a thermal updraft into the sky.

Morning	
Afternoon	
Evening	

Canyon Wren:
Found throughout the arid mountain country and canyonlands of western North America, the Canyon Wren nests and feeds in narrow rock crevices. Often, it announces its presence by its beautiful and distinctive song, a loud cascade of musical whistles.

Morning	
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Western pipistrelle (*Pipistrellus hesperus*):
Also known as the canyon bat, this is the smallest bat species in North America, and the most commonly seen bat in Zion. It is the first to come out in the evening, up to two hours before dark. Its wing beat is slow and weak, and at a quick glance it may appear to be a bird in flight.

Morning	
Afternoon	
Evening	

Brazilian free-tailed bat (*Tadarida brasiliensis*):
This large bat with a wingspan of 12-14" emerges sometime after 9 pm. Named because the end of their tail visibly extends beyond the edge of the tail membrane.

Morning	
Afternoon	
Evening	

Desert Cottontail - *Sylvilagus audubonii:*
Light colored, tan to gray, with a yellowish tinge. The underside of the body is whitish and often has an orange-brown throat patch. The tail is rounded and looks like a cottonball, but is darker above, white below. The average weight is two to three pounds. Females are larger than the males.

Morning	
Afternoon	
Evening	

Ringtail-(*Bassariscus astutus)*:
Ringtail are excellent climbers capable of ascending vertical walls, trees, rocky cliffs and even cacti. They are a member of the racoon family. They can also rotate their hind feet 180 degrees to help them to climb.

Morning	
Afternoon	
Evening	

Coyote- (*Canis latrans*):
Known as "song dogs", these canines use their wide variety of howls, yips, and barks to call the pack together again. They are skilled hunters, and will eat pretty much anything they can get their paws on.

Morning	
Afternoon	
Evening	

Animals of Zion

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Morning	
Afternoon	
Evening	

Montane Shrew - *Sorex monticolus:*

Small, long tailed shrews. Total length varies between 103 and 142mm, and tail length between 40-62mm. In summer shrews are brownish dorsally with silvery white or gray ventral pelage. The tail is indistinctly bicolored. Musk glands on the flanks are visible in breeding times.

Morning	
Afternoon	
Evening	

Cliff Chipmunk - *Neotamias dorsalis:*

A medium-large chipmunk that can be easily identified in the field by its mostly smoke gray upperparts, indistinct dorsal stripes (with the exception of one dark stripe along the spine), brown facial stripes, long bushy tail, stocky body, short legs, and white underbelly.

Morning	
Afternoon	
Evening	

N. Amer. Porcupine – *Erethizon dorsatum:*

The North American porcupine is a rodent. It has black to brownish-yellow fur and strong, short legs. It has hairless soles on its feet that help it climb trees. It has a round body, small ears and a small head. The most recognizable feature of the porcupine is its quills.

Morning	
Afternoon	
Evening	

Uinta Chipmunk – (*Neotamias umbrinus):*

It can be difficult to distinguish Uinta chipmunks from species of chipmunks strictly by sight. Look for light dorsal stripes are white and surround broader brown, rather than black, dorsal stripes. The outermost dark dorsal stripe is very faint or absent. Also has a dark-brown tail that is held horizontal while running. The flanks are generally brown or cinnamon in color. The species displays blackish ocular stripes, and blackish and grayish white coloration on the anterior and posterior part of the ears.

Morning	
Afternoon	
Evening	

Rock Squirrel – (*Spermophilus variegatus):*

The rock squirrel is a large ground squirrel that is 17-21 inches in length. It is mottled gray on its upper sides with a brownish rump and creamy white on its undersides. It has a long bushy tail with white edges.

Morning	
Afternoon	
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Morning	
Afternoon	
Evening	

Yellow-bellied Marmot – (*Marmota flaviven):*

Marmots are large burrowing rodents, about the size of a housecat, found in the Northern Hemisphere. Yellow-bellied Marmots are mammals with grizzled brownish fur, a yellow belly, and whitish spot between eyes. They have small round ears, a short white muzzle and black nose. The body is heavy-set with short legs and a furry reddish-brown tail. Male are heavier than females, ranging from 3 to 5 kg, while females range in weight from 1.6 to 4 kg.

Morning	
Afternoon	
Evening	

Mountain Lion – (*Puma concolor):*

Puma concolor means lion of one color. Adult mountain lions have a tan-colored coat with a head that is smaller in proportion to its body. The sexes look alike, though male lions are 30 to 40 percent larger than females. Atypical adult male will weigh 110 to 180 pounds and the female 80 to 130 pounds. The most recognizable feature of the American lion is its long and heavy tail, which measures almost two-thirds the length of its head and body. ***If you see one please inform your chaperone right away!**

Morning	
Afternoon	
Evening	

Mule Deer – (*Odocoileus hemionus):*

Mule Deer have large ears that move constantly and independently, from whence they get their name, "Mule" or "Burro Deer." They do not run as other deer, but have a peculiar and distinctive bounding leap over distances up to 8 yards, with all 4 feet coming down together. The Mule Deer is slower and less colorful than the White-tailed Deer, but its pastel, gray-buff color provides a physical adaptation to the desert environment.

Morning	
Afternoon	
Evening	

Bighorn Sheep – (*Ovis Canadensis):*

The bighorn sheep has tan or brown fur. It has a white belly, rump, and muzzle. It is best known for its large horns. The ram has large, thick curving horns.

Morning	
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Morning	
Afternoon	
Evening	

Measurements: Measurements are from snout to vent for amphibians and lizards (tail length not included).

† Threatened or endangered species

Amphibians:

Tiger Salamander - *Ambystoma tigrinum*:

3-6.5" large stocky salamander. Yellow to dark olive spots/ blotches with irregular edges on dark ground color.

Morning	
Afternoon	
Evening	

Great Basin Spadefoot - *Spea intermontanus*:

1.5-2.5" hourglass marking of gray or olive on back set off by ash-gray streaks. Pupils are vertical. Spade on hind foot wedge-shaped.

Morning	
Afternoon	
Evening	

Arizona Toad - *Bufo microscaphus*:

2-3.25" green-gray, brown colored with light V-shaped stripe across head. Warts red to brown (also called Southwestern Toad).

Morning	
Afternoon	
Evening	

Woodhouse's Toad - *Bufo woodhousii*:

1.25-5" gray, brown, or olive above with whitish dorsal stripe down middle of back; warts light. Unconfirmed native - Please report sightings; photos helpful.

Morning	
Afternoon	
Evening	

Northern Leopard Frog - *Rana pipiens*:

2-4.4"; greenish/brown frog with well defined, rounded pale bordered, dark spots; white stripe on upper jaw.

Morning	
Afternoon	
Evening	

Reptiles & Amphibians of Zion

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Lizards:

Plateau Lizard - *Sceloporus tristichus*:

1.6-3.25”; Plain gray to brown with yellow to green blotches; may be some blue on throat. One of the most frequently seen lizards in Zion.

Morning	
Afternoon	
Evening	

Common Sagebrush Lizard - *Sceloporus graciosus*:

1.8-2.6”; very similar to plateau lizard but slightly smaller and darker.

Morning	
Afternoon	
Evening	

Zebra-tailed Lizard - *Callisaurus draconoides*:

2.5-4”; ear openings present. Underside of tail with black bars. Belly markings at midpoint of body

Morning	
Afternoon	
Evening	

Desert Horned Lizard - *Phrynosoma platyrhinos*:

2.5-3.75”; similar to short-horned but has long head spines and is found at low elevations.

Morning	
Afternoon	
Evening	

Western Skink - *Eumeces skiltonianus*:

2.1-3.75”; body long and rounded; shiny appearance; body cream to light brown with dark stripe down each side and lighter stripe down back; tail bright blue in young, fading with age.

Morning	
Afternoon	
Evening	

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Evening	

86

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Snakes:

Gophersnake - *Pituophis catenifer*:

36-72”; yellow-gray to red-brown; dark brown-black blotches down back; dark line from eye to eye.

Morning	
Afternoon	
Evening	

Western Rattlesnake - *Crotalus oreganus*:

15-65”; generally gray to brown with dark hexagonal patches down back; wide, flat head and rattle on tail.

Morning	
Afternoon	
Evening	

Terrestrial Gartersnake - *Thamnophis elegans*:

18-30”; gray-green overall with light yellow lines along top and each side.

Morning	
Afternoon	
Evening	

Western Lyresnake - *Trimorphodon biscutatus*:

18-47.75”; gray with brown blotches edged in black on upperparts; lyre-shaped pattern on top of head.

Morning	
Afternoon	
Evening	

Reptiles & Amphibians of Zion

Measurements: Measurements are from snout to vent for amphibians and lizards (tail length not included).

† Threatened or endangered species

Snakes:

Gophersnake - *Pituophis catenifer*:

36-72”; yellow-gray to red-brown; dark brown-black blotches down back; dark line from eye to eye.

Morning	
Afternoon	
Evening	

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18-47.75”; gray with brown blotches edged in black on upperparts; lyre-shaped pattern on top of head.

Morning	
Afternoon	
Evening	

Water Birch *Betula nigra*:

Large multi stemmed shrub with several spreading trunks and a rounded crown of spreading and drooping branches, usually forming clumps or thicknes. Coarsely toothed leaves are dark green above and pale yellow-green beneath becoming dull yellow in fall. The bark is thin, bronze or cherry red, smooth and does not peel.

Morning	
Afternoon	
Evening	

Box Elder Maple *Acer negundo*:

Grows up to 10–25 meters tall, with a trunk diameter of 30–50 centimeters. It often has several trunks and can form impenetrable thickets. The shoots are green, often with a whitish to pink or violet waxy coating when young. The bark on its trunks is pale gray or light brown, deeply cleft into broad ridges, and scaly.

Morning	
Afternoon	
Evening	

Shrub Live Oak *Quercus turbinella* :

Quercus turbinella a dense shrub, 6-12 ft. high, however it may become more tree-like in favorable habitats. Rigid branches bear attractive, gray-green, bristle-tipped leaves. The holly-like leaves unfold a reddish color, changing to shiny lime-green before becoming blue and bloomy. The name *turbinella*, meaning like a little top, refers to the acorns.

Morning	
Afternoon	
Evening	

Quaking aspen - *Populus tremuloides*:

The trees have tall trunks, up to 25 meters (82 feet) tall, with smooth pale bark, scarred with black. The glossy green leaves, dull beneath, become golden to yellow, rarely red, in autumn. The species often propagates through its roots to form large clonal groves originating from a shared root system.

Morning	
Afternoon	
Evening	

Flora/Fauna of Zion

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Morning	
Afternoon	
Evening	

Fremont cottonwood - *Populus fremontii:*

A tree that as been known to grow 30 ft. in one year. Its ultimate height is up to 90 ft. it has broad, flattened, open crown of large, widely spreading branches. Bark is whitish and roughly cracked. The triangular, deciduous leaves are bright green turning yellow in fall.

Morning	
Afternoon	
Evening	

Cardinal-flower - *Lobelia cardinalis:*

This 1-6 ft. perennial has showy, red flowers. Has three spreading lower petals and two upper petals, all united into a tube at the base. Erect stems, often in clusters, with flowers resembling flaming red spires. Lower portion of stem is lined with lance-shaped leaves. Over picking has resulted in its scarcity in some areas. Depends on hummingbirds for pollination. Its common name comes from the bright red robes worn by Roman Catholic cardinals.

Morning	
Afternoon	
Evening	

Golden columbine - *Aquilegia chrysantha:*

Several stems and basal leaves form a bushy perennial columbine one to three feet tall with handsome, clear yellow flowers that are held relatively erect on long stalks rather than nodding. Leaves are usually divided into two or three sections.

Morning	
Afternoon	
Evening	

Yellow beeplant - *Cleome lutea:*

An erect, leafy, 1-3 ft. annual, branching especially in the upper portions of the plant. Clusters of compound leaves bear 3-7 leaflets. Showy, 4-petaled, yellow flowers crowd together in a dense, terminal raceme. Seed pods are long and narrow.

Morning	
Afternoon	
Evening	

Yarrow - *Achillea millefolium:*

Yarrow grows to 3 feet tall and has no branches except near the top. The leaves are alternate, 3-5 inches long, with flower heads arranged in large, compact clusters at the top of the stem. The flower head has 20-25 yellowish-white (rarely pink) ray flowers and similarly colored disk flowers.

Morning	
Afternoon	
Evening	

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Morning	
Afternoon	
Evening	

Desert marigold - *Baileya multiradiata*:

Its daisy-like flowers form impressive mounds of nearly solid yellow. The long-lasting, bright-yellow flowers rise on nearly leafless stems above the mounds of woolly, gray foliage. A grayish, woolly plant, branched and leafy mostly in the lower half, with brilliant yellow flowers on heads.

Morning	
Afternoon	
Evening	

Arizona thistle - *Cirsium arizonicum:*

The Arizona Thistle is extremely variable in its flower color and the shape of its leaves. However, the flower always appears only partly open, since the bracts never allow it to spread into the typical wide disk shape of other thistle species.

Morning	
Afternoon	
Evening	

Zion daisy - *Erigeron sionis:*

It is a perennial, colony-forming herb up to 25 cm tall, spreading by means of stolons (stems which grow at the soil surface) running along the surface of the ground. The complete flower array generally contains 1-4 flower heads. Each head contains 22–46 white ray florets surrounding many yellow disc florets.

Morning	
Afternoon	
Evening	

Hopi blanket flower - *Gaillardia pinnatifida:*

Red-dome blanket-flower or yellow gaillardia is a slender-stalked perennial, reaching a height of 2 ft. Divided leaves grow on the lower portion of the plant. The flower heads are up to 2 in. across and made up of yellow, three-cleft ray flowers surrounding a purplish -red sphere of disk flowers. The yellow rays are purple-veined on their undersides and sometimes fade to pale red near their bases.

Morning	
Afternoon	
Evening	

Desert paintbrush - *Castilleja chromosa:*

Has bristly gray-green to purple-red herbage. What looks to be flowers are actually the colourful red-orange bracts that hide the tubular yellow-green flowers that have a thin coat of white hairs.

Morning	
Afternoon	
Evening	

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Morning	
Afternoon	
Evening	

Hummingbird flower - *Zauschneria latifolia:*

Eye-catching as red lipstick, little red-orange trumpets stand out from leafy stems, creating a lovely sphere of color that lasts from mid-summer to frost. Native to droughty, rocky places at higher elevations, it also makes its home along waterways.

Morning	
Afternoon	
Evening	

Elkweed - *Swertia radiata:*

Grow more than three feet high, but they don't stand out because the flowers appear nondescript but when examined closer you find that, although the monument plant claims to be Yosemite's greenest wildflower, it's actually got large white patches on it's leaves, lots of little dark spots, and a bug-sized gauntlet of bristles on each petal.

Morning	
Afternoon	
Evening	

Sego lily - *Calochortus nuttallii:*

Growing 10-20 in. high, from an onion-like bulb, this perennial's erect, slender stem is usually unbranched and bears 2-4 linear leaves, 7-10 in. long. One to three very showy, white to lavender-blue, tulip-like flowers are borne atop the stem in a cluster. Flowers have three large petals with yellow bases and three narrower sepals. Occasionally petals are magenta or tinged with lilac. This is Utah's state flower; the Ute Indians called it sago, and taught Mormon settlers to eat the bulbs in times of scarcity.

Morning	
Afternoon	
Evening	

Bluedicks - *Dichelostemma pulchellum:*

Grows from vigorous corms (swollen stems) to about 30 inches tall, and blooms from Feb. to May. Handsome, metallic, purple bracts hold the tight heads of purple to blue funnel-shaped flowers on stiff single stems. The leaves are grass-like and may wither by bloom time. Long lived and dependable, it will naturalize easily as long as you plant it in well drained soil in the sun. Blue Dicks are edible too! The flowers are a pretty edition to salad and the corms have a sweet flavor, raw or cooked.

Morning	
Afternoon	
Evening	

Common chickweed - *Stellaria media:*

Stems are mostly forked and have a line of hairs down either side. Leaves are broadly egg shaped, have a pointy tip, and are mostly hairless or have hairy margins at the base. The leaves are spaced evenly and are opposite to one another along the stem. The smallflowers have what appear to be 10 petals, but are really five deeply–cut white petals.

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Afternoon	
Evening	

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Morning	
Afternoon	
Evening	

Grasses, sedges and rushes
Remember: Sedges have edges, Rushes are round, Grasses are hollow

92

Cheatgrass - *Bromus tectorum:*

Mature plants are unpalatable, the characteristic drooping seed heads becoming brittle as the plant dries, shattering upon impact with the ground. These sharp-tipped seeds work their way into the eyes, nostrils, mouths, and intestines of grazing animals.

Morning	
Afternoon	
Evening	

Panicled bulrush - *Scirpus microcarpus:*

low to mid elevation, throughout BC Leaves attractively tinged with red at the base (like a barber-pole effect). Good soil-stabilizer along stream banks, stormwater ponds and wet meadows.

Morning	
Afternoon	
Evening	

Needle-and-thread grass - *Stipa comate:*

Needle-and-Thread is a native, tufted, cool-season grass common to the prairies, plains and foothills of the western United States. It is a perennial bunchgrass, 1- 4 feet tall with erect, smooth culms and long, flat leaves 8- 12 inches long. The contracted panicle remains partially in the sheath. The source of its name is the 4- 5 inch long twisted awn which arises from the lemma. It detaches from the seed and gives the appearance of a short needle and long thread.

Morning	
Afternoon	
Evening	

Ovalhead sedge - *Carex festivella:*

In late spring multiple leafy culmps rise above the foliage to 2-3'. Each culm bears 2-5 rounded flower spikelets that are clustered closely together. Each of the green spikelets contains upper pistillate and lower staminate florets. The spikelets are rounded at top and base and contain many perigynia. The flowers transition into reddish brown summer seed spikes.

Morning	
Afternoon	
Evening	

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Evening	

Rock Formations of Zion National Park

The Three Patriarchs:

The Three Patriarchs dominate the valley. Abraham, Isaac, and Jacob rest on the west side of Zion Canyon at Birch Creek and are visible from almost everywhere within the valley. Mount Moroni is in front of the Three Patriarchs.

Morning	
Afternoon	
Evening	

The Pulpit:

Riverside Walk begins at the Temple of Sinawava, an open area named after the Paiute wolf god. Look for a rock that looks like a minister's pulpit called, appropriately, The Pulpit.

Morning	
Afternoon	
Evening	

The Spearhead:

Just north of Zion Lodge west of the river, look for a giant sandstone cliff that looks like its name, The Spearhead. This stone promontory is part of the lower section of Mount Majestic, located just north of Emerald Pools.

Morning	
Afternoon	
Evening	

Beehives

Beehives are the set of mound-like (not pointed) mountain peaks also seen from the administration area, which are shaped like, what else — beehives.

Morning	
Afternoon	
Evening	

Mountain of the Sun

Turn around and look south to see Mountain of the Sun, noted for capturing the sun the first thing in the morning and holding onto it longest at night. (Pictured is the arch on the west face)

Morning	
Afternoon	
Evening	

The Great White Throne

Look for the large, white mountain north of the lodge on the east side of the canyon. It's called the Great White Throne.

Morning	
Afternoon	
Evening	

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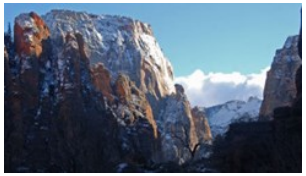

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Morning	
Afternoon	
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Angel's Landing:

Angel's Landing was named by Ethelbert Bingham in 1916 when he exclaimed to his friends, "only an angel could land on that!" Nearby, The Organ juts out toward Angel's Landing. Some think the wind passing through the pass sounds like a pipe organ

Morning	
Afternoon	
Evening	

Cathedral Mountain

The shuttle ride through Zion Canyon reveals some of Zion's best known landmarks such as Cathedral Mountain, located immediately west of Angels Landing.

Morning	
Afternoon	
Evening	

Kayenta Formations:

Consists of layers of reddish-brown and pink sandstone, and varicolored mudstone and siltstone deposited in streams and rivers within an arid environment. Kayenta is dominated by mudstones left behind on river floodplains and in small lakes, with thin layers of sandstone that represent actual stream channels.

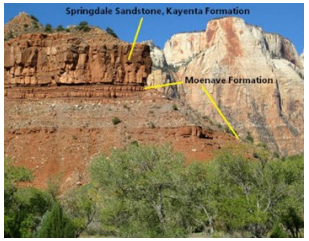
Morning	
Afternoon	
Evening	

Moenave Formations:

Consists of thin layers of reddish-brown sandstone, siltstone, and varicolored mudstone deposited in streams, floodplains, and lakes. The Moenave Formation is visible in lower Zion Canyon as the steep, easily eroded, reddish hillside.

Morning	
Afternoon	
Evening	

Example of both together:



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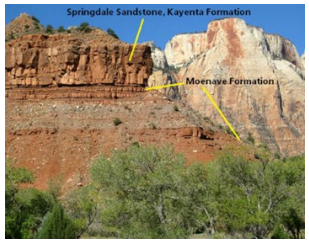


Morning	
Afternoon	
Evening	

Weeping Rock:

Continuous water "weeps" out of the Weeping Rock alcove, keeping lush hanging gardens moist. An impermeable shale, the Kayenta layer, makes up the floor of the slot canyon that prevents water from absorbing into the ground and forces it to find a place it can penetrate, such as at Weeping Rock. The water has been in the rocks for a very long time, about 1200 years in fact.

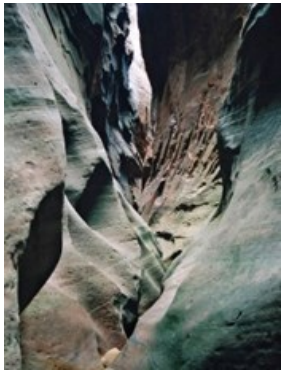
Morning	
Afternoon	
Evening	

The Narrows Slot Canyon:

The Narrows is the most popular hike in Zion National Park, and one of the world's best slot canyon hikes. It is pure fun and can be tailored to suite any ability level. The trail is basically the Virgin River. The canyon is so narrow, the river covers the bottom in many spots, which means you have to wade or swim to proceed. Plan on being wet.

Morning	
Afternoon	
Evening	

Echo Canyon Canyon:



The lower part of the canyon drops very sharply towards the main valley in a series of steep steps, narrow channels and circular potholes carved in the rock, but the drainage becomes temporarily wider and more level upstream. After half a mile further up the canyon, the cliffs close in to form a dark and very deep slot just a few feet wide, with smooth red and grey rock walls rising high above a rocky, boulder-strewn floor usually containing many pools of murky water.

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Evening	

Mis Notas:

96 Lo que quiero recordar de hoy:

Mis Notas:

Lo que quiero recordar de hoy:

Mis Notas:

Lo que quiero recordar de hoy:

Mis Notas:

Lo que quiero recordar de hoy:

97

Final Questions: From EVERYTHING that you have experienced during this trip (Hiking, animals, food, people, campfires, ANYTHING,) which one have you enjoyed the most and POR QUE???? Please explain.

¡¡¡GRACIAS!!!

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¡¡¡GRACIAS!!!

98

Rate your trip from 1-10.
(1 being the lowest; 10 being the highest)

What did you love the most about your trip?

What would you change?

What would you keep the same no matter what?

What do you wish we would have done?

How much money did you spend?

What advice would you give to students next year?

Rate your trip from 1-10.
(1 being the lowest; 10 being the highest)

What did you love the most about your trip?

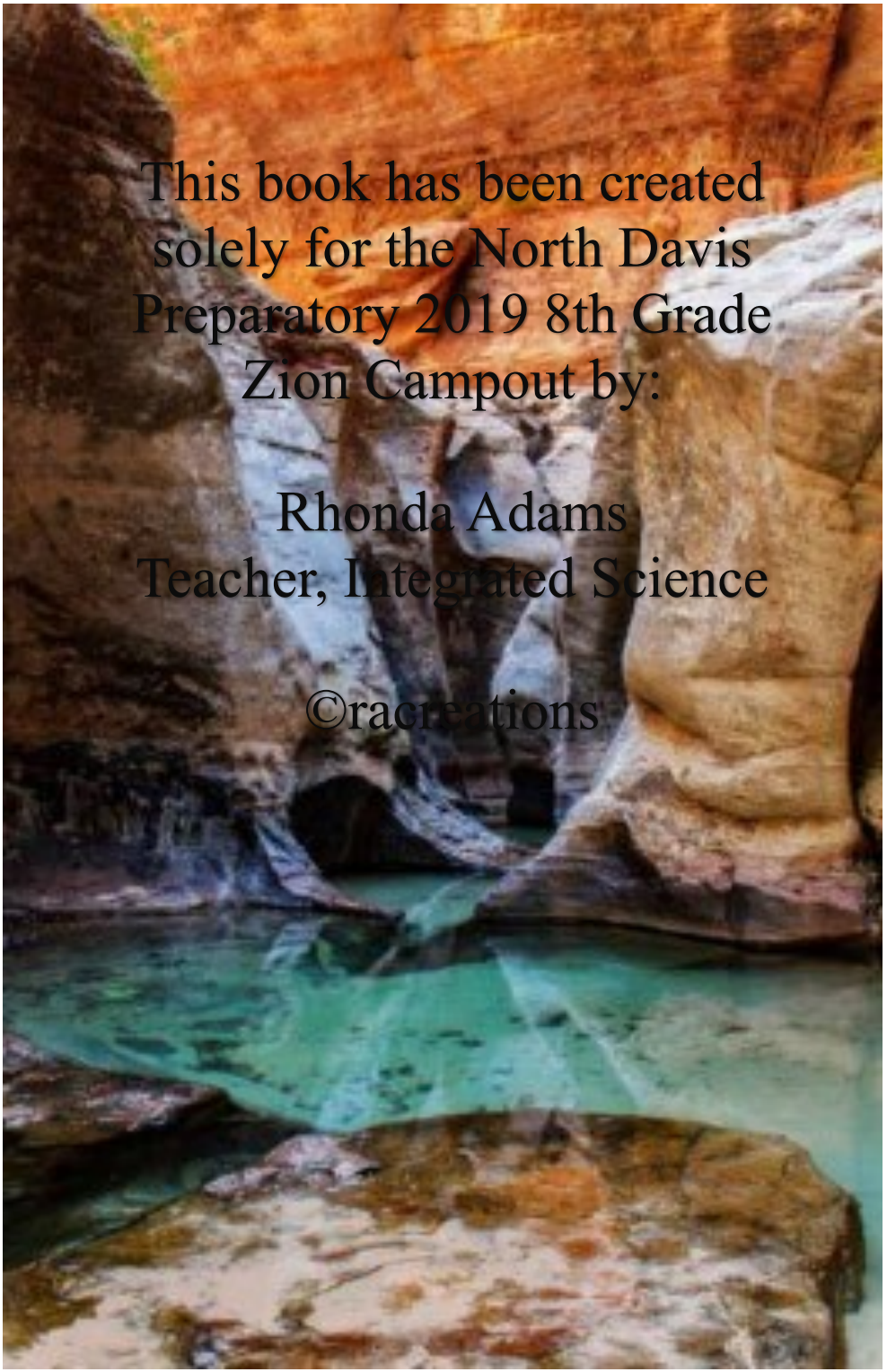
What would you change?

What would you keep the same no matter what?

What do you wish we would have done?

How much money did you spend?

What advice would you give to students next year?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Rhonda Adams
Teacher, Integrated Science
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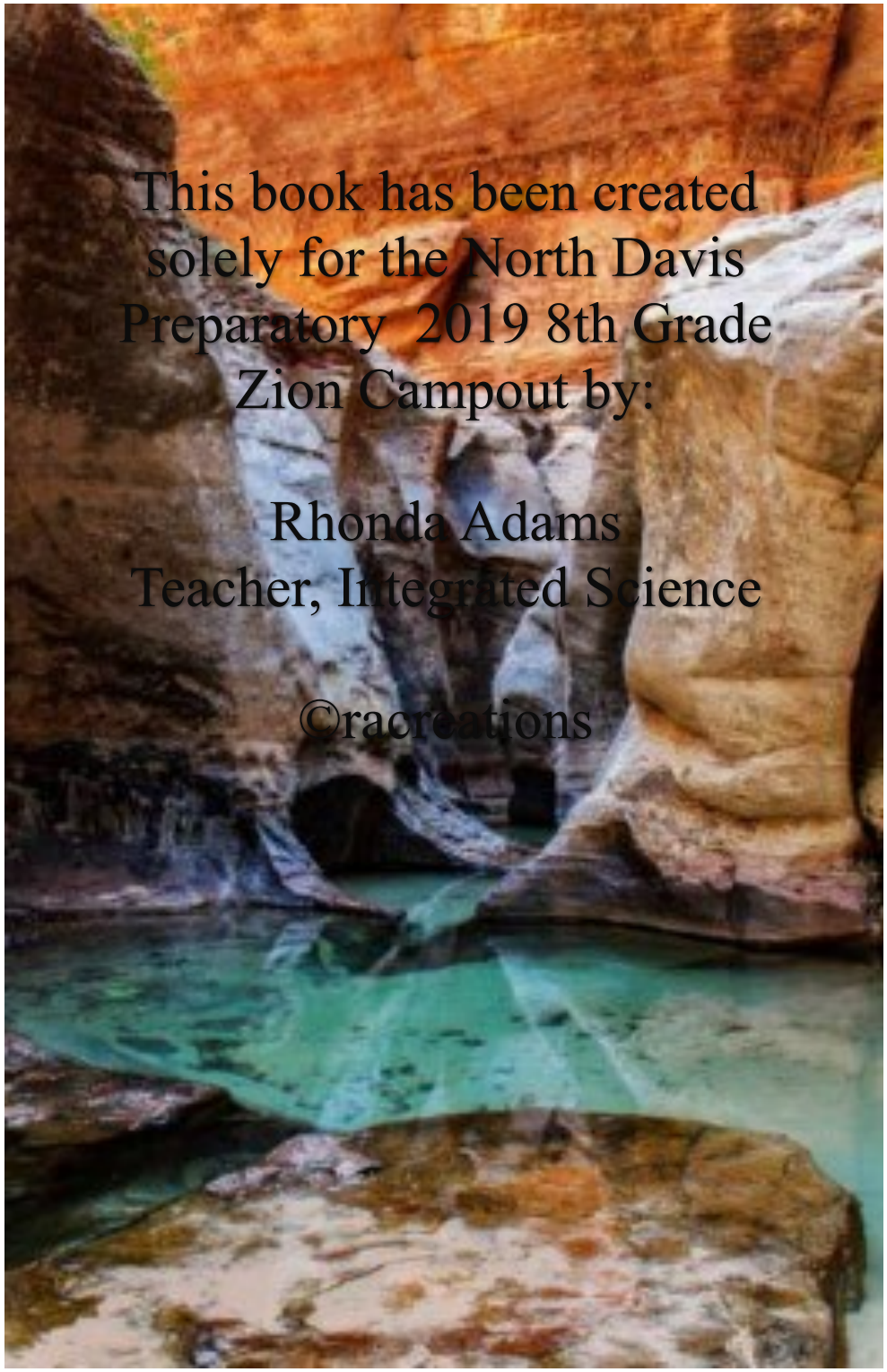
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