Welcome to Utah Master Naturalist!

Utah Master Naturalist was developed to help you initiate or continue your own personal journey to increase your understanding of, and appreciation for, Utah’s amazing natural world. We will explore and learn about the major ecosystems of Utah, the plant and animal communities that depend upon those systems, and our role in shaping our past, in determining our future, and as stewards of the land.

Utah Master Naturalist is a certification program developed by Utah State University Extension with the partnership of more than 25 other organizations in Utah. The mission of Utah Master Naturalist is to develop well-informed volunteers and professionals who provide education, outreach, and service promoting stewardship of natural resources within their communities. Our goal, then, is to assist you in assisting others to develop a greater appreciation and respect for Utah’s beautiful natural world.

“When we see the land as a community to which we belong, we may begin to use it with love and respect.” - Aldo Leopold

Participating in a Utah Master Naturalist course provides each of us opportunities to learn not only from the instructors and guest speakers, but also from each other. We each arrive at a Utah Master Naturalist course with our own rich collection of knowledge and experiences, and we have a unique opportunity to share that knowledge with each other. This helps us learn and grow not just as individuals, but together as a group with the understanding that there is always more to learn, and more to share.

This manual is your literary companion as you journey through a Utah Master Naturalist course. Ideally, you’ll become familiar with the contents of this manual before the course starts. That way, we can focus on applying this knowledge while we are out on field excursions. I hope you enjoy your time as a participant in a Utah Master Naturalist course, and that it truly helps you on that journey through our natural world.

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Introduction

The primary goal of Utah Master Naturalist is to promote stewardship of Utah’s natural world. In doing so, Utah Master Naturalist 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 Utah Master Naturalist:
- 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 Utah Master Naturalist class 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. 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.

In 2006, we conducted a needs assessment survey of agencies and organizations around Utah that include professional and volunteer naturalists in their staff. Results indicated that there is a need for a program such as Utah Master Naturalist to provide well-trained volunteers. Ninety-one percent of Utah organizations that responded to the survey use volunteers to deliver their programs. Although 55% of the respondents had volunteer training programs in place, 95% of the respondents stated that the UMN would be valuable training for new volunteers. The majority of organizations provide only 1-5 hours of training for their volunteers.

In addition to a greater need for more knowledgeable volunteers, an enormous change has been occurring in Utah for much of the past two centuries. As we will discuss throughout this section, the viewpoint of Utah’s inhabitants, with respect to the value of conserving Utah’s natural world, has changed with each group that has inhabited the state. Differing ideas about land use, conservation, and connection to the land have shaped where we are today.

Aldo Leopold, “Father of Modern Conservation,” believed that, in regard to being a naturalist, “personal satisfactions...are more important than fame.” That is, being a naturalist should be enjoyable- it should provide a level of personal satisfaction in addition to being a learning process. Aldo Leopold often thought that the 1940’s educational system did little, if anything to promote “personal amateur scholarship in the natural-history field”.

Aldo Leopold believed that one of the greatest downfalls of humanity is the idea that either humans are not part of nature, or that nature’s sole purpose is to serve the needs of humans. In order to treat the natural world with love and respect, we must first feel like we belong to it- that we are a part of it. In order
to feel a sense of belonging to our natural world, be must begin to understand it, even just a small part of it. To begin understanding our natural world, we must first learn about it. An essential part of learning about our natural world is experiencing it.

The Utah Master Naturalist Program aims to help us experience, learn about, and understand Utah’s natural world. By doing so, we will become more aware of how our actions affect the land, or community, in which we live. We will become better stewards of the land. We will develop what Aldo Leopold referred to as the “land ethic”.

**Important Naturalists**

Knowledge of natural history helps us understand and explain what we see, but a lack of knowledge does not necessarily exclude someone from being a naturalist; the only requirement for becoming a naturalist is curiosity. No naturalist, living or dead, was born with in-depth knowledge of the natural world. The pursuit of knowledge via learning about the biosphere, a pursuit all of you, and the people discussed below, were willing to initiate.

**Aldo Leopold**

Born January 11, 1887, near Burlington, Iowa, young Aldo spent his early childhood on adventures through the forests and rolling prairies. He developed a keen sense of observing details of the natural world, and acquired a masterful skill of expressing his thoughts and feelings through extensive writing.

Upon earning a degree in forestry from Yale, he worked for the U.S. Forest Service in Arizona, and was eventually transferred to New Mexico in 1911. It was during these years in the American Southwest that Leopold started formulating his feelings about a land ethic, as well as developing an uncommon ability to express himself through writing. Leopold started to sense that the land, and all its components, was a living organism: “The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land.” (Sand County Almanac page 204).

An avid hunter, Leopold eventually experienced the connection of predators to the health of entire ecosystems. Initially, he felt that anything which took game animals should be eradicated. His feelings changed after he shot a wolf: “I was young then, and full of trigger-itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunter’s paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view.” (Sand County Almanac).

He observed that lands in natural conditions were healthier than those affected by human developments and, in 1922, proposed that the entire Gila River valley be protected. Two years later, the area was designated as the Gila National Forest, the first of its kind in the country. This act was the catalyst which later earned him the unofficial title of “Father of the National Forest Wilderness System”, or simply the “Father of Modern Conservation”.

That same year, he was transferred to the Forest Products Lab in Madison, Wisconsin, and by 1928 was teaching at the University of Wisconsin. By this time, his reputation had expanded across the country, and he started writing full-time, or contracted out as a forestry or wildlife consultant. In 1935, two unique events occurred: First, several well-known conservationists (including Bob Marshall) invited Aldo to help them initiate the Wilderness Society; and second, he purchased a battered old chicken coop, cleaned it out, and created a haven which was affectionately known by his family and associates as The Shack. Even today,
the Leopold Education Foundation, Pheasants Forever, and other reputable organizations hold annual meetings at the shack.

Perhaps it was fitting, though untimely, that Aldo Leopold died of a heart attack in 1948 at the age of 61 while assisting a neighbor battling a grass fire near the shack.

“It is warm behind the driftwood now, for the wind has gone with the geese. So would I- if I were the wind.” (A Sand County Almanac).

Edward Abbey

Known as the Desert Anarchist, Edward Abbey was born in 1927 in Indiana, Pennsylvania. His childhood was during the Depression era, and his parents, though hard workers, were always considered poor. Their liberal views, and his early struggles, contributed to his independent thinking and frank expression of his opinions.

At 17, he left home and headed west, quickly falling in love with the deserts of the American Southwest. He eventually received a Masters Degree from the University of New Mexico, but his thesis, “Anarchism and the Morality of Violence” hinted of an ideology soon to be expressed in many of his writings. Abbey then worked as a seasonal ranger for the National Park Service at Arches National Park where he also gained more information to write three books through the 50’s and 60’s. In 1968, he gained some success as a writer with the publishing of Desert Solitaire, in which he portrayed his experiences in the Southwest. But notoriety came his way seven years later with his fictional work, The Monkey Wrench Gang, describing eco-sabotage against development in desert areas. Some people felt Abbey was encouraging militant destruction of property, but he simply called it a satire. Yet, several groups were formed and committed acts that became known as “monkey-wrenching.”

Although various groups may have questioned his motives, no one questioned his intellect. Abbey’s symbolic writings were sometimes garnished with philosophy and references to music. But his radical statements were the ones who kept him in the public eye, like “Keep America Beautiful…Burn a Billboard.”

Abbey felt what could probably be described as a spiritual connection to the desert. To him, living in the desert was important to who he was as a person. Being there in the remote wilderness was, to him, very intimate- very fulfilling.

He died March 14, 1989 with simple requests for his burial, though they violated state law. He wanted to be transported in a pickup truck, wrapped in his old sleeping bag, and buried in the desert. If someone asked about his finals words, they were “no comment.”

Terry Tempest Williams

Known as a prolific author, environmental activist, and naturalist, Terry Tempest Williams was born in Salt Lake City, Utah, in 1955. As a sixth-generation Mormon, Utah and its culture have had an influence on her writing style. “I write through my biases of gender, geography, and culture. I am a woman whose ideas have been shaped by the Great Basin and Colorado Plateau.” Williams gained fame for her book, Refuge: An Unnatural History of Family and Place in which she describes the flooding of the Bear River Migratory Bird Refuge and links it to the struggle her mother had with ovarian cancer. Her experiences kept her close to the land, with a pen in hand. She studied biology at the University of Utah, taught at Teton Science Schools and on a Navajo Reservation, and was the naturalist-in-residence at the Museum of Natural History.
in Salt Lake City. She is the author of 14 books, has contributed to over 30 others, been referenced in nearly 70 works, featured in 50 periodicals, and narrated various audio/video/film/TV productions. Her awards and honors are numerous and well deserved.

Quotes from an interview with Susan Ives, Director of Public Affairs for The Trust for Public Land, give some insight into her personal connections with nature:

Q. “Will we forget our relationship to the land?”
A. “…..we are losing our frame of reference as we become more urbanized and less connected to natural sources. I recently heard an interesting discussion among some biologists and sociologists who were saying that maybe we are sub-speciating. Maybe there are those of us who are becoming more urban and those who still need and yearn for wild places. Physically we may look the same, but internally there may be great differences.”

Q. “How do you think people can regain that frame of reference?”
A. “There is great power in being in place, in knowing the watershed we belong to, in knowing the geologic processes that have shaped the geography, in learning about the indigenous people who once lived there and who live there now...I fantasize that one day every school will have a bioregional curriculum and that by the time students graduate, they will be able to pass the “placement test”—they will know the migrating birds, reptiles, and mammals of their area; they will know the annual rainfall, the growing season. We need to relearn the most simple things that go back to the science of the soul, so that we are not faced with our own isolation but rather with a wonderfully sweeping sense of community—a community that is dynamic and alive.

A quote from an interview with Scott London, host of “Insight & Outlook” on NPR, further exemplifies Terry Tempest Williams’ commitment to developing a sense of place:

“I really believe that to stay home, to learn the names of things, to realize who we live among... The notion that we can extend our sense of community, our idea of community, to include all life forms — plants, animals, rocks, rivers and human beings — then I believe a politics of place emerges where we are deeply accountable to our communities, to our neighborhoods, to our home. Otherwise, who is there to chart the changes? If we are not home, if we are not rooted deeply in place, making that commitment to dig in and stay put ... if we don’t know the names of things, if don’t know pronghorn antelope, if we don’t know blacktail jackrabbit, if we don’t know sage, pinyon, juniper, then I think we are living a life without specificity, and then our lives become abstractions. Then we enter a place of true desolation.”

Selected References and Readings

Inhabitants of Utah’s Deserts

There have been many different human inhabitants of Utah’s deserts. In this section of the book, we will briefly discuss each of the major peoples, including the different American Indian tribes, explorers, early settlers, and modern conservationists. As a side note, while Native American was considered to be the most correct way to refer to Native peoples, it has more recently fallen out of favor among many Indian tribes. Therefore, we use the name American Indian and specific Indian tribes throughout this manual.

One thought to keep in mind throughout this program is that all throughout history and prehistory there have been people who used resources wisely, and those who have used resources unwisely. It is suspected that Paleo-Indians declined in numbers because they had overhunted the large game in which they depended. Later American Indian groups routinely fought bloody battles over resources. Similarly, we should remember that while there were ranchers whose actions have led to the degradation of Utah’s desert ecosystems over 100 years ago, there were also ranchers who knew the land well and took great care of it. So, it is not necessarily possible to label one group of humans as great caretakers of the land and the others despoilers. One thing for certain, though, is that those who use the land and resources unwisely eventually suffer the consequences of their actions, especially in the unforgiving deserts of Utah.

American Indians

Many American Indian cultures have long believed that all connections in life are made through nature’s expression and glory. Ancient Utah cultures maintained this connection with nature and taught it through their traditions. Their worldview was religious, filled with powerful, holy beings that either helped them or hindered those who interact with them. In general, the Utah Indian worldview sees the land as an interconnected whole; complete with rocks, trees, animals, water, clouds, and many other participants in a circle of life. Furthermore, they believe that humans exist with non-human entities, bonded by a mutual respect for the role each plays in nature.

American Indian cultures in Utah have survived in an austere environment over a long period of time, which has required them to have an intimate knowledge of the land and its resources. This is because they relied entirely on those resources. Utah’s ancient Indian cultures were mainly nomadic hunter-gatherers. Ancient cultures neither produced nor preserved food. However, as time went on, with the improvements of technology and the changing of climate, the cultures transformed into, or were replaced by, an agricultural society, tending crops and staying in permanent settlements, although they still relied entirely on the resources in the natural environment in which they lived.

Paleoindian Period (11,000-7,000 BC)

Paleoindians and prehistoric animals during the Ice Age. (Image from USU Eastern Prehistoric Museum)
Paleoindians walked Utah’s land as early as 11,000 B.C. This ancient hunter-gatherer society was highly nomadic and migrated from one food supply or place of shelter to another as the availability of plant and animal life made such relocations necessary. Paleoindians remained in Utah until about 6,500 B.C. during a time in which Utah was emerging from the last ice age. Temperatures rose significantly and spruce-fir forests receded to high altitudes; meanwhile, heat and drought tolerant pinyon-juniper and sagebrush-bunchgrass habitats replaced them. Paleoindians inhabited caves near lakes (some of which have dried up), such as Danger Cave near Wendover. In these caves, artifacts (knife blades, projectile points, and fire pits) have been found that suggest that this desert hunter-gatherer lifestyle supported a sparse population consisting of small social units of 25 to 30 people, probably made up of extended family members. Their lives were focused on sheer survival, and they spent most of their time and energy in their quest for food. Their diet was typically comprised of pine nuts, small seeds, and upland game animals (e.g., mountain sheep and fast-disappearing mega-mammals, including the Pleistocene mammoth and camel).

It has been suggested that this ancient nomadic people had little leisure or certainty of survival from one season to the next. There were no long-term building projects, complicated rituals, or collection of personal property evident among artifacts. Furthermore, the nomadic lifestyle of the Paleoindian culture helped to spread their people throughout the region. There is evidence of Paleoindian traders who carried goods between Utah and New Mexico (e.g., Clovis spear points made of obsidian from Utah sites).

**Archaic Period (9 – 8,000 BC-500 AD)**

The successors of the Paleoindian culture were the Great Basin and Plateau Archaic peoples. They lived in Utah from about 6,000 B.C. until about 400 A.D. These peoples were also hunter-gatherer cave dwellers; however, they also made brush and wood shelters and some were sedentary (i.e., at least semi-permanently lived in one place). This period is characterized by the utilization of more diverse ecological zones for hunting and gathering because the receding lakes and reduction of marshland forced the people into higher areas in search of food. As the weather warmed, population pressures increased near the water’s edge. Some people may have wanted to avoid contention with others over space and food near the water, so they moved into peripheral areas. This movement, and the extinction of megafauna, caused the Archaic peoples diet to become more diverse. In Hogup Cave, located in the Great Basin, the remains of four species of large mammals (i.e., deer, antelope, elk, and mountain sheep), 32 species of small mammals, 34 species of birds, and 36 different types of plants were found.

In addition to the newly inhabited environments, and varied diets of the archaic peoples, new tools were created to help in securing a food supply. Woven basketry, grinding stones, animal nets, and the atlatl (spear thrower) were some of the simple, but effective, tools that were invented to make their lives easier. As the pressures of population and environmental change came upon the archaic peoples, many different lifestyles were adopted to combat these challenges. Because of this, there was no natural progression from nomadic life to settled life although their cultures were changing. These people chose a lifestyle within their technological capability and took their cultural traits with them. Some people chose a more fixed, local lifestyle along the shores of lakes where there were more resources, and generally more people. On the other hand, some people chose to live in less fruitful locations with scarce resources, like the sagebrush flats, and continued to migrate from one food supply to another as the seasons came and went. However, identical types of basketry, projectile points, and grinding stones have been found at diverse sites suggesting similar cultural and technological attainment of the archaic peoples.
Atlatl replica, used by Archaic peoples for hunting.

Archaic peoples and their hunter-gatherer lifestyle. (*Image from Utah State History*).

**Agricultural Period (500-1300 AD)**

The Fremont people lived throughout northern, central, and southwestern Utah from about 400 A.D. to 1300 A.D., with the earliest dated sites found in northern Utah. They are believed to be descendants of the Mogollon people from New Mexico or from indigenous roots in the Great Basin. The Fremont culture started out as one with desert hunter-gatherer characteristics; however, it eventually transformed into a maize (corn)-bean-squash horticultural culture by 900 A.D.

The Fremont people lived in settlements of up to 20 sedentary home sites, which were occasionally tied to seasonal use. Their homes varied in construction from pit houses, made of wood and dirt, to adobe homes. Because these dwelling were made from what was available, these structures exhibit the Fremont people’s tie to their environment. The Fremont also made elaborate basketry, pottery, and clay figurines used for ceremonial purposes. Food, whether it was gathered from the surrounding environment or harvested, was stored in baskets in their pit houses, making it possible for them to stay in one location year-round. The evidence of gathered food being stored suggests that the Fremont people were not completely dependent on the crops they raised and were willing to travel great distances for the acquisition of food. However, the cultivation of corn, beans, and squash offered an alternative to traditional hunting and gathering activities, thus leading into a transformation of lifestyles, which gave rise to sedentary cultures.
The Fremont were hunter-gatherers and agricultural. (*Image from Utah State History*)

The **Ancestral Puebloan** peoples, formerly referred to as **Anasazi**, were one of the most impressive prehistoric cultures in America. They lived in the southeastern region of Utah from about 400 A.D. to 1300 A.D., leaving behind a heavy accumulation of dwellings and artifacts. The Ancestral Puebloans are thought to be descendants of the archaic peoples who practiced hunter-gatherer lifestyles. Because of the environment in which they lived, the Ancestral Puebloans were largely dependent on cultivating crops, since resources were scarce. Researchers have divided this period of occupation into different periods of sequence because their culture was continually changing. Each period is characterized by its complex settlement and artifact styles. Stages of the Ancestral Puebloans occupation in Utah are classified by Basketmaker I and II, and Pueblo I, II, and III.

*Ancestral Puebloans constructed elaborate cliff dwellings. (*Image from Utah State History*)*
The Basketmaker periods are distinguished by the introduction of beans for cultivation, stone axes, pottery, the utilization of larger pithouses with internal storage chambers, and the bow and arrow replacing the atlatl for hunting smaller game in the later Basketmaker stage. By 750 A.D., Pueblo I Ancestral Puebloans built their homes above ground in rectangular, connected blocks of rooms. They used rocks and jacal (framework of woven sticks and mud) as construction materials, and built their homes in clusters. They also incorporated at least one deep pit house within each cluster which may have served a ceremonial function, called a kiva. These structures included a sophisticated ventilator shaft to bring in fresh air and evacuate smoke from the room, thus creating a technique that the Ancestral Puebloans would continue to use through the next two stages in the common kiva.

The Pueblo II stage began around 900 A.D. during a time of increased precipitation and temperatures more conducive to agriculture production. During this stage, the Ancestral Puebloans decentralized their population and created satellite worksites. At no previous time had there been as many settlements spread over so much of the land as the Ancestral Puebloans at this time. However, entering into the last stage of Ancestral Puebloans occupation, Pueblo III (circa 1150 A.D.), these satellite settlements were gathered into a series of larger villages that were more defensible. They built communal plazas and homes clustered around springs at the heads of canyons. By 1300 A.D., almost all the Ancestral Puebloans had retreated south from Utah into Arizona and New Mexico for reasons unknown to researchers.

Transitional Period (1300-1900 AD)

Around 1300 A.D., Uto-Aztecan peoples began to expand into Utah from the surrounding areas. The Utes, the tribe for which Utah was named, occupied two-thirds of the state from Utah Valley down through Sanpete County and beyond. They were hunter-gatherers who quickly adopted the culture of the Plains Indians, using horses for travel and hunting buffalo. The Utes lived in wickiups, a dwelling made of brush, or in tepees, made from poles and the skins of animals.

They traveled in extended family units and were noted raiders and horse traders. The Shoshoni people were hunter-gatherers who occupied the areas north of the Salt Lake Valley. They, like the Utes, adopted many traits of the Plains Indians culture through trade with them. Shoshone, along with other closely related tribes, occupied much of the Great Basin states and spread as far north as southern Canada.

The other primary tribes living in Utah were the Goshutes and the Paiutes. The Goshutes occupied the areas west of the Salt Lake Valley throughout the inhospitable western deserts. They were extremely adaptive hunter-gatherers who collected seasonal seeds, grasses, roots, insects, and small reptiles. They also hunted deer, antelope, rabbits, and other small mammals. The Goshutes lived in small nomadic family bands and built wickiups made of brush for their shelters. The Paiutes occupied the areas directly southwest of Utah Valley. They combined their hunter-gatherer lifestyle with flood-plain gardening (an adaptation influenced by the Ancestral Puebloans). The Paiutes were a non-aggressive people and suffered from attacks of neighboring Ute tribes.

The Navajo, descendants of migrant Athabaskan peoples of the subarctic, arrived in Utah around 1400 A.D. in search of pasture for their sheep and goat herds. They occupied the desert southeast portion of Utah and were very adaptive hunter-gatherers that incorporated domestic livestock and agriculture into
their lifestyle. The Navajo people dwelled in hogans (house made of logs and mud, with a roof of earth) and lived in dispersed extended family units. Under immense pressure from raiding Utes, many Navajo were forced to retreat from Utah in the late 1700s.

All five of these tribes exist in Utah today, although many are not living on their traditional lands. These lands were places for hunting, fishing, gathering, and worship. They were sites where their people could contact the supernatural through ceremonies to invoke protection and sustain life through a holy means. A covenant based upon respect for unseen powers, coupled with an intimate knowledge of the land is what motivated Utah’s American Indians to live within the guidance given them during from myths and stories surrounding their traditional lands. Today, many are on reservations (land designated for the tribe by the U.S. government) some located far from their traditional homeland.

Each of these tribes had spiritual views of the earth as an interconnected whole. They used myth to define a truth that is real, sometimes tangible and intangible, but always considered a powerful force in explaining how and why things are the way they are. This is somewhat different from the Anglo American’s view of myth, generally viewed as amusing tales without true substance. The American Indian people use faith and knowledge to support their explanations of physical and social relations. These explanations
defined each group and guided them through the uncertainties of life. For Anglo Americans, truth is considered an objectively discovered fact through logic and observation therefore contrasting the American Indian’s view of truth as a preexisting framework, partially revealed in myth to help interpret phenomena. Despite the religious, rather than objective, culture of many American Indians, their understanding of the sacredness of the earth is an important perspective that deserves attention, understanding, and respect.

**Early European Explorers**

Utah’s first European explorers were Spaniards traveling from New Mexico. Venturing into this fringe territory, they hoped to prove the belief that there were numerous, easily mined treasures available and they held hopes to expand the Spanish Empire in order to thwart the expansion of other European powers. In 1765, Juan Maria Antonio Rivera and a small group of men entered Utah northeast of present-day Monticello and continued their exploration northward to the Colorado River near present-day Moab. Their main objective for this journey was to learn of the extent of Indian settlement, whether or not European settlers had arrived, and if the mythical Lake Copala Gran Teguayo (an area with a wealthy civilization) existed in the unexplored territory. They followed the Colorado River upstream back into Colorado and found no European settlements, no gold, and no notorious lake. However, they returned to New Mexico with the discovery of an excellent deep ford, now known as the Grand Canyon, which would later be used by other explorers.

Fathers Francisco Atanasio Dominguez and Silvestre Velez de Escalante were Spanish friars in search of a better route from Santa Fe, New Mexico, to Monterey, California, to avoid hostile American Indians. In 1776, led by two Ute Indians, the Dominguez-Escalante party crossed into Utah near present-day Dinosaur National Monument. They continued westward toward the homeland of their Ute guides in what is now known as Utah Valley. The Spaniards found abundant water, pasturage, croplands, game, fish, fowl, abundant timber, and friendly natives. This seemed a paradise inviting Spanish settlement, so the explorers promised to return within a year. From Utah Valley, the party traveled southwest perhaps on a route that is parallel to present-day Interstate 15. Midway between Milford and Cedar City, the party realized that an early winter would prevent them from finishing their journey, and decided to return to Santa Fe. Their expedition took them over 1,700 miles of uncharted territory. Their journals are filled with detailed descriptions and maps that were used later by others coming to the Utah territory. Despite the Spaniards enthusiasm for settling Utah Valley, it remained free of Spanish colonization.

In the early 1800s during the wake of the Lewis and Clark expedition, many Americans and British began trading in the Pacific Northwest. Excitement swept over the nation as potential profits from furs inspired the creation of several fur companies. These companies hired mountain men, men who traversed the country by the map existing in their mind and lived off the land. Their travels represent the most significant exploration of most of Utah and the west. Mountain men were business men, who became well-known for making the fur trade pay for their travels. Unaware that they were making history, the mountain men were constantly opening new trails, discovering mountain passes and lakes, and traveling along unnamed streams. The mountain men and the fur trade opened up trading posts throughout the Missouri River Valley and the Rocky Mountains. Rendezvous were held from 1825 to 1840 for mountain men and others to gather and sell their furs and stock up on supplies for their next outing. Several prominent mountain men who harvested furs and explored in the Utah area were Jim Bridger, John Fremont, Peter Ogden, Jedediah Smith, and John Weber.

**Mormon Pioneers**

Utah began to see Anglo-American settlers in 1847 with the arrival of the Mormon Pioneers. Mormons came to Utah to escape religious persecution in Ohio and Illinois. They were determined to settle in a place where they would be free to worship and live how they desired without being attacked by mobs. The Salt
Lake Valley, a buffer zone between the Ute and Shoshoni peoples, was settled in 1847 by the Mormons. By 1849, they began to extend settlements into Utah Valley. Within a year, Utah Valley grew from 30 families to 2,026 people. This growth resulted in conflicts with the Ute tribes who used the valley as a major trade crossroads and subsistence area. The Indians were forced off their traditional lands as the Mormons brought in cattle for grazing and began to plant crops. Two wars occurred, which revolved around subsistence raiding from Indians trying to avoid starvation resulting from the loss of their lands: the Walker War (1853-54) and the Black Hawk War (1863-68). Despite continued conflicts with Indians, Utah received 3,000 or more immigrants each summer/fall, resulting in 90 settlements, founded from Wellsville in the north to Washington in the south, within 10 years of the first coming of the pioneers.

During this period, the Mormon Church and the federal government’s Indian office (precursor to the Bureau of Indian Affairs) operated farms for the benefit of the Indian tribes; however, supplies were not adequate for their needs. In 1861, the Uintah Valley Reservation was designated by President Abraham Lincoln for Ute tribes in hopes that Indian-settler conflicts would be resolved and members of the tribes could continue living in their traditional ways. Mormon settlers were sent out as missionaries to teach the Indians about Mormonism in hopes to convert them to principles of the gospel. They also tried to teach the Indians in the arts of civilization in hopes to reduce conflicts between the two groups. Conflicts continued, however, particularly due to the lack of resources allotted to Utes within their reservation.

**Westward Expansion**

In the mid-1800s, the people of the United States began to feel that is was their mission to extend the “boundaries of freedom” from the Pacific to the Atlantic ocean. This goal became known as **Manifest Destiny**. This phrase gave Americans a sense of national pride, which motivated them to pass on their idealism and belief in self-governed institutions to those who were capable of achieving it themselves. Other factors influencing Manifest Destiny expansion were rapid population growth the east, economic depressions driving people to seek a frontier living where land was inexpensive or free, association of wealth with land ownership, opportunities for self-advancement or self-rule, and the opportunity to promote new commerce with west coast ports.

The Manifest Destiny ideal also contributed to the **California Gold Rush** that began in 1849. Gold was first discovered in California in 1848 and news of the discovery soon spread resulting in the migration of around 300,000 people to California from other areas of the United States and the world. The human and environmental impacts of this event were both detrimental and beneficial: 120,000 Native Americans died from disease, starvation, and genocidal attacks from 1849 to 1870; however, large-scale agriculture began, roads, schools, churches, and civic organizations were created in a short period of time, and the pressures for better communications and political connections lead to the statehood of California in 1850. In 1863, construction of the western leg of the first **Transcontinental Railroad** began, and the Central Pacific and Union Pacific railroads met at the **golden spike** on May 10, 1869, at Promontory Point in the Utah Territory. The completion of the Transcontinental Railroad provided a more convenient way for even more migrants to reach California and other destinations, such as Utah, along the way.
These events helped to transform Manifest Destiny into the American Dream, which, according to James Truslow Adams is “that dream of a land in which life should be better and richer and fuller for everyone, with opportunity for each according to ability or achievement.” The seemingly limitless land resources available to Americans provided the means for anyone to excel. Due to the large expanse of undeveloped land, and the growing population in the eastern United States, Congress passed the **Homestead Act of 1862**. This act offered the opportunity for Americans to obtain 160 acres of land in the West if they lived on the land for 5 years and improved it, which involved building a 12 by 14 foot dwelling and growing crops. After the 5-year period, the homesteader could file for his deed of title and the land was officially his. Further still, **John Wesley Powell**’s First and Second Expeditions on the Green and Colorado Rivers helped America understand the west. The first trip in 1869 was one of adventurous exploration; however the second trip in 1871 was for mapping and scientific exploration. Powell’s theory of the region, that the rivers preceded the canyons and cut them as the plateaus rose, was confirmed by these two trips. The Powell Survey (1870-1879), formally known as the United States Geological and Geographical Survey of the Territories - Second Division, came about from the Second Expedition. Not only did the Powell Survey improve the scientific understanding of the American West; it provided a road map for future explorers and settlers looking to make their mark in the untouched wilderness of the United States.

The passage of the Homestead Act led to Anglo Americans moving westward primarily for land settlement and development. The movement West by homesteaders quickly displaced the Indians from their native lands, particularly because of the competing land use philosophies. American settlers often believed that the land was there for them to inhabit and cultivate so they could fulfill the Manifest Destiny ideal, as opposed to the American Indian belief of their role within the larger ecosystem. Some Anglo Americans also believed that by inhabiting these remote areas and practicing agriculture, the climate would change and become more humid, fertile, and lush as the population increased, thus generating a more comfortable environment to live in. This theory was referred to as the ‘rain follows the plow.’ Settlers, climatologists, and politicians of the day promoted this theory to support increased migration into drier regions. The theory was developed, however, during wetter climatic fluctuations in the Great Plains region.
Eventually, the ‘rain follows the plow’ theory was refuted by climatologists, because it was based on faulty climatic evidence, particularly the assumption that human development can permanently alter the climate of a region. The Homestead Act became the staple for the development of the West, but a disregard of sustainable desert agriculture and the push to make money took its toll on the land.

The Colorado Plateau became an enormous feedlot by 1890 as hundreds of thousands of cattle and sheep grazed its lands. Livestock grazing was an important, and profitable, industry in the West; however, many grasslands, riparian areas, and ponderosa pine forests in Utah became overgrazed as a result. By the early 1900s, highland areas on the Colorado Plateau were so degraded that forest regeneration was brought to a halt. The area was described to be “as bare and compact as a roadbed.” Ranchers quickly became accustomed to the unregulated use and exploitation of public land as rangeland, and many believed these grazing resources would never be exhausted. In the early 1900s, federal forest reserves were established to protect forested areas. However, this resulted in livestock grazing in some of the most remote areas of timbered mountains. The unregulated grazing practices of Utah’s early settlers created large expanses of bare mountain slopes, resulting in rock and mud slides and a number of devastating floods in the early 1900s. Riparian areas, important for wildlife habitat and watersheds, were degraded resulting in dried up streams and loss of wildlife habitat. Effects of the overgrazing of livestock in the late 1800s and early 1900s in Utah are still apparent in some areas today. The overutilization of rangelands within the United States was referred to as the “Tragedy of the Commons.” Because land was viewed as a public resource, or available for common use, ranchers competed with one another for their animals to receive the most grazing land, which resulted in massive overstocking. Recovery of rangelands following widespread conservation measures is still in process due to the considerable damage done.

Humans in a Desert Climate

Although Utah is statistically the second driest state in the nation, and is perceived to be a desert state, its diversity in climate is as diverse as its landforms. With three dry climatic regions covering about one-third of the state each, humid: mountains and high plateaus; arid: valleys and flatlands; semi-arid: transitional places between mountains and valleys, drought in Utah is a common occurrence. Arid regions receive as little as 2 inches of precipitation a year and have an annual evapotranspiration rate (i.e., the total discharge of water from the earth’s surface to the atmosphere by evaporation and transpiration) of 30-50 inches, thus creating desert conditions.

Drought is a natural phenomenon that brings impacts that may take years to fully develop and years to recover from. Utah has experienced 10 major droughts in the last 205 years. During the 1800s, droughts in Utah lasted an average of 10 years and had 16 years between them. During the 1900s, droughts came more frequently, with an average of 13 years between them, but they didn’t last as long, averaging 8 years. Utah’s longest recorded drought lasted 14 years and occurred during 1870 to 1883. By the summer of 2008, after 9 years, Utah had ended another major drought. However, it is predicted from dendroclimatological (i.e., the study of the relation between the annual rings of trees and past climates) and climatological (i.e.,

![PDSI Southwestern United States](image-url)
the scientific study of climates) statistics that Utah could experience another period of drought lasting up to 10 years sometime during 2015 through 2021.

As Anglo Americans began to settle in Utah, they established towns along the mountains, mainly the Wasatch Front. Settlers channeled water coming out of the mountains into irrigation systems for crops and other daily needs. In the early 1900s, the federal government began to play a central role in natural resource management in the West. Utah residents became aware that water conservation was a necessity in their desert home, and therefore tried their hand in several irrigation projects. The federal government, after consideration of John Wesley Powell’s recommendations, passed the Reclamation Act, a program to develop the arid West by promoting farming opportunities for families, in 1902. The Act provided funding and engineering expertise for the construction of irrigation systems over much of Utah. These involved the damming and diverting of streams within the state, and streams flowing through other states as well. Utah’s first federal reclamation project was the Strawberry Valley Project which started in 1905. This project created a tunnel where water from the Colorado River drainage could be transported through the Wasatch Mountains. Many projects have followed, some with controversy over the protection of aquatic life, water ownership, and the ratio of benefits over costs of these projects themselves.

During the turn of the 20th century, the federal government recognized the need to set aside forest reserves to preserve watersheds and valuable timber supplies from destruction, mainly due to overgrazing. Utah’s first forest reserve was established in 1897 and was named Uinta. Although this helped to protect areas from the exploitation of resources, much of Utah’s land was being sold to settlers who continued grazing it unsustainably. Ranchers, who had been seeking legal authorization for these practices for years, grazed surrounding public land without permission. Then in 1934, the Taylor Grazing Act was passed which consolidated grazing units on public land, and a percentage of the receipts from grazing rights on public land were handed to the state or its taxing units; thus providing better regulation of grazing on Utah’s public land.

Today, Utah is home to almost three million people and has one of the highest growth rates in the nation. The main concentrations of people live along the Wasatch Front, and still collect water from the mountains for their daily needs. Even though Utah is an arid state it, has the second highest water use rate in the nation. One way that Utah residents stored seasonal water accumulation to use during other parts of the year is through the utilization of reservoirs and dams. Through the construction of dams, of which Utah has 384, water from streams, snowmelt, and floodwaters can be collected into reservoirs and used throughout the year. This also provides water for irrigation, drinking, hydropower, and flood control. Additionally, reservoirs provide recreation opportunities like fishing, boating, and water sports. In building dams and reservoirs, Utah hopes to be able to provide for the future water needs of its residents.

As the need of land and water conservation grew with the exploitation of resources, several individuals helped push the effort along. Aldo Leopold was a conservationist whose land ethic and writing helped change the mindset of many Americans and helped form modern resource regulations. Leopold believed that the role of mankind was to be a member of a land-community and not conqueror of it, implying a respect and interdependence of all its members. Wallace Stegner, a notable environmentalist and western writer, also believed that humans must learn to recognize and respect the mutually dependent relationship they have with natural communities. Stegner’s passion for the conservation of wild places was shown through his writing and, in the case of his Wilderness Letter to David Pesonen, became the mission statement adhered to by conservationists around the world. It also helped in the federal government’s creation of the National Wilderness Preservation System in 1964. Conservationists are often referred to as environmentalists and tend to favor aesthetic conservation of natural resources as well as oppose excessive commodity use. Because of the efforts of many conservationists and environmentalists, the West is full of protected lands, including national parks and wilderness areas, which are regulated for different amounts and types of use. Over half of Utah’s land is public land managed by government agencies for its protection and conservation.
When we think about this quote from Wallace Stegner...

"Angry as one may be at what careless people have done and still do to a noble habitat, it is hard to be pessimistic about the West. This is the native home of hope. When it finally learns that cooperation, not rugged individualism, is the pattern that most characterizes and preserves it, then it will have achieved itself and outlived its origins. Then it has a chance to create a society to match the scenery."

...We have to ask ourselves: Are we pessimistic about what has happened or continues to happen in the West? Or, are we optimistic; do we have hope? It’s very easy to choose sides or to blame others for problems, but only through cooperation that we can actually make positive accomplishments and create what Stegner refers to as a “society to match the scenery”.

Selected References and Readings

Human History
History of Utah Settlement
  http://historytogo.utah.gov/utah_chapters/pioneers_and_cowboys/index.html
Paiutes Indian Tribe of Utah http://www.utahpaiutes.org/
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Environmental Interpretation

While we all might not be interpreters, we all participate in, and enjoy interpretation. Everywhere we go there are signs or programs to help us understand and learn about the natural world around us. Depending on your background and interests, this session will hopefully help you better plan or appreciate interpretation.

What is Environmental Interpretation?

If interpretation is simply the act of translating or explaining the meaning of something, how do we apply this to nature or the environment? The key is linking a tangible resource with an intangible meaning. Freeman Tilden, an amateur naturalist and author of Interpreting Our Heritage, defined interpretation as “an educational activity which aims to reveal meanings and relationships through the use of original objects, by firsthand experience, and by illustrative media, rather than simply to communicate factual information.” The National Association for Interpretation states that “interpretation is a mission-based communication process that forges emotional and intellectual connections between the interests of the audience and the meanings inherent in the resource.” Enos Mills, an American naturalist who helped create Rocky Mountain National Park, said that “a nature guide is a naturalist who can guide others to the secrets of nature.”

While there are many similarities between environmental education and interpretation, there are several differences that set the two apart. Interpretation can be considered a type of environmental education, but not all environmental education is necessarily interpretation.

“Interpretation is the art of enhancing recreational activities while a strong environmental education program should be a formal learning experience.” - Larry Berrin, from Interpreting the Crooked Pine: Environmental Education vs. Interpretation.

<table>
<thead>
<tr>
<th>Environmental Education</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>1. Often a captive audience</td>
<td>1. Usually a non-captive audience</td>
</tr>
<tr>
<td>2. Structured learning</td>
<td>2. Informal/recreational learning</td>
</tr>
<tr>
<td>3. Addresses all major learning styles</td>
<td>3. Usually highly kinesthetic</td>
</tr>
<tr>
<td>4. Often delivered by a person</td>
<td>4. Can be self-guided</td>
</tr>
<tr>
<td>5. Taught in a variety of settings</td>
<td>5. In situ, often involves recreation</td>
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Interpretation or Information?

Field guides present information. Interpretation is a form of communication and describes the process of making factual information more understandable to your audience. For instance, a field guide can tell us that the two species of birds living in our marsh are red-winged blackbirds and yellow-headed blackbirds. However, the field guide will not tell us how these two species can occur in the same habitat when they occupy virtually the same niche (e.g., food and nesting habits). We have to dig deeper to reveal that, where the two blackbirds co-occur (in the western U.S.), the yellow-headed blackbird (a colonial nester) usually outcompetes the red-winged blackbird (a solitairy nester). Partly as a result of their different nesting behavior, red-winged blackbirds are pushed out of the prime habitat and are forced to nest in less suitable upland habitats. However, red-winged blackbirds are year-round in many parts of Utah, whereas yellow-headed blackbirds migrate south in winter. Isn’t this a more interesting story than just knowing what the
species are? In interpretation, one could relate this story to having overbearing house guests for the holidays. We know we’ll have to sleep on the couch and have less food available, but the rest of the year we’ll have more food and will be able to sleep in our own comfortable beds.

Interpretive techniques may be formal or informal, but the essence is to convey information in a manner that is effective. Interpretation is often described as a blend between art and science, but the backbone of interpretation is information. The art is the manner in which we share that information so that others may see and feel the same things we do and, in some cases, act on the information provided.

To do this effectively can be challenging because, unlike the classroom where students are compelled by exams and grades to pay attention, interpreters typically work with non-captive audiences that may choose not to listen if you fail to capture their interest. Perhaps the most important rule of good interpretation, therefore, is to know your audience — such as why they are there and the type of information they are likely to understand — and to be responsive to that audience. This may require a change in your original, planned approach, so be flexible.

Freeman Tilden’s Six Principles of Interpretation

Just as with philosophies of interpretation, principles of interpretation are described in different ways by different people. Freeman Tilden (Interpreting Our Heritage) outlined principles that are considered by many as core or guiding principles to effective environmental interpretation.

Principle #1: Any interpretation that does not somehow relate what is being displayed or described to something within the personality or experience of the visitor will be sterile.

Principle #2: Information is not interpretation; interpretation is revelation based upon information. All interpretation includes information but not all information includes interpretation.

Principle #3: Interpretation is an art, which combines many arts whether the materials presented are scientific, historical, or architectural. Any art is, in some degree, teachable.

Principle #4: The chief aim of interpretation is not instruction, but provocation.

Principle #5: Interpretation should aim to present a whole rather than a part, and must address itself to the whole man rather than any phase.

Principle #6: Interpretation addressed to children, say, up to the age of twelve, should not be a dilution of the presentation to adults, but should follow a fundamentally different approach. To be at its best it will require a separate program.

Qualities of Effective Interpretation

Sam Ham (Environmental Interpretation: A Practical Guide for People with Big Ideas and Small Budgets) also provided guidelines designed to improve the effectiveness of interpretation. In both cases, these principles are intended for structured, or formal, interpretive presentations.

Quality 1: Interpretation is pleasurable: Good interpretation should not only present information to the audience, but should also be entertaining. The audience is participating because they want to, not because they have to.

Quality 2: Interpretation is relevant: In order for interpretation to be relevant to our audience, it must both be meaningful and personal. Meaningful means it must connect with something we already know. This can be accomplished using examples, analogies, or comparisons. Personal refers to relating to the lives of the audience—something they care about.

Quality 3: Interpretation is organized: The program must be easy to follow or the audience will lose interest. Believe it or not, audiences that don’t have to pay attention won’t if they have to work too hard.
**Quality 4: Interpretation has a theme:** In addition to simply having a topic, interpretation should also have a theme. That is, it should have a major point, or message, that the interpreter is trying to get across. People remember themes, not facts!

**Types of Interpretation**

Information about the environment can be provided in a number of different ways, all of which are useful tools in environmental education. **Personal interpretation** includes information provided by an individual to an audience. Examples include presentations, demonstrations, guided activities, and other programs provided directly by an interpreter. **Non-personal interpretive** methods include things such as interpretive signs, brochures, audiotapes, exhibits, and other self-guided media. Both personal and non-personal approaches are widely used and both have their advantages and disadvantages. While personal interpretation methods include involving participants in the presentation, some may feel disconnected or disengaged due to the way the presentation is given. Non-personal interpretation methods allow visitors to go at their own pace, but may also lack important information due to a lack of space or finances during creation. Providing a mixture of both personal and non-personal interpretive materials is crucial to engaging the maximum number of people with important educational materials.

When an interpretive presentation or exhibit is planned, like a guided tour through a museum exhibit, it is considered **formal**. Formal interpretation should consider the key principles to interpretation and work toward a “take home” message with which the audience leaves. Sometimes, interpretation occurs on the spur of the moment, such as when a pair of ravens flies overhead. This type of interpretation is considered **informal** because there is not time to develop an organized message. Nonetheless, the learning opportunity is important to say something about the ravens, such as habitat requirements, where they are found, and their interesting behaviors. Both formal and informal, personal and non-personal approaches to interpretation are important tools in our environmental education tool box.

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![Examples of informal (left) and formal (right) interpretation. (Images by M. Larese-Casanova)](image)

**Developing Interpretation**

According to Freeman Tilden, developing effective interpretation is an art form. Just like artists select a specific medium to portray their thoughts and feelings, like painting or sculpting, people creating interpretive programs can also select a method to teach an audience. Consider following these general steps when developing interpretation.
Step 1: Have a good idea

From Interpretive Themes, David L. Larsen, National Park Service:

The best way to reveal meaning is through the expression of an idea. To be relevant and provoking, an interpretive product must cohesively develop an idea or ideas over the course of its delivery. A meaningful idea captures, organizes, and sustains the attention of the audience. It provides a platform for the audience to consider, react to, build upon, appropriate, and transform. A meaningful idea provides opportunities for audiences to make their own connections to the meanings of the resource. Without the cohesive development of a relevant idea or ideas, interpretive services are merely collections of related information, chronological narrative, or haphazard arrays of tangible/intangible links—they do not accomplish the desired outcomes of interpretation.

Effective interpretive themes help cohesively develop meaningful ideas. Successfully delivered interpretive themes are explored by and emerge from the whole of an interpretive product—by the force and effect of its entirety. When used well, interpretive themes provide a focus that encourages audiences to consider resource meanings and understand and appreciate the resource in ways they otherwise might have missed. An interpretive theme is a tool that helps interpreters affect the audience. Its purpose is to provide focus for the audiences’ personal connections.

An interpretive theme articulates a reason or reasons for caring about and caring for the resource. Using a theme, an interpreter hopes to provoke the audience to know the resource is meaningful and feel that its preservation matters.

Step 2: Develop a Theme

- When we develop formal interpretive programs, which may be presented during a guided walk, as a slide show, or when stationed at a specific landmark, we need to incorporate structure and a message into our interpretive presentation. This message is described as the “theme” and is the ultimate take home message. There are simple three steps to developing a theme:
  - Select a broad topic (example: desert animals)
  - Narrow your topic (example: Adaptations of desert animals)
  - Write a theme statement as a complete sentence (example: “In such a harsh environment, desert animals live on the edge of survival every day.”)

Now we have something specific upon which to develop an interpretive program. In selecting and developing your theme ask yourself:
- Is the theme stated as a complete sentence?
- Is the theme important to this site and will it enrich the visitor’s experience? (visitors will notice the different kinds of mammals and reptiles in the park.)
- Will the audience be able to relate to this theme and will they understand the take home message? (Deserts seem like a wasteland, so why are they important?)
- Is this a theme I care about? (we need enthusiasm!)
- Do I have the information I need? (if not, you need to find it!)

Ultimately, we need to keep reminding ourselves why educating others about nature is important. Environmental interpretation has tremendous potential to promote the conservation of natural areas by facilitating understanding and a greater appreciation for these resources, and the important ecological services they provide. A goal of environmental interpretation, therefore, is to convey information that promotes greater environmental responsibility or, in the words of Aldo Leopold a stronger land ethic.

Promoting environmental responsibility requires that the audience:
- understands (perceives and feels) the state of the environment;
- is motivated to respond to the needs of the environment; and,
- is provided information and/or action skills needed to respond to your message.
When developing and delivering interpretive programs, therefore, consider how your educational message promotes support for the conservation and management of natural areas by identifying the importance of:

- **natural areas** to visitors and their quality of life;
- **ecological health** of the site and at other natural areas for a sustainable future; and
- **supporting organizations** that make acquisition and management of natural areas possible.

Hopefully, our efforts will help others understand the value of wild things and wild places, and share that enthusiasm with even more people. Only in this way will we be able to promote stewardship of natural areas, and the plants and wildlife they support, for future generations.

While developing and revising a theme, it is important to document the goals and objectives of the interpretation. The goal is a broad expectation that you have for the interpretation, while an objective is a specific and measurable way to achieve our goal. An example of an interpretive goal and a set of objectives for meeting that goal may be:

**Goal:** Understand the diversity of adaptations of animals for surviving in a desert ecosystem.

**Objectives:**
1. Participants identify three morphological adaptations to managing body heat.
2. Participants understand that many species of wildlife are nocturnal in desert ecosystems.
3. Participants state two behavioral adaptations to surviving in a desert ecosystem.

### Step 3: Major Interpretive Components

A good interpretive presentation is not a scattered collection of facts or a series of unorganized slides, but a process of entertaining and informing an audience about a larger message. The presentation should carry the audience along like a good book. And, like a good book, this requires that we capture their attention right at the start with a provocative introductory statement or action, which has been described as the "pow" (Interpreters Handbook). For example, the statement - "Living in a harsh desert climate, animals must scrounge for food and water just to survive to the next day or week," may capture the attention and the curiosity of visitors.

Next, a "bridge" is needed to explain what that statement means and why the audience should care. “Because nutrients, food, and water are so scarce in the deserts of Utah, desert food webs are so diverse and complex.”

The "body" fleshes out these ideas. In our example regarding desert wildlife we might collect and describe some of the different animals in a desert, what they eat, and how they conserve water, as well as illustrate the complexity of a desert food web. We might also highlight some well-known or provocative species that inhabit deserts.

Finally, the "conclusion" should summarize the message that desert wildlife depend on the delicate balance of available food and water in Utah and explain why efforts to minimize the loss or destruction of desert habitats is important.

As interpreters, we have the opportunity to teach others about how history has influenced the condition of natural resources and wildlife populations today, what we’ve learned from history, and how these lessons might influence conservation efforts for the future. There are countless examples of human interaction with natural resources, such as attitudes toward large predators, the exploitation of virgin forests, conversion of natural areas into farms and cities, etc. Many of these actions were conducted in the context of social attitudes prevalent at the time; others were the result of greedy and often illegal exploitation for short-term personal gains. What have we learned from history, and how can it be applied to what is happening today? Is the burgeoning growth in some areas of Utah being conducted in a sustainable manner? Are wildlife populations and future generations of humans that also have the right to enjoy these resources being adequately considered? As naturalists, we learn to love all components of the natural world. As environmental interpreters, we strive to share our knowledge, to connect people to the
land, and to promote environmental literacy so that the lessons of history are neither forgotten nor ignored.

Planning Interpretation

Interpretive Tours

Guided field walks, canoe trips, or other excursions into nature carry a certain amount of uncertainty for visitors that it is the responsibility of the guide to consider and address. This is all part of being a good host and will contribute to a more enjoyable experience for your guests. As described in *The Interpreters Handbook*, “Trail interpretation has been likened to a string of pearls. Each pearl is a gem of insight. The strand is held together by a thread of unity, a theme along which all of the pearls are strung.” Some tips to consider when leading a tour include:

Arrive early (about 10 minutes) to allow time for bonding with your audience and for gathering them together.

Inform your audience prior to departure of what will transpire during the tour. Review pertinent information about the tour, such as the distance and duration of the walk, the type of shoes that are needed, and whether they should bring water, sun screen, or insect repellent. Inform your group of any specific rules that need to be followed or items (such as poison ivy) to be avoided - this is particularly important with children. Make sure participants know where the restroom facilities are located, and whether the opportunity to use restroom facilities will occur during the tour.

Plan round trips so guests will return to the original point of departure. Any deviation from this needs to be explained prior to departure. If a round-trip is not possible, plan to escort individuals back to the starting point if that is where they need to go.

Start on time and plan the first stop near the starting point to allow folks to catch up if they arrive late or need to make a last minute restroom stop.

Large groups and groups with children require assertive, but friendly leadership. This is especially important when potential risks exist to either the guests, or to wildlife that may be encountered during the tour (e.g., disturbance of nesting birds). As the naturalist and interpreter, the audience is going to look to you to be the leader. This requires that you take command of the tour in a friendly but decisive manner. Techniques that will facilitate your leadership role include:

- **Walk with purpose**, when you move, they move. Keep the group together and be the focus of attention when you have something to say.
- **Position yourself strategically** when you speak so that the entire audience can see and hear you clearly. This may require that you plan your stops where you can use a high point such as a rock or stump, or are able to step off the trail. In tight areas, such as along a trail, lead the group half-way past your speaking point, stop them, and return to the middle so you are surrounded by your audience rather than simply speaking to those in the front.
- **Use your voice effectively**. If you have something to say to the group, say it so the entire audience can hear you and say it with inflection and enthusiasm.
- **Connect with your audience** when you are speaking. Make eye contact. Speak to individuals as well as the group.
- **Interact with your audience**. Ask questions and encourage responses. Allow persons to contribute their own experiences to the conversation. Ask a volunteer from the group to assist in a demonstration. Have fun. Encourage your audience be a part of the program.
- **Use the power of a silent moment** for self-discovery and reflection. The most powerful ally we have during our interpretive programs is the beauty of nature. Use it to full advantage.

Guided tours should plan specific stops that have a clear purpose, such as the presentation of major concepts that are components of a larger theme. As with spoken presentations, guided tours should have a
beginning, a middle, and an end. Obviously, the information provided at each stop needs to interpret the site, so stops need to be selected that contribute to your theme. Stops should be fairly brief. At every stop, gather your audience and reclaim their attention before you begin speaking. Position yourself so the audience can see and hear you and between stops stay in front of your group so you don’t have to call them back if they go too far. For a guided tour that lasts approximately an hour, plan approximately 5 stops. The remainder of the time can be spent in providing spontaneous information, answering questions, interacting with your group, and by letting your guests enjoy nature and make self-discoveries. Efforts to fill every moment with information will detract from the principal reason your audience has come – to enjoy nature; So avoid being excessively enthusiastic and allow for quiet moments and let nature speak to your group directly. In wrapping up the tour, the interpreter should summarize information from the stops to provide participants with a sense of conclusion and to clarify your message.

Whether providing guided tours or working as a roaming interpreter, the ability to respond to spontaneous learning opportunities and to respond to interests of your audience is important. Spontaneous learning opportunities won’t typically have the structured components of a formal interpretive program, but can provide the same ultimate benefits by generating enthusiasm and interest in nature.

Be aware that learning opportunities can occur anywhere, at any time, and in many different ways. Although the appearance of a black bear or some other highly visible animal would be an obvious example of a memorable learning opportunity, there are other opportunities that may be less obvious that can increase the enjoyment of an outing for individuals. These opportunities can capitalize on all our senses. In addition to visible opportunities such as provided by the unexpected appearance of wildlife, be observant for the less obvious opportunities, such as insects, animal sign, bird nests, fire scars, and other evidence of biodiversity and the functions of nature. Listen for the sounds of nature like an owl, a mixed flock of birds foraging in the canopy, or maybe the absence of sounds from cars and other city noises. Feel the spongy leaf of a cattail and consider why this adaptation is important.

Listen for the sounds of nature like an owl, a mixed flock of birds foraging in the canopy, or maybe the absence of sounds from cars and other city noises. Feel the spongy leaf of a cattail and consider why this adaptation is important. Often the spontaneous learning opportunities will be the most memorable, so be prepared to capitalize on these and react to the curiosity of your audience.

If you provide an interpretive program, you will undoubtedly receive comments and questions. Some you may agree with, others you may not. Sometimes, you may have to deal with difficult people. Regardless, it is our responsibility to respond in a professional manner. Remember that people come from all types of life experiences that create all manner of attitudes. If we want to help promote stronger conservation ethics, we can only do so by helping people come to those conclusions, not by demanding they do so. When you ask a question, be patient and wait for an answer. The longer you wait, the more likely it is that you will receive a thoughtful response. Work to be as good a listener as you are a teacher.

Don’t forget to be kind. If the comments or questions from an audience are dismissed, they will soon learn not to respond at all. Alienating your audience will reduce or eliminate your effectiveness in delivering your message. At worst, it can generate disdain for you and, more importantly, for all of us working to promote environmental literacy. Instead, encourage interaction and questions. In dealing with questions and comments, it is sometimes helpful to clarify responses (“So do you mean that...”), other times it is useful to indicate we need to search for the answer (“Let’s check the field guide...”), and sometimes, it is ok to say “Hmm, I don’t know!” There is no shame in not knowing an answer, no one knows everything. But if you get the same question on different occasions, seek out the answer.

Last of all, we shouldn’t use our knowledge to show others what they don’t know. Our goal is about helping people get close to nature, to opening eyes, to reconnecting to the land, and to build a stronger conservation ethic; it’s not about who knows the most.
The Roman Room Technique

Becoming knowledgeable about a natural area in which you share information is essential to becoming a good interpreter. Developing effective guided tours requires that you learn the area, particularly at each planned interpretive stop.

A method that may help you to do this is called the Roman Room technique, an ancient and effective way of remembering information. Used by Roman Senators in preparation for orations and as the basis of a powerful mnemonic system used to learn foreign languages, this method can also be a useful tool to learn your natural area.

To use this technique, imagine a room that you know, such as your bedroom, office, or kitchen. Within the room are objects. Associate images representing the information you want to remember with the objects in the room. To recall information, simply take a tour around the room in your mind, visualizing the known objects and their associated images. This particular technique is one that can be useful when planning a nature walk or field trip. The essence of the technique is to consider the natural area your home and each interpretive stop is a room within that home.

Become familiar with items in each room (each interpretive stop). There may be a specific component or item within each room that is particularly interesting, or that makes that room unique. Perhaps it is the architecture of the room (such as the dominant tree species), a principal function of the room (such as a nesting site for an eagle), the primary inhabitants of the room (such as invasive species), or the history of the room (such as a restoration site) that you choose to illustrate.

This strategy provides a simple technique that can be useful in visualizing your interpretive options and for considering how you might string together different components to build on an interpretive theme that provides insight into the ecology of the area.

Public Speaking

Public speaking is difficult for some people. Consider that many Americans list public speaking as their #1 fear on surveys, with death coming in at #2. Being a good interpreter requires the ability to communicate effectively with an audience. Fortunately, there are tips that can help you to deal with anxiety associated with speaking in public.

- **Be prepared.** Your audience expects you to have something worthwhile to tell them. So you need to know what it is you want to communicate. And, although you can’t know everything, that’s okay. Learn from questions and build your knowledge base.
- **Be organized.** A poorly organized presentation will generate confusion as to your message. Your audience may lose interest and some individuals may become aggravated. Poor organization may result in questions that diverge from your message and that you are poorly equipped to answer. However, a well-organized presentation will send a clear message and generate questions on your theme that you likely will be prepared to answer.
- **Practice, but avoid memorizing.** Memorized presentations tend to be flat and dry in their delivery and, if you forget something, you may have trouble getting your talk back on track. Visual aids will help remind you of content in your presentation. Incorporating a few good lines and stories will engage the audience and personalize your presentation.
- **Be responsive.** Your audience has come to listen to you so give them your energy. Make lots of eye contact and encourage their questions. Be relaxed in your delivery and let the audience know that “I’m glad you’re here and I’m happy to share this place with you.”
- **Be confident.** If you wear a uniform, wear it proudly. Feeling good about yourself and your appearance always helps build confidence. If you have some trouble during the presentation, don’t fret. Move on and maybe even joke about it. Relax and enjoy yourself and remember that your
audience wants you to do well. They’ve come to hear what you have to say and they are on your side.

**Storytelling**

Storytelling is interpretation provided with imagination, and can be an effective technique for conveying a larger message, particularly with children. Stories should be presented in bold strokes and language should be simple, direct, and lively. Although the structure is sometimes complex, it is almost always linear – first this happened, then this, and ultimately the end. There are different types of stories that can be used or adapted to convey an environmental message. These include:

- **Folktales:** these are typically told orally and include fairy tales, myths and legends, tall tales, ghost stories, and fables.
- **Literary stories:** these are written stories intended to be read, such as *The Lorax* (Dr. Seuss).
- **Real-life stories:** these may be historical or from your own, personal experience.

For the story to be interpretive and provide a larger meaning also requires that you ask yourself whether the story adequately conveys your message. It also usually requires that you prepare to ask questions or engage your audience in discussion to clarify the stories message. Ultimately, the story will only be as good as the telling. To be an effective storyteller requires preparation and practice. There is no one style of storytelling, but some general tips are useful. Use a strong voice and word emphasis. Deliver the story in a location that is comfortable, intimate, and free of distractions. Part of the magic of storytelling is that it is personal, so make personal contact with your listeners. Talk to them, not at them. The story will get better each time it is told, so if storytelling is a technique you plan to use, tell your stories often and with enthusiasm.

**Working with Children**

Children can be a handful, especially when there are a lot of them. As the interpreter, you are in charge, so it is your responsibility to maintain control, of yourself as well as the children. Remember that children are not adults, so don’t expect them to act as adults and maintain your composure. Some tips to assist you in maintaining appropriate behavior include:

- **Make expectations of behavior clear early in the program**
- **Set specific limits on behavior** - i.e., stay on the trail, stay with your buddy
- **Give problem children something to do** - i.e., hold your props
- **Make your presence known** - i.e., stand next to problem children
- **Solicit help from other adults in managing problem children**
- **Don’t make empty threats** - be consistent in how you handle problems
- **Don’t yell** - yelling means you’ve lost control
- **Keep an upbeat attitude** - Usually, kids just want to be happy and have fun!
- **Model the behavior you want children to exhibit**

Tilden observed that effective interpretation for children requires a fundamentally different approach than for adults because perceptions and intellectual abilities of children differ from those of adults. These abilities vary with age and stage of growth. For our purposes, it is useful to examine three categories of child development, which are defined by intellectual development and age (from *Interpreter’s Handbook*).

The **pre-school** developmental stage encompasses the age group of 2-6 years, which is roughly preschool through 1st grade for most children. Children in this developmental stage are primarily self-oriented, so when you ask a question, a dozen hands will go up, not with answers, but with statements such as - “I have a turtle.” Children in this phase often do not question fantasy and believe in fairies and the like, and they also tend to view most things, including inanimate objects, as alive. And remember, these are young children, so keep it simple.
Techniques that work with this age group should engage them with play, fantasy, and activities to explore the senses. Effective teaching strategies include games and play, puppets, songs, stories (told or read), and sensory exploration.

During the grade-school stage (7-11 years), children respond best to direct personal experience. For this reason, this stage is often referred to as “concrete operational.” This stage also begins the developmental transition where the child begins to create order out of a complex world. Early in this phase, children are capable of recognizing simple concepts, such as time relationships (dinosaurs vs. current wildlife) and grouping items into simple categories (plants, animals, and rocks). Later in this phase, children are able to understand more complex relationships, such as the idea that fish and great blue herons are both components of a wetland community. Children in this stage can grasp the moral consequences of their actions and the actions of others. Consequently, children in this stage are quick to recognize the value of recycling, the impacts of pollution, and the need to conserve habitat for wildlife.

Techniques that work with this age group should incorporate concrete experiences. In group presentations, participation (such as answering questions) and humor are important. Effective teaching strategies include activities and games to teach concepts, exploration and discovery, sharing and empathizing, participation in stories, puppets, skits, and characters, devices that can be manipulated, physical and sensory involvement, questioning strategies and metaphors.

Adolescents (12-15 years) are approaching the full capabilities of the adult. Adolescents are able to understand complex relationships, such as the pros and cons of damming rivers. They also are able to view and weigh issues from different perspectives. Children at this age want to be viewed as adults, and want to express their opinion. They also prefer to take an active role in programs. The decision to actually participate in a program, however, is heavily influenced by the concern with peer-approval. This is an awkward stage for many children.

Techniques that work well with this group include programs that provide opportunity for active participation by more than one or a few individuals. Exploration and discovery or the involvement in an ongoing project, such as monitoring the soil crust or conducting inventories of organisms from sweep net samples, are examples of strategies that don’t isolate individuals in the spotlight and that provide a sense of worth in their participation. Effective teaching strategies include exploration and discovery, involvement in activities or projects, discussion and debate, simulation, role playing, and games that explore complex issues and processes.

Improving Access for Persons with Special Needs

We have a responsibility to ensure that all people, irrespective of their physical abilities, have the opportunity to learn about nature. Statistics reveal that 37% of the U.S. population has significant mobility, visual, hearing, or learning impairments. The number of people who are 65 years or older is about 10 percent and is increasing rapidly, and certain areas of Utah have a large percentage of older citizens. There are three broad categories of accessibility that need to be considered when planning to increase access for persons that possess special needs. These include:

- **Attitudinal access.** The first step in promoting greater access to opportunities for persons with physical disabilities or other special needs includes promoting an attitude of inclusiveness among staff, volunteers, and the general public.

- **Physical access.** Increasing the number and quality of opportunities, such as nature trails and wildlife viewing locations available to individuals that are physically challenged.

- **Communication access.** This includes methods of sharing the secrets of nature with people that possess communication disabilities, such as verbal, hearing, or vision, as well as learning disabilities. Becoming aware that these needs exist is the first step to increasing access and promoting environmental awareness among all members of society. There are several organizations in Utah that
promote increased access to the outdoors for persons with disabilities, including, but not necessarily limited to:

- Common Ground Outdoor Adventures, Logan (http://www.cgadventures.org/)
- National Ability Center, Park City (http://69.2.249.50/index.htm)
- SPLORE, SLC (http://www.splore.org/)

Selected References and Readings

Interpretation
Freeman Tilden http://www.rpts.tamu.edu/pugsley/Tilden.htm
Physical Characteristics

What is a Desert?

There are several key characteristics that define a desert. Historically, scientists believed that a desert was simply any area that received less than an average of 10 inches of precipitation annually. However, some areas of the world, such as the polar regions, receive less than 10 inches of precipitation each year, but are very different from deserts. Although less than 10 inches of precipitation falls at the poles each year, the precipitation falls as snow and tends to accumulate due to low temperatures. The definition of a desert was revised to include another key characteristic, high evaporation rates. A desert exists if there is the potential for the air to evaporate more water than is present. High rates of evaporation are the result of high amounts of solar radiation (i.e., sunshine), wind speed, and temperatures, at least for part of the year.

The timing and type of precipitation greatly influences the availability of water to plants, the primary producers in desert systems. If most of the annual precipitation falls as snow in the winter, it is unavailable to dormant plants and mostly infiltrates or evaporates before it can be taken up by the plants. Alternately, if most of the precipitation falls in the warmer months as brief, intense monsoon rains, then there will not be sufficient time for the soil to absorb the water, resulting in runoff. This is the main difference between cold and hot deserts.

Additionally, soil particle size greatly influences the availability of moisture to plants. A soil comprised mostly of fine particles doesn’t allow much penetration of water to reach the plant roots. Conversely, a soil of large particle size has quick infiltration rates, allowing water to be available to plant roots only for a short time. The ideal desert soil is a mixture of the two, with coarse soils to allow infiltration, and fine soils to hold moisture.

All of these factors combine to create an environment that results in sparse vegetation, which is also indicative of desert ecosystems, but not necessarily a defining factor.

An iconic Utah desert. (Image by M. Larese-Casanova)
World Deserts

Deserts cover 48% of the earth’s land surface and are located between 15 and 35 degrees north/south latitude. There is, of course, some variation from this rule due to the location of land masses, mountain ranges, and prevailing winds.

The world’s deserts, centered around 30 degrees north and south latitude. (Image from US Geological Survey)

Hadley cells circulate warm, moist air rising from the tropics near the equator toward the poles. As this warm, moist air rises, it cools which decreases its capacity to hold water vapor. The water vapor condenses and forms clouds that then release the water in the form of rain, mostly along the equator. After the water is released, the cool, dry air circulates toward the poles and sinks to the ground between 25 and 30 degrees latitude. As it does this, the cool air is warmed, causing moisture from the earth’s surface to evaporate; thus absorbing the moisture from the land below and forming dry, arid landscapes, or deserts. The world’s major arid regions include the Sahara, Syrian, Arabian, Kalahari, Thar, Gobi, Atacama, Australian, and North American deserts (Mojave, Sonoran, Chiuahuan, and Great Basin).

Utah Deserts

Utah’s landscape, the second driest in the United States, is approximately 80% desert. The Colorado Plateau desert province covers Utah’s southeastern quarter. It is perhaps the least densely-inhabited country remaining in the United States, excluding Alaska. The Colorado Plateau is a breathtaking and fascinating province of diverse geographic and ecological landscapes. This semi-arid region ranges in
elevation from 5,000 to 11,000 feet and showcases rugged plateaus, slot canyons, mountains, and river gorges with whitewater rapids.

The **Basin and Range** province’s unique topography was formed by extension of two plates of the earth’s crust being pulled apart. Because of this extension, the crust located underneath the Basin and Range province, in the western half of Utah, has been thinned and cracked making it some of the thinnest crust in the world. This extension has formed an alternating pattern of north/south trending basins (down fallen blocks of crust) and ranges (up-tilted corners of crust slabs) that are defined by extensive internal drainage. Here, water cannot find an outlet to the ocean, and evaporates or soaks into the dry ground.

Many North-South oriented mountain ranges influence deserts because they are very tall and wide. The Sierra Nevada, for example, does not let much Pacific moisture reach desert areas because of the **rain shadow** effect. This effect occurs when tall mountain ranges force precipitation to fall on their windward sides. As the moist Pacific air moves over the mountains, it cools and moisture condenses, causing precipitation on the windward side. When that air reaches the leeward side, it is dry because it has lost the majority of its moisture. The air then warms and expands as it travels across the desert, drawing moisture out of the soil, plants, and animals.

Utah’s deserts have long, dry summers with an average high temperature between 21-27°C (69-80°F), with temperatures reaching up to 46°C (114° F), but normally not exceeding 38°C (104°F). Winter generates precipitation largely as snowfall with average temperatures between 2-4°C (35-39°F) and drop to 0°C (32°F) or below. Evening temperatures in the desert are cool, at around 50°F. Cool nights help both plants and animals by reducing moisture loss from transpiration, sweating, and breathing. Additionally, condensation of dew caused by night cooling may equal or exceed the rainfall received by some deserts.

Utah deserts receive very low and/or concentrated rainfall in the form of snow in the winter or in short bursts between long rainless periods in summer months. Average precipitation ranges from 3-10 inches annually and evaporation rates regularly exceed rainfall rates. Sometimes when rain starts falling in the desert, it evaporates before even reaching the ground. This causes the total moisture in a desert to be even less than that which falls as precipitation. It is because of this high evaporation rate and low accumulation of water, resulting in low atmospheric humidity, that deserts have a high daily temperature fluctuation. Temperate deciduous forests, for example, may have 80 percent humidity or more during the day. This water reflects and absorbs sunlight and the energy it brings. At night, the water acts like a blanket, trapping heat inside the forest. Because deserts have relatively low humidity (i.e., water in the air), typically between 10-20%, and low densities of vegetation, they cool and warm rapidly with the rising and setting of the sun.

Because of these harsh climatic conditions, plants and animals that make the desert their home have unique adaptations which allow them to live there. Many desert plants, like cacti, have adapted ways to store water for long periods of time as well as prevent water loss through evaporation. Desert animals
have also adapted energy and water saving strategies like estivation (summer dormancy), living in underground burrows, and having highly efficient kidneys. We will discuss these species more in-depth later.

Hot deserts generally occur between 20 and 35 degrees latitude and range in elevation from sea level (or below) up to 6,000 feet above sea level. The **Mojave Desert** is the only hot desert in Utah. Hot deserts receive very little rain during any season with an average of 2-5 inches annually. As mentioned above, precipitation tends to fall in short, concentrated bursts with much of the precipitation evaporating before it reaches the ground, referred to as *virga*. Evapotranspiration is greater in hot deserts because the amount of water lost far exceeds the amount of water received. Hot deserts don’t experience particularly cold temperatures, although temperatures drop sharply at night. Mean annual temperatures range from 20-25°C (68-77°F), while extreme maximum temperatures range from 43.5-49°C (109-120°F). Minimum temperatures sometimes drop as low as -18°C (-4°F).

![The cold Great Basin Desert. (Image by M. Larese-Casanova)](image)

![The hot Mojave Desert. (Image by M. Larese-Casanova)](image)

Cold deserts occur in higher latitudes and in the interior of large continents. They are hot in summer and bitterly cold in winter. Elevations of cold deserts range from 3,000 feet to over 12,000 feet above sea level. Characterized by cold winters with snowfall and occasional rainfall during the summer, the Colorado Plateau and Great Basin are known as cold deserts. Because of winter snowfall, cold deserts receive a greater mean annual precipitation than hot deserts, ranging from 5-10 inches. Although low humidity allows greater penetration of solar radiation, winter air temperatures frequently drop below freezing. Like in a hot desert, summer air and ground temperatures in cold deserts can reach levels lethal for many organisms. After sunset, the ground rapidly loses heat to the night sky and surrounding air temperatures drop significantly before dawn. Temperature fluctuations of over 40 degrees Fahrenheit in a 24-hour
period are not uncommon. Mean winter temperatures range between -2 to 4°C (28-39°F) and mean summer temperatures between 21-26°C (69-78°F).

The least amount of precipitation falls in Utah’s deserts. (Image from U.S. Geological Survey)

Utah’s Desert Ecoregions

Colorado Plateau

The Colorado Plateau is the largest desert ecoregion in Utah. It is a landscape of uplifted, layered, flat-lying, eroded sedimentary rock. Water, the agent of change within the Colorado Plateau, has created many diverse land features including mountains, high plateaus, low valleys, slot canyons, pinnacles, towers, arches, bridges, deep canyons and washes. The Colorado and Green Rivers, along with their tributaries, are responsible for the majority of this spectacular topographical variety.

Because of the diverse landscape found within the Colorado Plateau, there is great ecological diversity that is supported. This diversity, including high alpine tundra, boreal forest, salt deserts and biological soil crusts, creates micro-habitats where plant and animal life can flourish in the variable climate, elevation, and soil. Furthermore, the Colorado Plateau supports six of the seven North American life zones (alpine, subalpine, montane, transitional, upper Sonoran, and lower Sonoran), which is a rare biological occurrence. This diversity is also one reason that there are five national parks, six national monuments, a national recreation area, and several state parks all within the Utah portion of the
Colorado Plateau. Along with the great biodiversity and natural attractions, the Colorado Plateau has one of the largest deposits of hydrocarbons (coal, oil, oil shale, tar sands, gilsonite, and natural gas) in the world.

![Deep canyons create cooler, moister microclimates where plants grow. (Image by M. Larese-Casanova)](image)

The variable topography of the Canyonlands region of the Colorado Plateau has created a vast region of unique environments. From its towering pinnacles and plateaus to deep canyons and flat valleys, Canyonlands receives an average of 9 inches of precipitation each year, mostly from melting of winter snow. Elevations range from 4,000 to 7,000 feet above sea level, with peaks over 12,000 feet. Because of its higher elevation, snowfall, and dry air that evaporates more moisture than is received, it is considered a cold desert. These conditions create an area with a unique blend of vegetation and wildlife. The soils found in this region are also unique. Nitrogen fixing biological soil crusts help keep water and nutrients in the soil, making it possible for a variety of plants to grow. Among the uniqueness of the area are many exposed rocky cliffs and escarpments that provide suitable habitat for numerous desert wildlife species, like desert bighorn sheep.

Central Basin and Range

In Utah, the **Central Basin and Range**, also called the **Great Basin**, was once covered by ancient Lake Bonneville (size comparable to Lake Michigan). The lowest part of the Great Basin is still under water, covered by the **Great Salt Lake**, and is about 4,200 feet in elevation at the surface. Compared to the Northern Basin and Range region to the north, the Great Basin region is warmer and contains a higher density of mountains. If you look at an aerial photo of the Great Basin, it will appear as an army of caterpillars is on the march northward. In the Great Basin, interior basins are 4,000 to 5,000 feet above sea level and ranges can be as high as 12,000 feet above sea level.

The Central Basin and Range consists of alternating low/high mountains and dry basins/salt flats. The **Bonneville**
Salt Flats were formed through the evaporation of Lake Bonneville. This was once the bed of the ancient lake and is made up of mostly potash salts ranging from 1 inch to 6 feet deep. Playas (un-drained mud or salt-encrusted flats) are another geologic feature found in the Basin and Range provinces. Playas are the result of the deposition of sedimentary material in the basins in-between the ranges. When these areas receive precipitation, shallow, ephemeral (short-lived) ponds may fill the basins, but generally don’t last long as the moisture quickly evaporates or is absorbed into the soil. However, in some areas where the soils are more suitable for collecting and holding water, wetlands and marshes are formed and provide habitat for a variety of wildlife. Because of the variety of climate, soils, and topography, vegetation in this area include types found in the upper Sonoran (high desert), transition (foothill), and montane (mountain) life zones; from sagebrush-grasslands, juniper and pinyon pine, to aspen and fir stands.

The mountains of the Great Basin were created by normal faults and have a north/south trend. These mountains are separated by valleys or basins and average between 25 to 50 miles long and 15 to 20 miles wide. The basins are areas of water and soil accumulation and must drain internally (water either evaporates or gets soaked into the ground) because they are self-contained.

The gradual cracking and tilting of the Earth’s crust as it is pulled apart, creating wide basins, and small mountain ranges in between. (Image from Angelier and Colletta, 1983)

Plateaus, foothills, and low mountains in the Central Basin and Range receive an annual precipitation of 12 to 15 inches. These areas are generally located between 4,000 and 6,000 feet and are cooler than lower areas of the state, with annual average temperatures ranging from 50°F to 65°F. These climatic conditions allow for a more stable soil/vegetation regime. Grasses and other soil binding vegetation types are prevalent in these areas, preventing extensive erosion and runoff of surface water.
In the Great Basin, broad flat basins are separated by small mountain ranges. *(Image by M. Larese-Casanova)*

The basins and valleys are also located at mid-elevations, around 4,000 to 5,000 feet above sea level. These low-lying areas, in comparison to the surrounding mountains, collect runoff from winter and summer storms. The average precipitation for these areas is approximately 12 inches a year. Temperatures can also vary greatly depending on the location of the basin or valley and individual characteristics of the valley. For example, Cache Valley has average summer temperatures of 71° F and average winter temperatures of 24° F. The soils located in valleys and basins are well-developed fertile soils suitable for farming and crop growing.

**Mojave Basin and Range**

The Mojave Basin and Range in the southwestern corner of Utah is similar to the Central Basin and Range; it is made up of north/south trending mountains separated by broad, desert plains. Also present are alluvial fans and playas in low elevations. However, the Mojave sub-region is much lower, ranging in elevation from 282 feet below sea level (the lowest elevation on dry land in the world, located in the Badwater Basin in Death Valley) to 3,950 above sea level with some mountain peaks exceeding 11,000 feet. The Utah portion of the Mojave sub-region receives 2-3 inches of annual precipitation, mainly during summer months. The annual average temperature ranges from 43° F in the high mountains to 76° F in the low basins. Death Valley National Park, located in the California and Nevada area of the Mojave sub-region, is considered one of the hottest, driest places in the Western Hemisphere. The average annual precipitation is 1.96 inches and has summer temperatures as high as 134° F.
The hot, dry, sparsely vegetated Mojave Desert. (Image by M. Larese-Casanova)

The Utah portion of the Mojave Basin and Range province is known as a desert, semi-desert, and upland mountain area. Because it receives very little precipitation, the footslope remains arid and only supports thin stands of desert vegetation; namely creosote bush, Joshua tree, juniper, yucca, cactus, and Mormon tea. Soils are well drained but consist primarily of sandy loam, which results in rapid percolation following precipitation events. Due to poor soil conditions, there are typically few trees with annual forbs and grasses growing in wetter years. This sub-region generally has up to 210 non-freezing days a year, resulting in a year-round growing season.

Northern Basin and Range

The Northern Basin and Range, located in the northeastern corner of Utah, shares similarities with the Central and Mojave Basin and Range regions containing level basins and valleys separated by north/south trending mountain ranges. However, the basins in this region are bordered by long, gently sloping alluvial fans at the mouth of most canyons. There are also a few volcanic plateaus which rise abruptly above the valleys. Elevation in the Northern Basin and Range varies from 4,000 feet to 7,200 feet. Annual precipitation ranges from 4 to 20 inches with mountains receiving the most. Precipitation is distributed evenly throughout fall, winter, and spring, but summers remain hot and dry. Average temperatures for the Northern Basin and Range fall between 41°F to 50°F. This area is a major migration route for waterfowl, including tundra swans, lesser snow geese, American widgeons, pintail, canvasback, and ruddy ducks that use the wetlands found within the basins of this region.
Pliocene (5-1.6 million years ago) volcanic activity has left lava plains and shallow intrusive igneous rock flows throughout the Northern Basin and Range. Alluvial deposits, playas, marshes, and flat salt deposits occur in the valleys, which creates semi-arid conditions. These conditions limit the natural vegetation to shrub-grass and saltbush/sagebrush, with exception of the higher elevation mountains, which support a mix of conifers and aspen stands. Beside the scattered barren lava plains, the hills and low mountains have a desert sagebrush vegetation type and are used for cattle grazing. Many of the alluvial valleys in this region are used for agriculture, made possible through irrigation. Due to the differences in elevation and topography, soil conditions vary significantly. Lowland areas typically have poorly-drained, fine soils with high water tables while most of the upland areas have well-drained, sandier soils.

Wyoming Basin and Range

The Wyoming Basin and Range is composed of a broad intermontane basin interrupted by high rugged hills and low mountains. It has narrow valleys with steep gradients, alluvial fans, and piedmont plains and slopes from the surrounding mountains. Although dominated by grasslands and shrublands, this region is nearly surrounded by forested mountains. It is located between the Middle Rockies, Southern Rockies, and Wasatch Mountains. The Wyoming Basin and Range is somewhat drier than the Northwestern Great Plains to the north and doesn’t have the extensive cover of pinyon-juniper woodland of the Colorado Plateau to the south. Annual precipitation ranges from 7-20 inches and average temperatures for the region are between 39°F to 52°F. Elevation ranges from 3,000-8,000 feet above sea level and is comprised of conglomerates, sandstones, and shales with dune sands. This region also contains extensive natural gas
and petroleum fields.

The Wyoming sub-region’s rolling, rugged hills are considered semi-arid and support sagebrush, wheatgrass, saltbrush, and needlegrass communities. Pronghorn antelope utilize this region’s rangeland year round as well as the endangered Utah prairie dog and other small mammals. Surface water in this region seems scarce; however, it abundantly fills in some valleys creating marshes suitable for waterfowl. There are several major rivers flowing through the region and groundwater is meager in most areas. Much of the soils in this region are mesic (moderate soil moisture) and have loamy textures.

![The broad, rolling hills of the Wyoming Basin and Range. (Image by M. Larese-Casonova)](image)

**Wetland Ecosystems**

Wetland ecosystems are most common in Utah above 4,000 feet in elevation because the climatic variables allow for water draining from mountains to be collected and remain for a moderate length of time. A wetland is an area where water is present for at least part of the year, has well-developed hydric soils (saturated enough soils to create a lack of oxygen in the soil horizon), with bacteria and animals adapted to live in the wet environment. Although common at mid-elevations, wetlands are found throughout the state, from mountain meadow marshes and glacial lakes in high elevations, to desert potholes and hanging gardens in low elevations.

Although often temporary, wetlands, such as potholes, hanging gardens, playas, salt flats, and mud flats, are extremely important to life in the desert. These systems not only provide drinking water for desert wildlife, but also moist microhabitats for endemic plants to thrive and breeding habitat for bacteria, invertebrates, and amphibians. Many of these organisms are highly adapted to take advantage of the brief presence of water, and then remain dormant for the rest of the year. During dormancy, they must endure intense heat, solar radiation, desiccation, and freezing while they wait to be rehydrated once more.
Precious pothole wetlands bring life to the dry desert. (Image by M. Larese-Casanova)

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 crisscrossed 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.

Canyonlands

Canyonlands is a result of the Paradox Formation and the millions of years of sediment deposition and erosion that followed. Ten million years ago, a gradual uplift of sedimentary rock layers occurred, creating
the area known as the Colorado Plateau. The uplift of this region marked a shift from a time of deposition to one of erosion (i.e., the gradual wearing away of land surface materials) as the layers of rock were exposed to streams, wind, and precipitation. Rivers, like the Colorado River, have carved canyons over 2,000 feet deep. As the Colorado River cut its way downward through the rock layers, it also carried millions of tons of sediment away from the Colorado Plateau toward the Pacific Ocean. Wind and rain eroded the weaker layers of sedimentary rock, mesas, buttes, and spires with “standing rocks” (i.e., erosion resistant layers of rock) left on top. Floods abrasively rushed past layers, carving canyons and creating ephemeral pools or “potholes” (i.e., naturally occurring basins or pools in sandstone that collect rainwater and wind-blown sediment); ice occurred as water molecules expand during winter, which loosens surface material and widens cracks making the layers of rock vulnerable to further erosion by water and wind. Erosion has created the iconic landscape of the Colorado Plateau and will continue to transform it in the future.

The heavily eroded canyons of the Colorado Plateau. (Image by M. Larese-Casonova)

The liquefaction of the Paradox Formation is also a major force shaping the land. The Paradox Formation consists of deeply buried layers of salts, gypsum, and black shales, which liquefy under the immense weight of the overlying rock. The salt flows to areas of less pressure, causing salt domes when layers bend upward and salt valleys when the rock erodes and collapses into spaces abandoned by the salt. Examples of salt domes and valleys within Canyonlands is Upheaval Dome, and the grabens located in the Needles District of the park. However, there is also a theory that Upheaval Dome is an impact crater.

Upheaval Dome, from above. (Image from Canyonlands National Park)
The geologic layers of southern Utah. *(Image from Arches National Park)*
Arches, Windows, and Natural Bridges

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. (Image from Arches National Park)

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 landforms in a relatively small area.
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.

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.

Grand Staircase

The Paradox Formation has, yet again, been an active participant in the formation of another region, called the Grand Staircase, in southern Utah. As you recall, the Paradox Formation is vast a salt deposit
underneath layers and layers of sedimentary rock, formed over millions of years. As the Colorado Plateau began its slow uplift around 10 million years ago, five tilted, southward, facing escarpments called stairsteps began to be formed, creating the Grand Staircase area. Today, as these escarpments have eroded over time, the stairsteps rise to 6,000 feet and from the area of the North Rim of the Grand Canyon through Zion National Park, encompassing an area of almost 2 million acres of plateaus, mesas, buttes, and slot canyons. Described by their colors, the stairsteps are, from oldest to youngest: chocolate, vermilion, white, gray and pink.

The rainbow of rock layers in the Grand Staircase. Red dots from left to right indicate the Pink Cliffs, Grey Cliffs, White Cliffs, Vermilion Cliffs, Chocolate Cliffs. (Image from National Park Service)

The chocolate layer is found at the North Rim of the Grand Canyon. It is the bottommost, and oldest, stairstep and is made of limestone formed between 200 and 225 million years ago. Next is the vermilion layer, which is reddish in color. These cliffs are 165 to 200 million years old and made of cemented silt and desert dunes. The white layer is made up of towering Navajo sandstone cliffs, as seen in Zion National Park. This thin, white layer of rock was deposited 150 million years ago at a time when streams flowed over the desert and later covered by great dunes of sand. The gray layer is located between Zion National Park and Bryce Canyon National Park and is made up of shale and sandstone deposited 130 million years ago. It is the same age as the dinosaurs! The last layer is the pink layer, which is only 50 to 60 million years old, with its exposed layers visible in Bryce Canyon and Cedar Breaks.

Desert Varnish

Desert varnish forms on the vertical surface of sandstone cliffs and outcrops. The thin, dark, outer layer of stone occurs due to a combination of wind-blown soils that are rich in iron or manganese oxides, and oxidation carried out by microorganisms. The final, important ingredient is water. Where water flows down the rock face, microorganisms can survive and create desert varnish. Quite often, desert varnish looks like a large amount of paint, or varnish, was spilled at the top of a sandstone cliff. Oxides and clays rich in iron produce a red, orange or yellow varnish, whereas manganese oxides result in a black varnish. Desert varnish can be as thick as 1 inch and is highly durable. Some desert varnished rock is thought to be many thousands of years old. In southern Utah, petroglyphs are often chiseled through desert varnish, revealing the “clean” sandstone below.
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 salt pans, 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. In the desert, it is more important to have compacted soil than loose soil because wind and water erosion are strong forces in desert environments. The nutrients that get trapped in desert soils by microorganisms can easily be washed or blown away when churned into dust by grazing animals or recreational vehicles.

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Desert Communities

Biological Soil Crusts

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.

Biological soil crust relief increases with age. (Image by M. Larese-Casanova)

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.

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 its 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.

Composition

Utah’s desert areas are often comprised of vast expanses of barren rock (generally known as slickrock) or poorly developed soils, neither of which are suitable for much vegetation growth. However, the growth of biological soil crust helps provide nutrients and collect water for plants to establish. Some 500 plant species, including non-vascular plants, cyanobacteria, and some deciduous plants, have adapted to these barren conditions and can flourish in Utah’s desert areas; pinyon pine can even be found growing straight out of the rock in cracks or pockets where soil accumulate to support these trees.

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.

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.

Changes Throughout History

Utah’s arid country is a picturesque draw for recreationists throughout the year. Utah’s deserts are popular areas for camping, hiking, exploring, photography, rock climbing, mountain biking, and all-terrain vehicle use. Many visitors take advantage of the warmer, drier temperatures of these desert areas and climb the face of 1,000 foot cliffs, race their four-wheelers across the sand dunes or sagebrush flats, or just take a hike.
through the pristine vistas of these unique environments. Visitation to Utah’s deserts has steadily increased over the past century, with tourism and recreation as the main industry of several towns, such as Moab, Springdale, and Bryce.

**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.

**Structure**

Grasslands are made up of a many types of bunchgrasses, and often wildflowers, with sparse shrubs and trees. Common plants that can be found in Utah’s grasslands are bitterbrush, yucca, Indian paintbrush, rabbitbrush, and sagebrush. Because of the dryness of the area and the abundant grasses, grasslands have been very susceptible to lightning-caused wildfires. The grasses burn up quickly; however, many species have adapted to rapid regrowth after fires, as opposed to trees, which are slower to regrow.

**Composition**

In Utah, the Great Basin grassland area occurs in the western and northern regions. It is cooler and wetter than the Plains grassland that occurs in the eastern and southern regions of the state. The Great Basin grasslands are dominated by galleta grass and Indian rice grass. The Plains grassland region is dominated by blue grama grass or other gramas; it receives 1 to 5 inches less precipitation each year than the Great Basin grassland areas and is warmer and more arid. Most of the native, cold-tolerant, cool season bunch grasses found in these areas are most productive during spring through summer months.

**Ecology**

Although Utah’s drier climate mostly supports short-grass prairies, it is still valuable habitat for wildlife like its tall-grass prairie neighbor. Songbirds, raptors, mice, prairie dogs, ground squirrels, pheasants, wild
turkeys, snakes, coyotes, pronghorn, and even bison continue to roam in Utah’s grasslands. Once home to millions of bison and pronghorn, Utah’s grasslands are have changed since the pioneers first encountered them. Overgrazing of the lush grasses in the late 1800s created an opportunity for invasive plants, such as cheatgrass, to invade. Additionally, many overgrazed areas were reseeded with nonnative grasses, such as crested wheatgrass. Lastly, bison and pronghorn were hunted nearly to extinction and settlers turned much of the grasslands into cropland in northern Utah.

**Changes Throughout History**

During the late 1800s, settlers began to graze livestock in Utah’s grasslands. The high intensity of the grazing resulted in the extensive altering of these ecosystems in a short period of time. The native bunchgrasses found here generally were not tolerant of grazing, and therefore not capable to recover after grazing. This ultimately resulted in the loss of much of the grasslands dominated by native grasses in Utah. Furthermore, with the loss of the native grasses came the expansion of shrub species and invasive species like cheatgrass. Wildfires became less frequent with the lack of grasses to burn and increased fire suppression by settlers, which also enabled shrub species to overtake the once lush grassland areas.

A few of Utah’s remaining native grasslands can be found around Topaz Mountain near Dugway, and in protected areas like Grand Staircase Escalante National Monument, or on remote mesa tops and borders of dry farms. The exclusion of grazing and road construction in these protected areas has allowed grasslands, pinyon-juniper woodlands, and other ecosystems to remain relatively unchanged. However, grazing continues in many areas which are not protected and the colonization of cheatgrass instead of native grasses is expected to continue. The current mixture of grasslands dominated by cheatgrass reflects a continuing alteration of the Colorado Plateau region.

**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 mid-summer. Playas sparsely covered with these shrubs provide valuable habitat for migratory shorebirds, especially on the fringes of the Great Salt Lake.

![A salt desert shrubland in the Great Basin.](image by M. Larese-Casanova)

**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.

**Changes Throughout History**

Saltbush shrublands didn’t get much attention by American Indians, leaving the first real use of these harsh areas to sheep men around 1869. The vast majority of these lands are federal and state owned (e.g., Bureau of Land Management, Military, and Utah School and Institutional Trust Lands Administration), leaving the area open to grazing. Although saltbush shrublands have some nutritious vegetation, many of the species are poisonous to livestock. Sheep were grazed in these areas because they require less water
than cows and could use the snow during winter. Sheep grazing in saltbush shrublands was heavy during the early 1900s and peaked during World War I because wool was in high demand for the military. As a result, these shrublands were drastically overgrazed. Recovery was slow because of year-round grazing practices. As the vegetation recovered, more halogeton, shadscale, and rabbitbrush were established, making more of the forage poisonous for livestock. Because of this, desert saltbush shrublands have been considered “wastelands” and have been used for bombing ranges and toxic waste disposal sites. However, some of these areas have been sequestered from traditional uses, such as livestock grazing and motorized vehicle use, as wilderness areas.

Abandoned corral out in the Great Basin.

**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.

A typical cool desert shrubland.
*Image by M. Larese-Casanova*
Composition

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.

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.

Changes Throughout History

Sagebrush shrublands are becoming increasingly degraded and fragmented largely in part to livestock grazing, road and residential development, and farming. Historically, there were as many as 156,000,000 acres of sagebrush shrublands; however, since the time of European settlement in the west, thirty-two percent has been removed due to livestock grazing, and eradication. Settlers considered sagebrush poor forage for livestock and a hindrance to agricultural developments. Overgrazing in sagebrush shrublands increases soil water loss, increasing aridity of the community. Overgrazing, combined with the trampling that accompanies it, reduces the biomass of deep roots, litter cover (which helps with nutrient cycling), and number of sagebrush and grass seedlings that can grow within the stand. As a result, the understory diversity in many of these areas has been reduced to only a few different species, when historically there were many different species of native bunchgrasses and herbaceous perennials. Cheatgrass, an invasive exotic with a strong foothold in Utah rangelands, has become the dominant ground cover in many
sagebrush shrubland ecosystems partly due to overgrazing. This invasion has led to significant shrubland loss due to a dramatic change in natural fire regimes. Fire roars through the dense, carpet-like cover of cheatgrass much quicker and easier than native bunchgrasses; furthermore, these shrublands are slow to recover overgrazing and wildfire.

While there have been numerous detrimental impacts to Utah’s sagebrush shrublands throughout history, many more recent management and restoration efforts, as discussed in the Management section of this manual, have had positive impacts.

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.

The unique Joshua trees of the Mojave Desert. (Image by M. Larese-Casanova)
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; 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.

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.

Changes Throughout History

Creosote bush shrublands occur in environments that make livestock grazing difficult. Harsh temperature changes and low accumulation of precipitation cannot sustain large numbers of animals; however, grazing during winter months in these ecosystems has been the norm for a century. Overgrazing can be a problem in these areas due to high competition for sparse grasses. Urbanization in creosote bush shrublands is increasingly displacing this ecosystem, especially in southwestern Utah. The milder winter temperatures draw people from colder areas to build homes in these unique environments. Urbanization has also been a contributor to the introduction of non-native grasses that increasingly invade creosote bush.

Cattle graze the sparse vegetation of the Mojave Desert. (Image from National Park Service)
shrublands and disrupt the natural heterogeneous spatial pattern that acts as a natural fire break. With an increase in urbanization to these areas also comes an increase of outdoor recreation. Creosote bush shrublands are sensitive to high impact uses because of the soil type, with its already limited nutrients. Off-road vehicle use is an increasingly popular hobby for Utah residents, and the impacts from this recreation use create scars on the landscape that last for decades.

**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. (Image by M. Larese-Casanova)](image)

**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.

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.

Changes Throughout History

American Indians have utilized pinyon-juniper woodlands for approximately 6,000 years. Pinyon pine seeds provided a stable food source that allowed native peoples to expand into mountainous areas. They used plant fibers from these trees for firewood, building material, tools, baskets, dyes, textiles, and in ceremonies. American Indians also extracted pitch from the trees and used it in building and in medicines. Pine nut gathering was cause for festivity for native peoples and the fruits were also used for cosmetic and medicinal purposes. When settlers came to inhabit Utah's desert areas, pinyon and juniper wood was collected for fire wood and building materials as well. The early settlers thought these woodlands were of little importance except for fuel wood and pine nuts it provided, however they generally regarded pinyon-juniper woodlands as invasive rangeland.

Overgrazing in pinyon-juniper woodlands has diminished and altered herbaceous vegetation, which has led to widespread desertification of understory conditions. Year-round grazing is believed to have suppressed former fire regimes, resulting in an increased density of trees in these ecosystems, which disrupts the essential interspaces between trees. Both grazing and fire suppression have resulted in the expansion of pinyon-juniper woodlands across the West.
Another impact to pinyon-juniper woodlands is a process called **chaining** that clears away all understory, and in some cases pinyon and juniper trees. This process improves areas for livestock forage and habitat for wildlife such as sage grouse, but it has been detrimental to soil communities and archaeological sites. Increased runoff, soil erosion, and invasion by big sagebrush and skakeweed have also resulted from these activities. Furthermore, woodland communities have expanded over the course of the last century on the Colorado Plateau, with pinyons and junipers expanding upslope into ponderosa pine forests as well as downslope into grass and shrub communities. The densities of these stands are now such that they can support catastrophic crown fires (i.e., intense fires that burn entire trees from the understory to the top of the tree), rather than more frequent regenerating fires.

Chaining pinyon pine to promote shrubland growth. *(Image from Rocky Mountain Elk Foundation)*

**Selected References and Readings**


*Ladybird Johnson Wildflower Center Native Plant Image gallery* http://www.wildflower.org/gallery/
Range Plants of Utah http://extension.usu.edu/range/index.htm
Vascular Plant Biodiversity http://www.brazadv.com/images/biodiversity.bmp
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.
Across the U.S., primary productivity is lowest in the dry Intermountain West and at high altitude mountain ranges. (Image from NASA)

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. 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. Ecological diversity may also exist within an ecoregion, like Zion National Park, because it contains forest, meadow, desert, river, and wetland habitats.

**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.
Regional vascular plant diversity across the globe. (Image from Barthlott et al., 1999)

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.

Vertebrate species diversity is particularly high in deserts.
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.

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. (Image by M. Larese-Casanova)](image)

**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.
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.

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. 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.
Crassulacean Acid Metabolism

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.

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.
Animal Adaptations to Desert Ecosystems

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. (Image by M. Larese-Casanova)

A desert tortoise burrow serves as refuge from the desert heat. (Image by M. Larese-Casanova)
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.

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.

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 (mimicry), 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, the uncanny ability to remain motionless for extended periods of time, adding to the impression that they are part of the environment. 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.

Aestivation

**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 flow and oxygen to its tissues.
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.

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 overheating. 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.

**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.

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**Mammals**

Management

Public Lands

Utah encompasses 54 million acres of land, 36 million acres of which is federally owned, meaning that 65% of Utah is public land (with the exception of 4.6% that is owned by the military). The State of Utah owns 7.2% of the land area, which houses 42 state parks to preserve and provide natural, cultural, and recreational resources. Four percent of Utah’s land is owned by American Indian tribes, including Navajo, Ute, Paiute, Goshute, and Shoshone. The remainder of Utah’s land is privately owned, approximately 24%.

The photo below is a little outdated, but still useful for comparing percentage of public land in each state.

WHO OWNS THE WEST?
Federal Land as a Percentage of Total State Land Area

Bureau of Land Management

The Bureau of Land Management (BLM) is the federal agency that manages the most land in Utah. With 23 million acres (42% of land in the state) of diverse landscapes under its management, the BLM manages these public lands for a variety of uses including mineral extraction, energy production, livestock forage, for the protection of historical and cultural resources. From remote snow-capped peaks, colorful red-rock canyons, to sprawling desert lowlands, BLM lands offer prime opportunities for solitude and enjoyable outdoor recreation. Within Utah, 18% of all BLM-managed lands are part of the National Landscape Conservation System, which is a collection of federally protected areas. This system includes approximately 4.2 million acres of land which are nationally significant landscapes recognized for their...
cultural, ecological and scientific values. These areas include national monuments, national conservation areas, national historic and scenic trails, wild and scenic rivers, wilderness areas, and wilderness study areas. Their protected status ensures these areas are conserved as well as restored to a more natural state. One of these areas, Grand Staircase-Escalante National Monument was the BLM’s first national monument and is located in beautiful red-rock country encompassing 1.9 million acres. This area was designated as a national monument in 1996 because of the unique blend of its archaeological, historical, paleontological, geological, and biological resources.

The energy production on Utah’s BLM lands plays a key role in meeting the energy demands of the region. Each year, upward of 500 billion cubic feet of natural gas is extracted in Utah and continues to provide for the state’s energy needs. Grazing occurs on nearly all BLM managed lands. The BLM authorizes grazing allotments through permits with which 1.2 million animal unit months (the amount of forage needed for one cow and calf, one horse, or five sheep or goats for a month) of livestock use are allowable. The BLM encourages public involvement in their planning processes, realizing that managing 23 million acres of public land affects many people. This type of planning emphasizes a collaborative effort on behalf of local, State, and Tribal governments as well as the public, user groups, and industry to identify the appropriate multiple uses of public lands.

National Park Service

The National Park Service cares for some of the nations most admired landscapes. With nearly 400 natural, cultural, and recreational sites across the nation, the National Park Service manages these areas for preservation, protection, and public enjoyment, as well as to share the legacies of the land. The National Park Service manages 3.6% of the land in the United States and incorporates an extensive management system, including public outreach and research, in part, to monitor human use and restoration. Throughout the country, the National Park Service manages 58 national parks, 776 campgrounds, 12,250 miles of unpaved trails, 763 miles of paved trails, 2,451 miles of Scenic Rivers, 120 National Historic Parks, 54 Wilderness Areas, and 277 million visitors in 2007.

In Utah, the National Park Service manages 1.6% of the land, encompassing four national parks, including Zion, one of the nation’s first national parks, six national monuments, four historic trails, one historic site, and one national recreation area. The National Park Service also helps communities throughout the U.S. preserve and enhance important local heritage and recreational opportunities by creating community parks and local recreation facilities, conserving rivers and streams, and developing trails and greenways. National Parks also serve as outdoor laboratories for physical, biological, and cultural research because of the relatively natural condition in which they are maintained.

Bureau of Reclamation

The Bureau of Reclamation serves to manage, develop, and protect water and related resources in an environmentally and economically sound manner for the benefit of the American public. Through the effective use of water, the Bureau of Reclamation strives to protect local economies and preserve natural resources and ecosystems. The leadership, use of technical expertise, efficient operations, responsive customer service, and the creativity of people is how it manages its facilities to fulfill water user contracts and protect and enhance conditions for fish, wildlife, land, and cultural resources. The Bureau of Reclamation is the nation’s largest wholesale water supplier operating 245 million acre-feet of water on 384 reservoirs. It provides one in five western farmers with irrigation water and is the second largest producer of hydropower in the nation, operating 58 hydroelectric powerplants. The Bureau delivers 10 trillion gallons of water to over 31 million people each year. It also helps manage 289 recreation sites, which have 90 million visits annually. In Utah, the Bureau of Reclamation manages Glen Canyon National Recreation Area, Lake Powell, and several other reservoirs including Starvation and Jordanelle. The Bureau
of Reclamation also helps to provide quality habitat for fish and wildlife, especially for species that are federally threatened or endangered.

Utah State Lands

**Utah State Parks** manages 96,000 acres of land in Utah for the enjoyment of the public. Utah State Parks manage 42 parks (recreation, heritage, and scenic parks) across the state, including several beautiful desert state parks such as Dead Horse Point, Antelope Island, Goblin Valley, and Kodachrome Basin. The agency also administers grants to help local governments purchase land that aims to preserve and enhance linear river corridors for both wildlife habitat and recreation purposes. For instance, Riverway Enhancement funds have been used for projects on rivers throughout the state. Furthermore, it encourages the development of a statewide trails system and administers grants for the renovation, construction, acquisition of trailheads, properties, and trail corridors for multiple-use, non-motorized trails. The Division of Parks and Recreation also manage their lands for off-highway vehicles (OHV) by creating trails suitable for their use, educating the public about OHV safety, and requiring registration fees that go directly to support these recreational activities. Boating safety is another program Utah State Parks focuses on, mainly because several of its state parks are located on reservoirs, and it wants visitors to have a safe and enjoyable experience.

The **Utah Division of Wildlife Resources** manages several Wildlife Management Areas (WMA) throughout the state. A notable WMA in desert habitat is Hardware Ranch, located up Blacksmith Fork Canyon in the Bear River Range of northern Utah. The mission of Hardware Ranch WMA is “to provide healthy habitats that support sustainable wildlife populations, and to increase public awareness and stewardship of Utah’s wildlife.” The main research and management efforts at Hardware Ranch focus on understanding and maintaining healthy elk populations.

Approximately 6%, or 3.4 million acres, of Utah is managed by the **School and Institutional Trust Lands Administration (SITLA)**. The expressed mission of SITLA is to “generating revenue through oil, gas, and mineral leases, rent, and royalties; real estate development and sales; and surface estate sales, leases, and easements” to benefit public K-12 schools, hospitals, colleges, and universities. SITLA lands are distributed across the state in a checkerboard pattern, including a diverse array of ecosystems. In addition to generating revenue to benefit schools, SITLA partners with agencies and non-profits on projects, such as at the Nine-Mile Canyon Petroglyph Site, to preserve natural, historic, and cultural resources.

**Trust for Public Lands**

The **Trust for Public Land (TPL)** is a national non-profit land conservation organization that strives to conserve land where people can experience nature. In Utah, TPL has helped conserve 47,000 acres of land for agriculture, culturally significant sites, trails, and community parks since 1985. One significant benefit of private land trusts, like TPL, is that they have great flexibility in creating partnerships between individual landowners, government agencies, and other private organizations quickly to assure permanent conservation of the land. The most common form of protection for land is through conservation easements, which assist landowners in designating their property for the purpose of natural resource conservation. Easements also assure that landowners receive economic benefits for their willingness to conserve land resources. TPL not only negotiates transactions for the landowner, but also assists in raising funds and determining conservation priorities.

For many years, TPL has worked with 40 local communities and the U.S. Forest Service to acquire and protect land along Wasatch Front’s benches for the creation of the Bonneville Shoreline Trail, which runs from Logan to Santaquin. In 2007, TPL helped acquire 1,240 acres of critical wildlife habitat in the Wasatch Mountain Range just east of Draper, which helped connect existing public lands in the foothills, the Lone Peak Wilderness area and Corner Canyon property that TPL worked to protect in 2005. This transaction
protected over a mile of the Bonneville Shoreline Trail and improves public access to existing open space that is now a part of the National Forest. TPL also played a critical role in the preservation of a historically important ranch in the Park City corridor. Development plans for the ranchland threatened the loss of this defining characteristic of Park City; however, with the creativity of TPL and the donation of some 20 acres of surrounding land, the ranch was preserved.

Grazing

Historic Land Use

By 1880, there was a firmly established “village livestock industry” in Utah’s central mountain valleys. These settlements relied on livestock as the means of livelihood. Families with children would even tend to herds in mountain meadows during the summer. As livestock numbers in the West grew, stockmen from surrounding areas pushed and extended their herds onto what were the last ranges available in Utah. Regionally important towns like Spanish Fork and Nephi were strategically placed for livestock as they were trailed between ranges in the Great Basin and Colorado Plateau. Competition for range between cattlemen and sheepmen peaked in the 1890s as both were encouraged to produce meat and wool. Settlers also used techniques such as chaining, to clear the land in order to convert woodlands into grasslands for livestock forage. Due to competing livestock producers and land conversion practices, over 300,000 head of cattle roamed Utah’s landscape simultaneously with 3,000,000 sheep at the turn of the 20th Century, greatly contributing to the overgrazing of Utah’s land. The diversity of vegetation in many of these areas was lost and the land was impacted by trampling, soil erosion, flooding, and the influx of invasive species.

Utah’s landscape presents more desert ranges suitable for winter grazing than it does mountain pastures. However, with its wide range of diverse landscapes, 70% of Utah provides suitable grazing opportunities depending on the time of year. Livestock are grazed in high mountain meadows during the heat of summer, on lower foothills and plateaus during spring and fall, and in Utah’s deserts in winter. Largely because of year-round grazing opportunities, early settlers heavily overstocked the fragile desert rangelands. The results of these practices were overgrazed landscapes, lack of sufficient forage, flooding, soil erosion, and of the destruction of riparian areas and wildlife habitat. Sanpete County ranges were said to be destitute of grass from grazing and trampling only to be replaced by “desert weed” and plagued by regular floods. The Wasatch Front was experiencing the same problems by the 1930s.

Albert F. Potter, a grazing expert hired by the General Land Office in the Department of the Interior, traveled 2,000 miles in the summer of 1902 performing a complete survey of potential Forest Reserves in
Utah. The primary purpose for the survey was to address the “spoilation” of Utah’s rangelands over a 20 year period (1880-1900) due to settlers overstocking their livestock. Potter said of livestock producers in Utah “Quick profits and fortunes lead to speculation and incredible numbers of stock were placed upon the range. Cowman was arrayed against sheep man, big owners against small, and might ruled more often than right.” Thankfully, Potter discovered the rampant abuse of grazing rights and was soon in a position to influence real change in livestock management in Utah.

Potter later became the newly-formed U.S. Forest Service’s Chief of Grazing and organized the first grazing policies, regulations, and procedures. Potter was able to assure that federal management of rangelands in Utah was shared with stockmen and local forest officials. In 1905, the Forest Reserves in Utah were transferred to the newly created U.S. Forest Service and renamed National Forests. The first national forest in Utah was the Uinta National Forest which covered an area of what are now three national forests. Today, there are six national forests in Utah that are all managed using multiple use strategies, which includes timber, mineral, and water preservation, as well as providing grazing and outdoor recreation opportunities.

Current Management

Through sound grazing management practices and range improvements, Utah’s lands look, and function, better than at any time in the past century. As grazing continues to be an important use of Utah’s land, it is continually in competition for resources with an ever growing number of other uses, such as energy development and outdoor recreation. It is pertinent to have trained personnel to help agencies and landowners implement the best, and most up-to-date, technology and management techniques. With this knowledge and assistance, grazing land resources will be conserved and enhanced to provide benefits to all the citizens of Utah.

Presently, the Bureau of Land Management (BLM) is one agency striving to maintain the health of public lands. The BLM uses rangeland health standards and guidelines developed with input from citizen-based Resource Advisory Councils throughout the West. The standards provide specific conditions, such as the presence of stream bank vegetation and sufficient canopy and ground cover, for defining rangeland health. The guidelines offer management techniques designed to maintain public lands in a healthy state, as defined by the standards; techniques include seed spreading and periodic rest from grazing in certain areas during critical growth periods. With these standards and guidelines in place, well-managed rangelands can provide numerous environmental benefits such as healthy watersheds and wildlife habitat, recreational opportunities, and can help prevent severe wildfires and the spread of invasive plant species.
The BLM is responsible for managing 1,472 grazing allotments in Utah that cover 21.9 million acres of land. It manages these allotments through grazing permits that authorize 1.2 million Animal Unit Months to graze annually. The amount of grazing that occurs on BLM land each year is affected by drought, wildfire, and market conditions; hence the 1.2 million AUMs can vary significantly based on environmental conditions. For instance, the amount of grazing authorized by the BLM has gradually decreased since 1941, due to a reduction in amount of forage available caused by drought, wildfire, and development. The BLM’s overall objective in managing grazing on public lands is to ensure long-term health and productivity of the land and the beneficial influence of healthy watersheds. In Utah, the BLM’s range program is focused on monitoring and performing a standards assessment that must be met before grazing permits can be renewed every 10 years. Together with private landowners, the BLM’s grazing management helps maintain open spaces, provide habitat for wildlife, offer a variety of recreational opportunities, and preserve the character of the rural West.

![An area overgrazed in 1919 (left) was colonized by sagebrush by 1943 (right). (Images from USU Extension)](images)

Utah’s Grazing Land Conservation Initiative (GLCI) was organized in the early 1990s and is a partnership between producers, conservation district officials, federal agency specialists, and researchers who have united to improve Utah’s private grazing lands. The mission of the Utah GLCI is to encourage private landowners to improve their grazing lands, as well as coordinate technical and financial assistance programs for private landowners. The GLCI also endeavors to educate private landowners and the public at large about the benefits of healthy grazing lands, as well as promote long-term research and demonstration programs to improve Utah grazing lands.

Because private grazing land in Utah provides many products that benefit much of Utah, the GLCI seeks to provide technical assistance for private landowners who are willing to voluntarily improve their lands to do so. Utah GLCI respects private property rights, encourages diversification to achieve multiple benefits, and emphasizes training, education, and increased public awareness. Grazing land science has improved over the last several years, causing the value and demand of healthy grazing land to be higher due to the recognized value of clean air, healthy wildlife populations and habitat, improved fisheries and aquatic systems, and healthy riparian areas. Utah GLCI helps collaborative processes between all groups and integrates grazing land science to help land owners recognize and manage conservation issues to meet ecological and economic demands.

The Grassland Reserve Program (GRP) is a voluntary program that assists landowners in restoring and protecting grassland, rangeland, pastureland, and shrubland while managing them as grazing lands. Landowners may file for an easement with the National Resources Conservation Service (NRCS), which coordinates implementation of GRP, and voluntarily limit future cropping or development practices while continuing grazing practices. The GRP strives to protect vulnerable lands that are threatened by conversion due to cropping or urban development in order for present and future utilization of grassland resources.
The GRP is able to help sustain plant and animal diversity of native rangeland areas through its efforts. In addition to improving the environmental quality of these rangelands the restoration and protection of these areas can also positively contribute to the economy of Utah. Through the GRP, the U.S. Department of Agriculture directs financial resources and technical expertise to help landowners protect and restore native grasslands and rangelands.

Many other cooperative programs strive to improve Utah’s grazing lands not just for the benefit of grazing livestock, but also to improve wildlife habitat, protect watersheds, and support multiple use of public lands. The Utah Department of Agriculture and Food Grazing Improvement Program aims to promote grazing on Utah’s public lands through using science-based management principles to improve rangelands and watersheds. The Utah Watershed Restoration Initiative is a partnership that participates in projects that enhance wildlife and biological diversity, water quality and quantity, and sustainable use of natural resources. Projects include sage-grouse habitat restoration, riparian and wetland restoration, and fuels reduction in forests through prescribed burning. Lastly, the Utah State University Extension Rangeland program provides expertise and resources to rangeland managers across Utah. By disseminating science-based best practices across the state, USU Extension helps to ensure wise management of Utah’s rangelands for the future.

Although overgrazing has had major impacts on Utah’s landscape in the past, new range land science has shown that grazing can be used as a tool to restore these lands and improve biodiversity. In Utah, many areas have seen a decline in biodiversity as sagebrush and juniper communities out-compete grasses and forbs that once shared the landscape. Large numbers of grazing livestock and fire suppression have been integral factors in the loss of biodiversity in Utah. As livestock grazing has increased, the number of browsers (sheep, goats, and pronghorn) decreased which led to higher densities of woody plants, like sagebrush and juniper. As woody species increased, they out-competed the native grasses and forbs, changing the ecosystem from a grassland to a shrubland. Furthermore, livestock are generally grazed in the same areas year after year in the spring when grasses are most vulnerable.

However, it has been shown that livestock grazing can be used as a way to increase and restore biodiversity to landscapes. Livestock can decrease the prevalence of invasive and weedy species allowing desirable species to make a foothold. For instance, because sagebrush is not tolerant of grazing, it should be grazed in the fall by sheep when grasses and forbs are dormant. This will decrease the abundance of sagebrush without harmful consequences to other vegetation types, especially if the sheep have been provided with supplemental nutrients (e.g., causes the sheep to ingest greater quantities of sagebrush). As the diversity of vegetation increases, the ecosystem will be more stable and resilient to environmental changes, in addition to providing a variety of nutrients and habitats for plant and animal life to continue to flourish.

Ongoing Issues

The extensive livestock grazing and fire suppression of the early 1900s has resulted in a landscapes prone to frequent, intense wildfires. Regrowth of rangelands after extensive grazing, combined with the absence of frequent fires, promoted rangeland structure changes and biomass accumulation, which now reduce the effectiveness of fire suppression and increase the size of wildfires. The prevalence of invasive species, like cheatgrass, creates an unbroken path along the ground for fires to travel quickly. Denser woodlands create prime crown fire candidates. Land-use history may be the primary factor for increasing wildfire frequencies, which gives land managers hope that ecological restoration and fuel management can be potential solutions.
Farming

Historic Land Use

Early Utah settlers, primarily Mormon pioneers, saw the vast landscape as a land where problems would cease to exist if it were “regulated as it would be under the government of God.” Mormon leaders were spokesmen for agriculture, and agrarian values became central to settlers throughout Utah. Utah’s pioneers taught cultivated gardens, raised chickens and cows, and took part in other agricultural practices. These land use traditions looked beyond economics and became second nature for many of Utah’s early settlers.

Mountain streams were diverted to make irrigating crops possible and, where irrigation was not possible, dry farming techniques were adopted. Dry farming depends upon efficient storage of limited moisture in the soil and the selection of crops and growing methods that make the best use of this moisture. By 1905, the Utah Agricultural College, now Utah State University, had established six experimental farms for developing dry farming techniques. Several of these techniques include tilling the land shortly after harvest and keeping it free from weeds year-round, while leaving enough plant debris and soil clods to trap moisture and prevent runoff and soil erosion. These techniques assured that the maximum amount of moisture possible will remain in the soil for crop growth. Typical crops grown with dry farming methods are drought resistant, are very high in nutrients, and can sell at higher market prices but are often times fed to livestock.

Current Management

Desert farmers in Utah grow high-value fruits and vegetables that are for local consumption as well as export. They also grow high-protein alfalfa, which not only stabilizes the soil in fragile desert environments but is the supporting foundation of the livestock industry, making up 76% of Utah’s agriculture economy. Utah farmers also produce other feed for livestock including hay, oats, and silage. Agriculture continues to be important not only economically, but also culturally, to Utah residents. Like their forebears, Utahns today see security in agriculture and their lives take form and context from a patchwork of land-related influences.
Because of Utah’s arid climate, most of the land is unsuitable for growing crops. In order to support farming, transmontane tunnels and canals were created to divert water from the Colorado River drainage system to the Great Basin drainage system. After the passage of the Reclamation Act of 1902, irrigation projects, like the Strawberry Reservoir and Central Utah Project, were constructed in order to transport water to areas where crops were being established. Twenty-two percent Utah land is used as farmland. The majority of farmland in Utah is privately owned and managed for livestock as well as crop production. Desert farmers in Utah rely heavily on tradition and will continue to grow crops through good times and difficult times.

Irrigating alfalfa in the southern Utah desert.

Ongoing Issues

With the passage of the Reclamation Act of 1902 came the creation of water subsidies for farmers in the West’s arid landscapes. These subsidies guaranteed water for farmers and ranchers no matter the cost. As a result, 82% of Utah’s water goes to the farming industry. Only 1% of the state’s income is generated by the farming industry, which tends to cause some contention between farmers and other industries that want farmers to become more self-sufficient. Utah farmers use the federal subsidies for things such as building more efficient sprinkling systems and growing high nutrient crops like alfalfa, of which costs can be greater than market value.

Mining

Historic Land Use

Mining in Utah provided a vital aspect of the economic, industrial, political, and social growth during the state’s early years. The mining of gold, silver, copper, lead, zinc, uranium, and coal has contributed greatly to the state’s history. Mormon pioneers participated in the discovery of gold in California, although church leaders at the time discouraged members from the search for precious metals. Leaders thought that such pursuits would distract members from agricultural responsibilities that were seen as the foundation of permanence and stability. However, gold dust imported from California between 1848 and 1851 was processed by early Utahns, which led to mining operations beginning in Utah. Commercial mining began around 1862 with the mining of gold and silver in the Bingham Canyon area and Wasatch Mountains. Other early mining areas include Park City, Big Cottonwood Canyon, the Tintic districts, and Oquirrh
Mountain range. In the late 1880s, surface deposits began to dwindle and corporate interests began to take over individual operations.

Large smelting plants were built in the Salt Lake Valley and were of great importance to Utah’s economy. The increased economic growth helped Utah change from its agrarian base to a more industrialized economy. As additional new industries and technology grew from mining, the influx of laborers fueled population growth. Immigrants, from within and beyond the U.S., provided much of the labor for the growing mining industry. Increased mining claims and the associated population growth lead to the considerable loss of rangeland as land was converted for mining and housing.

Silver and gold mining in Utah required deep shafts to be dug out of the earth as miners searched for these precious metals. The shafts were supported by logs cut from the abundant pinyon-juniper woodlands; ultimately resulting in the rapid deforestation of some areas. Pinyon pine and juniper trees were also used as firewood to make charcoal for smelting processes of these and other metals.

Current Management

The extraction of energy resources in Utah occurs all across the state. It is regulated by the Utah Division of Oil, Gas, and Mining whose role includes not only the extraction of energy resources, but also the recovery of sites when extraction is completed. Responsibilities of this division include drilling, testing, equipping, completing, operating, producing, plugging wells, and reclaiming sites. The mission of this division, and Utah’s Oil and Gas Program, is to promote exploration, development, and conservation of oil and natural gas resources in Utah, to foster a fair economic return to the general public for these resources, and to maintain sound regulatory practices to ensure environmentally acceptable activities. Utah is 11th in the nation in crude oil production and 10th for natural gas production. The Utah Division of Oil, Gas and Mining presently regulates approximately 13,000 oil and gas wells throughout the state.

Ongoing Issues

Oil and gas exploration in Utah and has been beneficial; however, it can cause a number of challenges for land managers. If agencies fail to adequately analyze the exploration project’s effects on natural and cultural resources, the results can be harmful to the environment. Wildlife habitat can be destroyed, exploration sites may be slow to recover, invasive weeds may be introduced with new roads and out-compete native vegetation, and noise and heavy equipment use near national and state parks (and other areas set aside for preservation of resources) may impact visitors’ experiences. Environmental groups have strongly voiced their concern over the last few years about existing and proposed exploration projects in southern and southeastern Utah. One such issue that has been controversial is the estimated 1.8 trillion barrels of oil contained in tar sands and oil shale along the Green River Formation in eastern Utah. It has been speculated that the amount of recoverable oil trapped in the limestone rock formation may be more
than what is available in the Middle East. This oil reserve is not yet being commercially developed because the process to extract the oil is extremely difficult and expensive.

Energy resource extraction on public lands has been occurring for the last 100 years. The discovery of rich natural gas and mineral deposits in Utah’s protected areas has brought an influx of difficult decisions for federal land managers. With pressures from federal government agencies, oil/gas companies, and environmental groups, land managers strive to utilize appropriate scientific practices in performing environmental assessments as well as involve interested parties in the decision making process. However, higher authorities have the final say on the authorization of mining permits. The Bush administration allowed drilling on 130,000 acres in eastern Utah, of which many parcels are within view of scenic areas that attract visitors throughout the year. Because of the large amount of revenue brought in by extractive operations, the number of permits in Utah will continue to rise for high demand energy and mineral resources.

Nine Mile Canyon has seen an influx of industrial traffic over the last few years because rich deposits of natural gas beneath the Tavaputs Plateau were discovered. In addition, commercially important mineral deposits and other geological resources have also been discovered. BLM designated Nine Mile Canyon as a Scenic Backcountry Byway in 1990 because it contains the highest concentration of rock art sites from American Indians in North America with over 10,000 individual images. The BLM has struggled to satisfy the public with its effort to balance energy development in the canyon as well as to preserve its cultural resources. Nine Mile Canyon is on the National Trust for Historic Preservation’s list of America’s Most Endangered Places in hopes to further protect this cultural resource from damage caused by energy resource exploration and extraction. Other sensitive areas under close watch by all groups (e.g., environmental, governmental, and private) are areas around Arches National Park and Dinosaur National Monument where similar situations exist. As presidential administrations changed in early 2009, some 77 parcels near Nine Mile Canyon, Arches National Park, and Dinosaur National Monument where oil and gas exploration and extraction were leased to take place have been canceled. The government will be reviewing the environmental assessment on these parcels, which may take several years. For now, these scenic Utah parcels remain unaffected by the footprint of energy resource extraction.

Recreation

Historic Land Use

Outdoor recreation opportunities in Utah are seemingly endless; however, it wasn’t always that way. Utah’s first settlers were busy trying to make a living for their families and didn’t have much free time or income to devote to leisure activities. It wasn’t until several national parks were established in southern Utah that outdoor recreation became popular. With road improvements throughout the state, Utah’s varied scenic landscapes began to draw visitors not only from Utah, but surrounding states as well. Small cafés and hotels popped up around these areas to accommodate tourists, which brought economic benefits to rural residents that traditional industries, like agriculture, no longer could.

As Utah’s economy grew and stabilized, with population growth and the introduction of new industries, residents began to have more time for leisure activities. Jobs in service and retail industries began to flourish, including government employment related to tourism. Through the middle and later decades of
the twentieth century, Utah began to emphasize tourism and outdoor recreation as a major economic stimulant. Plentiful areas for camping, boating, fishing, hiking, mountain biking, canyoneering, horse riding, and many other opportunities are located throughout Utah and are a major draw for visitors from throughout the world. After all, Utah has the nation’s greatest concentration of national parks, 13 alpine ski resorts, the largest quarry of Jurassic Period dinosaur bones ever discovered, and unique geologic features across the state; who wouldn’t want to come and enjoy their free time in Utah?

Mountain biking and rock climbing are extremely popular in Utah.

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”.

Early visitors to Zion Canyon. (Image from National Park Service)
Current Management

Outdoor recreation has the potential to cause environmental degradation, especially in heavily used areas. However, while land managers have the directive to manage the land for multiple uses, they also have the mandate to promote conservation of the land and its unique resources. The National Park Service (NPS) is a land management agency that preserves the natural and cultural resources for the enjoyment, education, and inspiration of visitors today and into the future. This is accomplished by working cooperatively with federal, state, tribal, and local governments, private organizations, businesses, and encouraging citizen involvement in management decisions. The NPS incorporates social, economic, environmental, and ethical considerations in their decision making process and uses research and technology for new findings and to improve work practices, products, and services. By doing these things, the NPS is able to maximize visitor use without significantly degrading the resource.

Camping in designated areas protects fragile desert ecosystems. (Images by M. Larese-Casanova)

Utah is seen as an outdoor recreation Mecca, where opportunities seem endless from high alpine backpacking to boating in Glen Canyon National Recreation Area. Several areas in Utah are managed more specifically for recreation because of the heavy use they receive. One such place is Little Sahara Recreation Area which is heavily frequented by all-terrain vehicle (ATV) users and campers. Hikers and birders also enjoy the non-motorized Rockwell area for its diverse array of plant and animal life, some of which are endemic to Little Sahara Recreation Area. Giant four-winged saltbush is an endemic plant that grows in the dune fields of Little Sahara. Because this species is not found to occur naturally anywhere else in the world, land managers try to educate the public about its special adaptations and why it is important not to run it over with their ATVs or use it as firewood. However, in a place such as Little Sahara where public use is sometimes extremely high (Easter weekend generally sees some 3,000 people for a 3-day period) managing for species conservation and recreation can be difficult to do without conflict. It is for this reason that land management agencies involve public input when making management decisions. Although it is often times difficult to make both sides happy, land managers attempt to do what will be best for the resource and the user.
A tiny beetle and thousands of off road vehicles create a difficult balancing act at Coral Pink Sand Dunes State Park.

Ongoing Issues

Outdoor recreation, if unmanaged or managed poorly, can have a degrading effect on the natural environment. Off-road vehicle, bicycle, and foot traffic compact soils and can trample plant life. This is especially true when done off designated trails, resulting in the disturbance of wildlife, and destruction of soils and plant life which can lead to other environmental issues like soil erosion. These kinds of impacts generally take many years to recover naturally, especially in sensitive areas like deserts. Biological soil crusts are extremely susceptible to impacts from recreationists. The crusts provide an environment for life to flourish in the harsh desert climate. If disturbed, they cannot perform their life-sustaining abilities. Because all recreation-related impacts cannot be prevented, land management agencies strive to educate recreationists about their recreation choices and the impacts they may cause. Regular maintenance on trails and camping areas are performed on Utah’s public lands by management agencies and volunteer organizations in efforts to prevent major environmental damage; however, with the amount of use some areas receive, restoration projects are unavoidable.

Species Conservation

Historic Perspective

President Nixon stated, “Nothing is more priceless and more worthy of preservation than the rich array of animal life with which our country has been blessed,” upon signing the Endangered Species Act (ESA) of 1973. The ESA replaced the Endangered Species Conservation Act of 1969, and provided better measures for the conservation of threatened or endangered species and their habitats. Species are considered endangered if extinction throughout all or a significant part of its range is likely if left unprotected. Species are considered threatened if likely to become endangered in the foreseeable future.

Currently, there are approximately 1,900 plant and animal species listed for protection under the ESA; a vast majority of these species are found within the continental U.S. The ESA was passed because it was becoming widely understood that, because of human activity, many of our nation’s plants and wildlife would become extinct without protection. The U.S. Fish and Wildlife Service (USFWS) is widely responsible for the implementation of the ESA and enforcement of for violations. State agencies act in cooperation with the USFWS to create comprehensive management plans for endangered and threatened species within their own state. When a species meets recovery standards established by the ESA, the species is removed from the list but is monitored for 5 years afterward.
Current Management

The desert tortoise was listed as threatened under the Endangered Species Act in 1990 after high mortality rates occurred from upper respiratory tract disease in 1989. After a comprehensive review of the desert tortoise, scientists determined that long-term protection was needed due to numerous threats including loss of habitat to development, invasion of non-native grasses and weeds, wildfires, and predation. Desert tortoise populations have been in steady decline over the last several years and scientists are still learning about the relationship of these threats to population decline. More than 40 years of data show that there is not one threat that seems to impact tortoises more than another, but an accumulation of threats that drive the declining numbers.

Red Cliffs Desert Reserve was established in 1996 for the protection of vast and diverse landscapes in Washington County, Utah, which serve as high-quality wildlife habitat. This designation not only protects valuable wildlife habitat, but also protects the spectacular display of surrounding red rock outcrops from development and recreation. The Red Cliffs Desert Reserve is located in a place where three distinct ecosystems merge: the Mojave Desert, the Great Basin, and the Colorado Plateau. The reserve encompasses a rich biological array of life, including several endemic species.

One of the most endangered mammal species in the U.S. is the black-footed ferret. The black-footed ferret is dependent on prairie dogs as their primary food item, and utilizes their tunnels as shelter. A dramatic reduction of prairie dog numbers occurred from the late 19th century to the mid-20th century due to habitat destruction and extermination by humans. In turn, reduced prairie dog populations was the primary cause for the rapid decline in black-footed ferret populations. At a point when the species was considered extinct, a wild population was discovered in 1986 in Meeteetse, Wyoming. The remaining black-footed ferrets were collected and placed in a captive breeding program in order to recover the species from extinction. The recovery effort contained a six-step process that began with ensuring success of captive breeding, locating reintroduction habitat, finding other populations of ferrets, devising release strategies, managing reintroduced and other populations, and building programs for public support of the recovery effort.

Scientists estimate that more than 10,000 acres of prairie dog colonies are required to sustain a healthy black-footed ferret population; however, remaining prairie dog colonies are small and fragmented often separated by great distances. Although challenging, more than 6,500 ferret kits have been produced in captivity since 1987 and over 2,300 have been released into 15 different recovery areas since 1991. Most reintroduced ferrets have been released into experimental population areas outside of protected lands. Although the black-footed ferret is dependent upon prairie dogs, there are few protective regulations in place for prairie dogs. Farmers and ranchers still consider them a nuisance leading to them being poisoned and shot. Due to smaller prairie dog populations, the majority aren’t large or stable enough to support black-footed ferret populations. However, efforts continue and several pairs of wild-born kits have been discovered in the last few years.

Gunnison sage-grouse was added as a candidate to the Endangered Species list in 2000. Even though the grouse may have deserved a listing as an endangered or threatened species, it was determined that other species had a higher priority, which made its official status according to the Endangered Species Act “warranted, but precluded.” Seven populations of Gunnison sage-grouse inhabit Colorado and Utah with about 40% of its habitat is located on private land. Fortunately, the landowners have been active in conservation practices to benefit the grouse. Gunnison sage-grouse were removed from the Candidate list in 2005 after studies found that populations of Gunnison sage-grouse had been stable for 10 years and its habitat was sufficient to support growing populations. Furthermore, 72 landowners who own 102,000 acres of Gunnison sage-grouse habitat, had expressed interest in voluntary conservation efforts. By entering into Candidate Conservation Agreements (CCAs), arrangements under the ESA designed to prevent the need for listing through preventative conservation efforts, these private landowners work cooperatively with the Utah Division of Wildlife Resources and the Colorado Division of Wildlife to perform conservation
measures to benefit the species while still allowing them to use their land productively. These agreements also allow the continuance of informal monitoring of the Gunnison sage-grouse.

There have been 12 sage-grouse working groups established in Utah since 1998. These groups are comprised of landowners, environmentalists, scientists, and agency personnel who are working together for the conservation of Gunnison sage-grouse. Community-based Conservation Program Specialists from Utah State University Extension facilitates three of these groups in their efforts. These specialists were contracted in 2001 by the Utah Division of Wildlife Resources to guide these groups. Despite best efforts to conserve Gunnison sage-grouse populations at the state level, the species was listed in 2014 as Threatened under the ESA. While this may seem as a defeat of local efforts, the species was proposed to be listed as Endangered, but was reduced to Threatened thanks to conservation efforts.

Maintaining species diversity is a key component of maintaining healthy ecosystems. Antelope Island State Park, located in the Great Salt Lake, is a prime example of land managers striving to conserve the diversity of unique species. Antelope Island’s ecosystem has remarkable complexities that have fascinated people who have visited and studied it. Early settlers recognized its importance and, in 1893, 12 American bison, a minute fraction of the small number of remaining bison in North America, were brought to the island. The island now supports a herd of approximately 700 bison. In 1993, pronghorn were brought to the island, and in 1997 California bighorn sheep were transplanted to the island. The bighorn sheep were put on the Island in order to help restore the species to parts of Utah. The herd has grown significantly since their reintroduction, with 200 animals occupying the upland areas of the island. Antelope Island represents a natural resources management success, which created a stable, highly diverse ecosystem.

Antelope Island is home to many other mammals and birds. Although the island is small, about 27,000 acres, there is enough habitat for each species to survive and maintain genetic diversity. Antelope Island’s success is unique primarily because it is an island where natural protections, like its placement in Great Salt Lake, have provided an ideal refuge from development, and even large predators. Some smaller, older National Parks have been shown to lose more species to extinction than larger ones. Additionally, principles of island biogeography dictate that smaller, more isolated islands are less capable of supporting large, diverse populations of plants and animals. Smaller populations are less likely to survive environmental disturbances, and have less genetic diversity making them more susceptible to disease.

Ongoing Issues

Invasive species require extensive management to maintain natural ecosystems and native species that occur throughout Utah. One detrimental invasive species that is now widespread through Utah’s landscapes is cheatgrass (Bromus tectorum). This species dominates open areas, especially after disturbance (e.g., development, fire, heavy grazing). Cheatgrass has an earlier growing season, meaning that it finishes its life cycle early in the summer, allowing it to use soil moisture, grow, and produce seed before most other native grasses. During the driest parts of the summer, its fine, dry texture increases the likelihood and intensity wildfire. Subsequently, recurring short-interval wildfires helps spread and maintain cheatgrass dominance in most areas by clearing out competing vegetation. Furthermore, with each wildfire comes further loss of important browse for native wildlife because the shorter wildfire intervals don’t allow enough time for plants to regenerate. Fragmentation of plant/wildlife habitat also occurs due to cheatgrass invasion and increased wildfires through creation of habitat gaps within ranges. Active and aggressive management of invasive species along with the restoration of native plant communities is critical to decreasing the dramatic effects they have on Utah’s landscape. However, such management is expensive and labor intensive and isn’t always possible for land management agencies to perform.

Overgrazing of many of Utah’s landscapes has diminished and altered herbaceous vegetation, which has led to widespread reduction of species diversity and production. As a result, invasive species like cheatgrass have invaded and been a factor in dramatically altering natural environments. Brown-headed cowbirds, North America’s most notorious brood parasite (i.e., using other birds species as hosts for
incubating and raising their chicks) have expanded their range due to the fragmentation of forests, more open areas as habitat preference, and, especially, recurring cattle grazing. Historically, cowbirds followed migratory bison populations, eating the insects that were stirred up by the bison’s hooves, and intermittently depositing an egg in another bird’s nest. With the decline in bison and increase in more sedentary cattle, nest parasitism has increased dramatically. Brown-headed cowbirds have been recorded parasitizing up to 75% of over 220 host species nests in an area. This has resulted in lower reproductive success of certain forest songbirds and may be responsible for recent declines in population numbers.

Because federal and state agencies require funding to undertake conservation and restoration projects, the amount of work they can perform largely depends on their annual budget. Beginning a couple of decades ago, budgets for land management agencies were on a continual decline. Programs and staff had to be reduced in order for agencies to continue operating, resulting in the neglect of issues that needed attention. With continual federal budget cuts, some felt that each “budget axes forest programs, undercuts our wildlife refuges, puts programs to save endangered species under the knife, neglects the needs of our national parks, and puts a stopper in important water programs.” When presidential administrations changed in 2009, there was a turnaround as the Obama Administration allocated stimulus monies to multiple agencies to help with maintenance backlogs and the continuance of conservation projects.

Regardless of funding, species conservation and other management issues are always a challenge. Accomplishing management goals often requires cooperation not just between agencies, but also between agencies and other entities, such as conservation organizations, user groups, and individual citizens. While they may have drastically different interests, they may all share a common goal. One of the most important parts of this cooperation is to focus on the common goals that everyone shares and work toward a solution. When we think of this quote from Wallace Stegner from the beginning of this book, hopefully it all makes sense...

"Angry as one may be at what careless people have done, and still do, to a noble habitat, it is hard to be pessimistic about the West. This is the native home of hope. When it finally learns that cooperation, not rugged individualism, is the pattern that most characterizes and preserves it, then it will have achieved itself and outlived its origins. Then it has a chance to create a society to match the scenery."

Selected References and Readings


Changes in Utah’s Rangelands Over Time http://extension.usu.edu/rra/


Introduction to Rangelands - Utah Rangelands http://extension.usu.edu/rangelands/htm/intro-rangelands


Trust for Public Lands - Utah http://www.tpl.org/tier2_rl.cfm?folder_id=675

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Utah Grazing Lands Conservation Initiative http://www.usu.edu/utahglci/grazing.htm

Utah Department of Agriculture and Food - Utah Grazing Improvement Program
http://www.ag.utah.gov/animals.html?id=273:grazing-improvement&catid=64
Utah State and Institution Trust Lands Administration https://trustlands.utah.gov/
Virtual Utah http://earth.gis.usu.edu/utah/index.html
Watershed Restoration Initiative https://watershed.utah.gov/
Stewardship

What is Environmental Stewardship?

The literal definition of a steward is “one who manages property or affairs for someone else.” How does this definition apply to environmental stewardship? When considering the effects of land use, it is important to include all components together as a whole: the land and the resources and people that occupy the land. Aldo Leopold believed that human benefit, economic benefit in particular, was the primary driving force behind land use. This can be summed up in the following quote:

“We end, I think, at what might be called the standard paradox of the twentieth century; our tools are better than we are, and grow faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in history; to live on a piece of land without spoiling it... [Q]uit thinking about decent land use as solely an economic problem. Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong otherwise.”

One should accept the intrinsic value of all resources on the land:

“A land ethic of course cannot prevent the alteration, management, and use of these 'resources,' but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state. In short, a land ethic changes the role of [humans] from conqueror of the land-community to a plain member and citizen of it.”

Considering Our Own Resource Use

There are countless ways for us to think about, and be more efficient in, our use of natural resources. Living in a desert climate, our most important resource is water. You’d be surprised by how many aspects of our lives use and depend on water or affect water resources in some way.

Living in Utah, we all know that scarce water and high evaporation are great reasons to conserve water in our landscapes. That doesn’t mean a yard full of rocks and cow skulls, though! We can have yards with beautiful native and ornamental plantings and still conserve water, as long as we are putting some thought into it. There are several organizations, such as slowtheflow.org or the Center for Water-Efficient Landscaping, that can help you select beautiful, well-adapted plants and design a landscape that will not only look great, but also fit into Utah’s desert climate.

There are many things that we take for granted that can affect the natural world. Our travel or transportation patterns can have a great impact on natural systems, from harmful vehicle exhaust to contaminant buildup next to roads. Exploring the ideas of carpooling or using mass transit will not only help to reduce air pollution, but could also save us money, gas, and possibly time. Do you like to travel to exotic locations when you vacation, or do you stay close to home? Even how we travel by vehicle or on foot while we are in deserts has a dramatic effect on desert ecosystems. Staying on dirt roads and established trails minimizes our impact on fragile desert soils.

There is a lot to think about when we begin to consider how we use natural resources. The important thing is to address this issue at your own pace and start out with solutions that are easy to implement.
Being an Active Citizen

It was Edward Abbey who said “sentiment without action is the ruin of the soul”. There are many important ways in which we can do something. Stewardship can be promoted by educating not only others, but also ourselves. It is great to be an educator, but we can all start with our personal lives. We cannot begin to promote stewardship to others unless we have a better understanding of our own resource use. We should always ask ourselves where our resources come from, how much we are using, and if there is a way to conserve resources more wisely. Once we have made the change within ourselves we can then begin to empower others to do the same.

Showing your support for sustainable natural resource management can include everything from planting a waterwise landscape with habitat for songbirds to participating in a larger volunteer project to restore bird habitat. There are also several agencies and organizations, such as the Utah Division of Wildlife Resources and Utah State University Water Quality Extension, have developed citizen monitoring programs. These programs are excellent venues for applying knowledge and working with (and learning from) resource professionals. Monitoring can also include something as simple as recording seasonal observations of songbirds in your backyard and entering observations into eBird.

Volunteering is one of the most effective ways to promote stewardship. Our commitment of time to a person, project, or organization serves as an example of our unending desire to help others understand, appreciate, or manage Utah’s natural world.

“Never doubt that a small group of committed people can change the world. Indeed, it is the only thing that ever has.” - Margaret Mead

Promoting Stewardship in Our Professional Lives

Many of us work or volunteer as educators or land managers, so it is important to discuss some ideas to consider in our professional lives if we’re going to be effective stewards. Balancing use and resource protection is critical for ensuring a sustainable operation, for protecting wildlife and habitats, and for ensuring a high-quality experience for our audience.

Essentially, this means we need to plan for what, how, and how much in regard to resource use. How these decisions are made will influence the impacts on the environment and the type of experience that we might provide to our audience, from school children to park visitors. As individuals, we can influence planning decisions by becoming involved on committees, planning boards, and as voters.

Site Planning

In terms of planning for or managing a site for visitors, our first priority is protecting our sites from degradation. Recognizing impacts to the natural areas we manage, such as changes in plant communities, erosion, and declines in wildlife sightings, is critical for planning how to reduce those impacts. This step is just as critical to a neighborhood park as it is of a preserve that is thousands of acres in size. If we notice negative impacts, let someone in charge know about it.

What about when visitors leave our sites? Educating visitors to the potential impacts of offsite practices, such as nutrient loading from residential areas or the negative impacts of non-native plants and animals on natural communities, can help them recognize potentially damaging behaviors. An informed public is also better equipped to participate in decisions regarding land use strategies and ensuring development in Utah incorporates conserving natural areas as a high priority.

Remember that on a regional basis, we are all in this together. For that reason, we should promote other responsible nature-based opportunities - by doing so, we promote and reward good land stewardship and responsible behaviors to the benefit of nature.
Limiting Inappropriate Behavior

Informing persons about appropriate behavior can be a delicate topic. There may be times, such as the beginning of a tour, when we need to inform people about behaviors we expect them to observe ("Kids, we need to stay on the trail"). Likewise, there may be times when we need to explain to someone that his or her actions are not appropriate ("Ma’am, picking wildflowers within the park is prohibited"). To reach our audience with messages regarding ethical behavior, we need to be tactful and respectful. It is our responsibility as naturalists to inform people of the potential consequences of inappropriate behaviors, and to provide explanations that place these behaviors in perspective. In other words, an explanation can go a long way to helping people understand and support appropriate behaviors.

More often than not, people don’t recognize their actions as harmful. For example, prohibiting the picking of a single flower in a park when those same flowers can be seen growing along any roadside ditch seems a bit absurd to most people. However, this seems less absurd when one considers the potential cumulative impact of dozens or hundreds of visitors picking flowers along the trail each day. So, we should try to deliver our message in a straightforward and friendly manner and we will probably find that most people appreciate the information, rather than resent it.

Considering All Points of View

Living in a sustainable society that conserves biodiversity and wild places, that maintains important ecological functions and services, and that leaves a legacy of responsible environmental stewardship for future generations to enjoy is an admirable ethical goal. How we accomplish this goal, however, is not easily resolved when decisions are being made that affect individuals and communities. Often these issues are described and argued in terms of "rights."

There are many perspectives on the issues of rights. Discussing these perspectives is often contentious because of their respective consequences. Consequently, discussions regarding issues that affect the rights of plants and animals, individuals, society, and of future generations are neither straightforward nor easily resolved, but need to be considered. Regardless of the position taken, an ethical approach will consider and attempt to balance the element of fairness for all stakeholders, including future generations.

The policies and philosophies we support at local, state, and national levels ultimately influence the outcome of these issues and their collective effects on the environment at scales that range from local parks, to regional strategies for maintaining wildlife corridors, to the debate on global warming. Ultimately, these decisions will weigh heavily not only on the type of world we live in, but in the world that future generations inherit and the manner in which that world will nourish those generations, both in terms of food and soul.
Stewardship in Our Personal Lives

Sharing our knowledge with others can take one of many forms. Not all of us are trained or employed as educators. Our knowledge can be shared with colleagues via discussions, reports, or management plans. We can also share our knowledge with others while volunteering on a restoration project. We can even share our knowledge with friends and family while on a leisurely hike through the woods. Sharing knowledge and passion doesn’t have to be planned and doesn’t have to be a lesson.

Every educator is a role model to his or her students. Many students, especially children, learn by example. Because children are incredibly perceptive, we must be sure we truly believe in what we are teaching prior to teaching it to students. In leading by example, educators have the great opportunity, and responsibility, of making the connection between ideal and reality.

By serving as a role model and sharing our knowledge with others, we will promote environmental literacy and, ultimately, greater stewardship of Utah’s natural world. One thing is for certain: by participating in the Utah Master Naturalist Program, we haven’t learned all we need to know. Truly being a “Master Naturalist” requires a lifetime of exploring and learning! While our knowledge will always increase with effort, we will never know everything. We are people whom others will know have not only gained a wealth of knowledge related to Utah’s natural world, but have also made a commitment to taking steps in our lives toward being effective stewards.

There is no standard way that someone should be a steward. There is a lot to think about, and it all takes time to sink in. But, it gets easier! As we think more and more about the impacts that we have, and can have, on Utah’s natural world, it will eventually become part of the decisions we make in our everyday life. Most importantly, we should have fun! Being a Utah Master Naturalist should not feel like it is a chore. Promoting stewardship should be something that we want to do, something that we find a way to do even if in some small but personal way. This idea of promoting environmental stewardship through literacy is best summed up in another quote from Aldo Leopold:

“When we see the land as a community to which we belong, we may begin to use it with love and respect.”

Most people can say they love themselves, their family, their friends, and perhaps their community. Remember that environmental stewardship requires expanding the idea of one’s community beyond the human component to include the soils, waters, plants, and animals. Before doing this, we must first understand the land where we live. We must become environmentally literate citizens, and education is the essential key to achieving this.

*Thank you for participating in the Utah Master Naturalist Program! Congratulations on completing the course and may you continue to enjoy exploring, learning about, and conserving Utah’s amazing natural world!*