Rocky Mountain

National Park Service
U.S. Department of Interior
Rocky Mountain National Park

Winter Ecology Teacher Guide

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Rocky Mountain National Park

Rocky Mountain National Park (RMNP) is defined by the rugged Rocky Mountains that cut through the heart of the park from north to south. These mountains have shaped the landscape and created the conditions for the ecosystems we find within the park. Three of the park's ecosystems, the montane, subalpine, and alpine tundra are delineated by elevation, with the montane ecosystem comprising the lowest elevations in the park (5,600 – 9,500 ft.) and the alpine tundra ecosystem comprising the highest elevations in the park (11,000 – 14,259 ft.). This fragile alpine tundra, which comprises 1/3 of the park, is one of the main scenic and scientific features for which the park was established and is one of the largest and best preserved examples of this ecosystem in the lower 48 states.

Environmental Education was formalized at RMNP with the inception of the Heart of the Rockies program in 1992. Our curriculum is built on the principles of RMNP's founding father, Enos Mills. Mills felt children should be given the opportunity to explore and learn in the outdoors for nature is the world's greatest teacher. A belief that is kept alive today through every education program.

RMNP was established on January 26, 1915 through the efforts of local residents, especially Enos Mills, Abner Spague, and F.O. Stanley. Today the park covers 415 square miles of beautiful terrain, most of which is designated Wilderness.

Lessons Written and Compiled By
Rocky Mountain National Park Environmental Education Staff

Teacher Guide Created by Nicole Wardo 4/2013

Teacher Guides

Teacher guides have been developed by the education staff at RMNP and each focuses on a topic of significance to the Park. These guides serve as an introductory resource to the topic and the information provided is used by park educators to develop curriculum based education programs. Guides benefit teachers by providing the background information necessary to build a strong foundation for teaching students about specific park related topics; they may also be used as a resource for preparing students for field trips to RMNP. Each guide contains a resources and references section to provide for more in-depth study.

Rocky Mountain National Park Education Program Goals

1. Increase accessibility to Rocky Mountain National Park for students from our gateway communities and under-served students who otherwise would not have the opportunity to visit the park.

2. Develop a variety of internal and external partnerships with other park operations, school districts, universities, professional educational organizations, agencies, friends groups, and various funding organizations.

3. Conduct workshops to train teachers to take a larger role in their student's experience at Rocky Mountain National Park.

4. Develop distance learning opportunities to serve students from outside our visiting area.

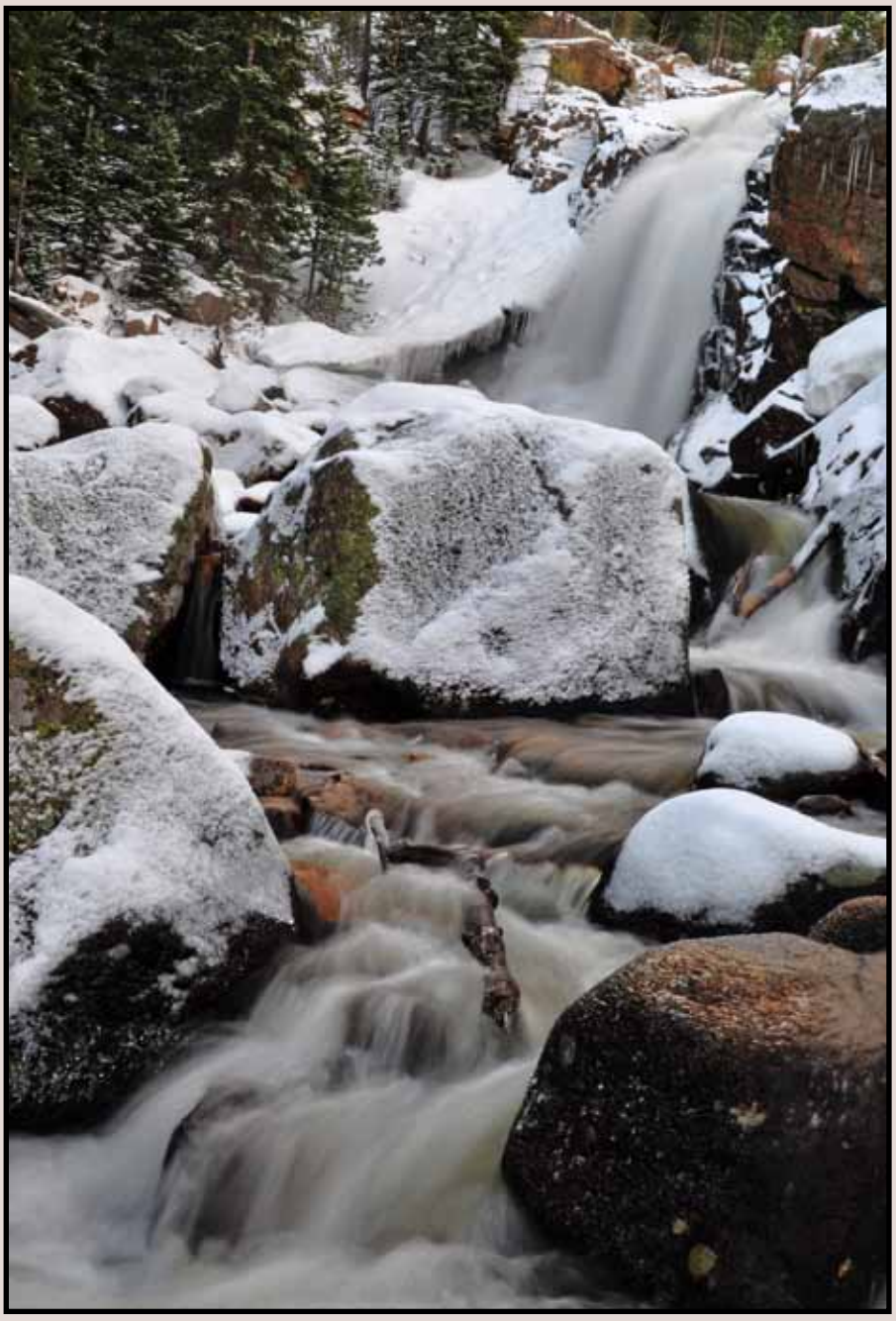
Schedule an Education Program with a Ranger

Field trips to national parks offer unique opportunities for studying and experiencing natural and cultural resources. Field trips are a great way to make abstract concepts from the classroom concrete. RMNP is an ideal outdoor classroom. It has a diversity of natural resources, easy spring and fall access, and is in close proximity to Front Range and Grand County communities.

Rocky Mountain National Park, like many national parks, offers ranger-led education programs. Heart of the Rockies, Rocky's education program, provides free field and classroom based education programs, aligned to Colorado education standards. School groups should make reservations at least 6 months in advance. National Park entrance fee waivers may also be available for school visits. For further information or to schedule a program please contact Mark DeGregorio, Education Program Manager, at (970) 586-3777.

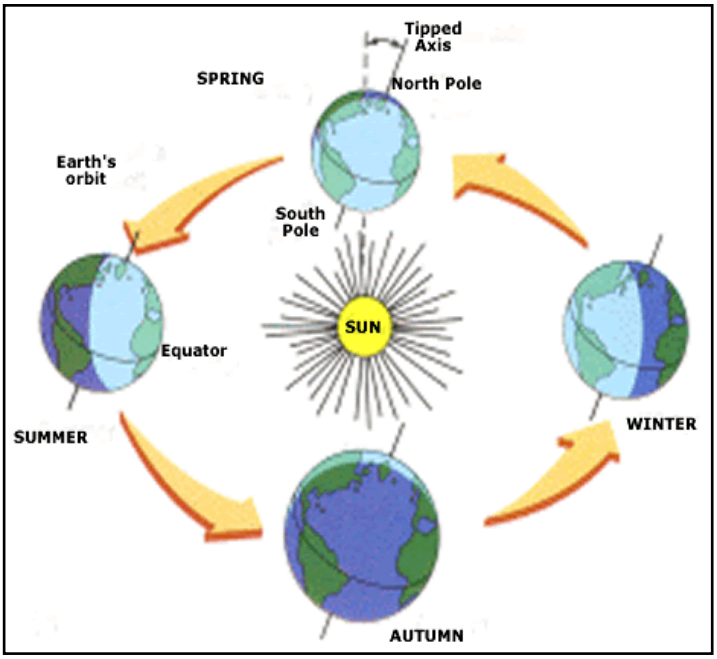
A variety of ranger-led education programs are offered seasonally. Programs in the spring and fall are generally similar focusing on a variety of park topics; programs in the winter are limited to snowshoeing programs and classroom programs focusing on winter. To see a list of the latest available programs please visit http://www.nps.gov/romo/forteachers/planafieldtrip.htm.

Winter Ecology
Background Information



Introduction

Winter is the longest season in Rocky Mountain National Park (RMNP) lasting up to seven months in some ecosystems. Winter is characterized by cold temperatures and wind chills, short days, low light, and slow growing seasons. These characteristics can prove very challenging and make winter the most difficult season for plants, animals, and humans. Scientists refer to these challenges as the five vectors or SCREW factors of winter: snow, cold, radiation, energy, and wind. Each vector requires consideration for humans recreating in winter and preparation for plants and animals in order to survive.



Each year the winter solstice, the shortest day of the year, officially marks the start of winter. The 23.5° tilt of the earth on its axis is the reason seasons occur in the northern and southern hemispheres; as the earth rotates around the sun, different areas receive more direct sunlight. Consider North America in the summer, it is tilted toward the sun and therefore receives more direct rays creating warmer temperatures and longer days. During winter, though earth is closer to the sun, the tilt is at a lesser angle which allows more diffused light from the sun to reach the northern hemisphere resulting in colder temperatures, less light, and therefore shorter days.

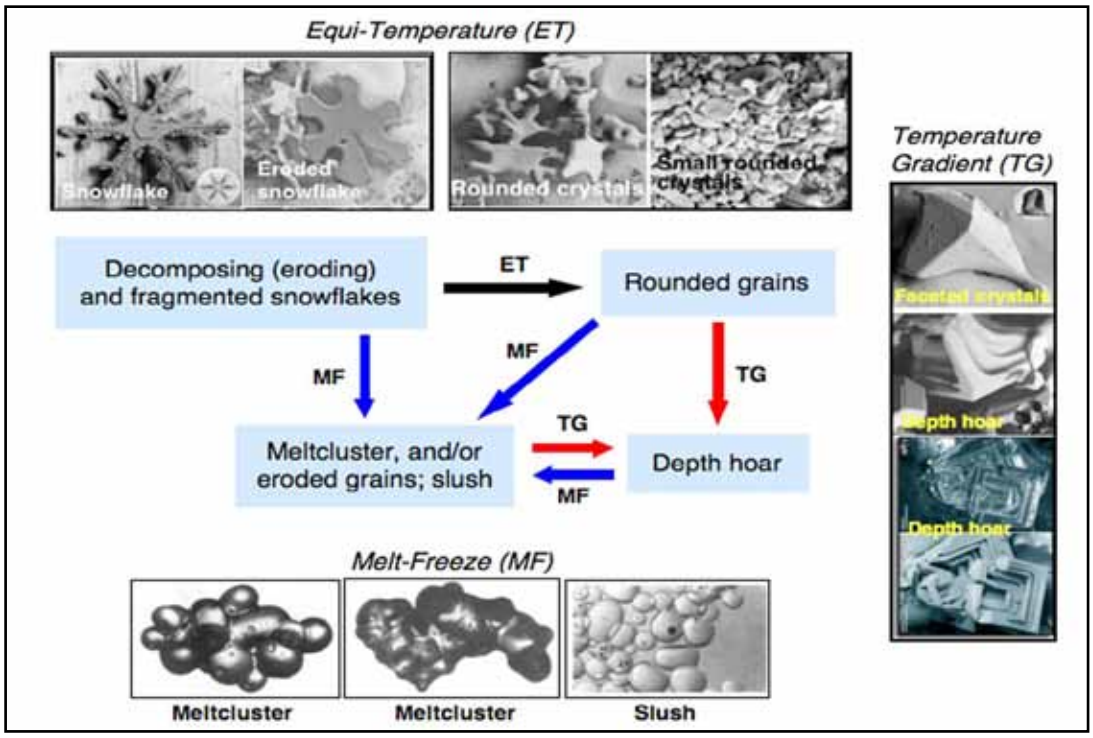
The Continental Divide runs northwest to southeast through the center of RMNP and helps to create two diverse climate patterns. The range of altitudes within the park is responsible for the varying climates; as elevation increases, temperature decreases causing a change in the environment. The Continental Divide creates what is referred to as a rain shadow effect, a dry area on the leeward side of the mountains, which greatly influences climate in the park. As warm moist air travels from the west side of the park and is pushed by the predominant winds toward the top of the mountains, it condenses and precipitates before it passes over the top of the divide. Then the air, now lacking moisture, travels toward the east side of the park creating a drier climate.

Snow

How does snow form?

Although snow is a challenge of winter, it is also an important component of the ecosystem and an important resource for the flora and fauna of the park as well as humans. Understanding snow is an important part of understanding the ecology of winter and the ecology of RMNP. When a cloud becomes colder than 15°F, the droplets of water freeze onto bits of dust forming ice crystals.

Temperature, air currents, and humidity all influence the shape and size of ice crystals; therefore, each ice crystal has a unique shape which is dependent upon those factors as it passes through the atmosphere. When the crystals become too heavy to float in the cloud, they fall as snowflakes, changing many times as they collide, stick together, and pass through different air temperatures and moisture levels. As the ice crystals pass through the atmosphere, they may come in contact with warm air, creating a slight melting affect, or cooler air which causes the crystals to grow slowly. Ice crystals bond together into larger fluffy flakes with the presence of higher temperatures and increased humidity; however, if the crystals melt too much and refreeze the precipitation will fall as sleet instead of snow.



Snowpack

Winter snowpack is constantly changing since snow does not stay the same once it falls to the ground: various factors and environmental conditions influence snowpack. As new snow falls throughout the winter season, old snow undergoes metamorphosis due to environmental factors such as weather, wind, melting, and soil temperature. The resulting snowpack is a combination of layers varying in hardness, cohesion, and strength causing distinction between the layers. The influence of these environmental factors most often causes snow to go through three types of metamorphosis:

Equi-Temperature: This metamorphosis occurs when the temperature is almost the same vertically throughout the snowpack; this is also referred to as isothermal. Changes in this snowpack occur when snow remains cold and temperatures stay near freezing – this causes snow to become dense, harden, and shrink. Crystals in this layer are eroding or fragmented, but can be characterized by their typical snowflake appearance with hexagonal structure and rounded edges.

Melt-Freeze: This change happens during conditions of periodic melting and freezing. As snow melts on the surface water percolates down through the snowpack and refreezes when the temperature dips below freezing; snowpack may be weakened during melting and strengthened during freezing. Crystals in the Melt-Freeze layer will appear rounded and begin to form clusters and have a slushy texture.

Temperature-Gradient: The most common snow metamorphosis in RMNP, Temperature-Gradient, takes place when the temperature within the snowpack fluctuates dramatically from top to bottom. Radiant heat from the ground rises through the snow causing sublimation which produces large loose crystals with angular corners, similar to a cube. This unbound snow is often referred to as sugar snow, corn snow, or depth hoar.

Watershed and SNOTEL Sites

Snowpack is Colorado's key water reservoir because it traps water in a frozen state and slowly releases it throughout the year; however, the air content in a layer of fresh snow can be as much as 97%, providing little to no usable water. If all precipitation came in the form of rain, the water would quickly be lost to ground infiltration and flooding; in Colorado 80% of all precipitation evaporates, sublimates, or transpires from plants.

The snowcapped view from Trail Ridge Road of Forest Canyon below where the headwaters of the Big Thompson River begin.

Since snowpack is an important resource for RMNP and the state of Colorado, scientists track the amount of usable water within the snowpack. This is known as the Snow Water Equivalent (SWE). If scientists know the depth of snow, its weight per unit volume, and the density of water they can calculate the water content of the snow. The SWE is significant to scientists because it enables them to track changes in snowpack over time and therefore changes in climate, as well as immediate information/projections pertaining to communities affected by the watershed.

Colorado Site - Bear Lake (322)

(As of: Thu Apr 18 14:11:51 CDT 2013)
Provisional data, subject to revision

Date	Snow Water Equivalent (in)	Snow Depth (in)	Year-to-Date Precipitation (in)	Observed Temp (degF)	Max Temp (degF)	Min Temp (degF)	Avg Temp (degF)
2013-04-11	11.1	41	13.3	22	35	20	29
2013-04-12	11.2	40	13.4	29	42	28	32
2013-04-13	11.3	39	13.5	29	44	23	34
2013-04-14	11.8	45	13.8	23	25	17	21
2013-04-15	12.0	46	14.1	22	22	15	20
2013-04-16	13.6		15.6	15	25	9	20
2013-04-17	14.0	64	16.3	18	22	0	15
2013-04-18	14.5	67	16.8	0			

Pertinent snowpack data is gathered from numerous SNOTEL (snowpack telemetry) sites located in thirteen western states and managed by the Natural Resources Conservation Service; since 1983 RMNP has managed one of 114 SNOTEL sites in the state of Colorado. The park's SNOTEL site is located at Bear Lake and records daily snowpack and weather data. The data gathered from the SNOTEL sites include the snow water equivalent, snow depth, year-to-date precipitation, wind speed, and current temperature as shown in the table above.

For more information on SNOTEL sites in Colorado visit: http://www.wcc.nrcs.usda.gov/snow/.

Animal Adaptations in Winter

Animals that spend all winter in the park make changes to their behavior and bodies in preparation for winter. There are two environmental cues which trigger physical and/or behavioral changes in animals in preparation for winter: photoperiod (day length) and average daily temperature. Ecologists have found animals respond to these environmental cues in three different ways.

The arrival of Western bluebirds marks the first sign of spring in RMNP.

Chionophiles, from the Greek word meaning snow loving, are animals which thrive in cold and snowy climates. Chionophiles found in the park include snowshoe hares, ptarmigan, and long-tailed weasels because they have specialized adaptations to help them endure the harshest environmental conditions.

Chioneuphores, from the Greek word meaning snow tolerating, do not have definite adaptations for life in the snow. Examples of these animals in the park include coyotes, mule deer, and fox since they will change their behavior in order to survive.

Chionophobes, from the Greek word meaning snow fearing, are not able to adapt to snow and are most commonly found in warmer regions during the winter. These include migrating animals in the park such as broad-tailed hummingbirds and mountain and western bluebirds.

In simple terms, animals use three basic strategies to survive winter: hibernate (torpor/dormancy), migrate, or tolerate (stay active and adapt).

Hibernation

Animals that spend winter in the park but are inactive are considered dormant. There are two ways to classify dormancy: hibernation is considered a prolonged state of dormancy, whereas torpor is characterized by short periods of inactivity. For example, during times of exceptionally cold weather animals such as raccoons, skunks, and black bear will experience periods of torpor (lasting anywhere from twenty-four hours to a few weeks) enabling them to slow their metabolism and reduce their body temperature in order to conserve energy. However, other animals such as the yellow-bellied marmot are true hibernators, entering into a physical state during which their metabolism slows, they do not eat, drink, or defecate, and body temperature lowers significantly to survive through months of inactivity. A marmot's body temperature may drop as low as 37°F and heart rate can decrease to fewer than five beats per minute during the peak of hibernation. During this state minimal energy is expended, and the animal's layers of brown fat (a special layer of fat which generates body heat by its ability to convert blood to sugars quickly) usually meets their body's minor demands.

A yellow-bellied marmot enjoys the view and sun bathes on an alpine rock outcrop.

Migration
Migrators leave a habitat with undesirable conditions to find one desirable for the winter. The trigger may be local climate, availability of food, or reasons related to mating. Birds such as the western tanager and rufous hummingbird are icons of migration in RMNP; however, there are two types of migration. Most often the classic example of horizontal migration comes to mind – birds migrate south to a warmer climate during winter where their food source is abundant and conditions are not as harsh. In contrast, vertical migration takes place when a species moves up or down in elevation. For example, during the summer in RMNP elk herds reside in the alpine where food is abundant in moist grassy meadows, temperatures are cooler than at lower elevations, and predators are scarce. In autumn, elk herds begin migrating to lower elevations such as the montane ecosystem where they complete their mating ritual and reside at an elevation where conditions are less harsh and where greater food resources can be found. This is known as vertical migration.

Large reserves of energy are needed to complete migration patterns and animals often compete against other species for resources once they arrive to their wintering destination. This strategy of coping with winter can cause an immense amount of strain on species in the park.

A herd of elk that are spending the winter in Moraine Park graze on more woody fibrous vegetation to get through the winter months, switching from an herbaceous diet in the spring and summer.

Toleration
Species in RMNP that tolerate winter are affected in different ways by the properties of snow layers and snow depth. Though many animals in the park are adapted to tolerate winter, snow can serve as a help or hindrance by influencing movement and food storage/availability.

Snow layers can be broken into three different zones based upon the Latin word nives meaning snow: supranivean, intranivean, and subnivean.

Supranivean Layer
The supranivean, meaning on top of the snow, is the most commonly used layer of snow since it is the surface layer. The properties of the supranivean layer can directly affect tolerator species in the park.

Consider a top layer of snow that is deep and airy, in contrast to a compacted top layer of snow. Animals such as fox, coyotes, and mule deer are not well adapted for movement in deep airy snow – the distribution of their body weight and small surface area of their feet mean movement is not efficient and can make catching prey difficult. However, animals such as the snowshoe hare are specifically adapted to move across deep airy snow effortlessly because of their light body weight and feet which are built to distribute weight evenly across the snowpack.

Snowshoe hare in winter fur.

Animals that make their home in this layer of snow are masters of evading predators and finding shelter from cold temperatures, snow, and wind. Living on top of the snowpack means animals need to adapt to a constantly changing environment and seek shelter from harsh conditions in rock formations, evergreens with low growing branches, brushy undergrowth, and tree wells. Several subalpine tolerators such as the snowshoe hare, long-tailed weasel, and ptarmigan grow extra fur or feathers and molt to white from shades of brown in winter allowing them to camouflage with the snow and hide from predators. Stimulated by change in day length, it can take up to ten weeks in the fall and spring for the molt to occur.

Ecologists classify animals that move on the surface layer of snow into three categories of track patterns: walkers, hoppers, and lopers. When recreating in winter, knowing these simple classifications can be helpful in basic animal track identification.

Winter Track Patterns

Walker	Hopper	Loper
		
Animals include: mule deer, coyote, mountain lion	Animals include: snowshoe hare, pine squirrel	Animals include: long-tailed weasel, pine marten, deer mouse

Intranivean Layer
Intranivean, meaning within the snow, is utilized as a reservoir for water storage and serves as an important layer for insulating understory plants. Under substantial snow cover, the ground surface usually remains unfrozen. As snow covers plants and drifts against the trunks of trees, it protects plants from cold temperatures, wind, and predators. Snow will insulate the next year's buds, bulbs, and roots locking in valuable moisture and preparing plants for spring.

Subnivean Layer
The subnivean layer, meaning under the snow, is the layer in the snowpack where the snow meets the ground. This layer of snow experiences sublimation as radiant heat rises from the ground and therefore produces large loose crystals. The unbound snowpack serves as an important habitat ideal for small mammals such as deer mice and voles since the layer is easy to move through. This bottom layer of snow provides protection from predators and insulation, even in the coldest temperatures the subnivean realm stays a consistent 32°F.

Although snow serves as both a benefit and disadvantage to various life forms in the park, it is important to note all the animals who winter in the park are specifically adapted to live with snow and it plays a part in their survival. Snow is an invaluable resource and its absence could affect their ability to survive.

Plant Adaptations in Winter

The flora of the park also have developed many adaptations to help them survive harsh winter conditions in the Rocky Mountains. Near the end of summer and beginning of fall, plants begin to prepare for the winter months. Perennials such as rose crown, lupine, and the pasque flower survive winter; the above ground portion of the plant will die back each year, but they retain an active root system through the winter, protected by layers of snow, and the plant is able to grow back in the spring. The common evening primrose, red clover, and western wallflower are all biennials in the park; during the first winter they will die off, retaining an active root system, and come back for a second growing season, producing seeds to ensure survival. Annuals in the park, such as moss gentian, have only one growing season which means they will produce many flowers and seeds which fall to the ground and germinate the next year. These specific plant characteristics and adaptations are influenced by the seasonal variations in climate as well as habitat which all comprise individual plant phenology.

Rose crown growing near Thunder Lake.

Deciduous Trees

As the photoperiod becomes shorter, deciduous trees, such as aspen and cottonwood, and woody shrubs, such as willow and wax currant, go into a state of dormancy to avoid unfavorable winter conditions. With the decrease in day length, cooler temperatures, and conditions similar to drought (water is not readily available since it is mostly in a frozen state) growth is impeded. To conserve energy, deciduous trees and shrubs change the color of their leaves as chlorophyll is transferred and eventually shed them in response to the environmental conditions. To conserve moisture after the leaves shed, leaf scars begin to harden and fill with a corky substance called suberin, a waterproof material that heals and protects the leaf scar. While losing leaves may seem costly, deciduous trees have a few ways to maximize the benefits: available nutrients are moved from the leaves and stored in the root system for the next growing season, and fallen leaves serve as mulch, surrounding the tree in nutrient rich soil.

Evergreen Trees

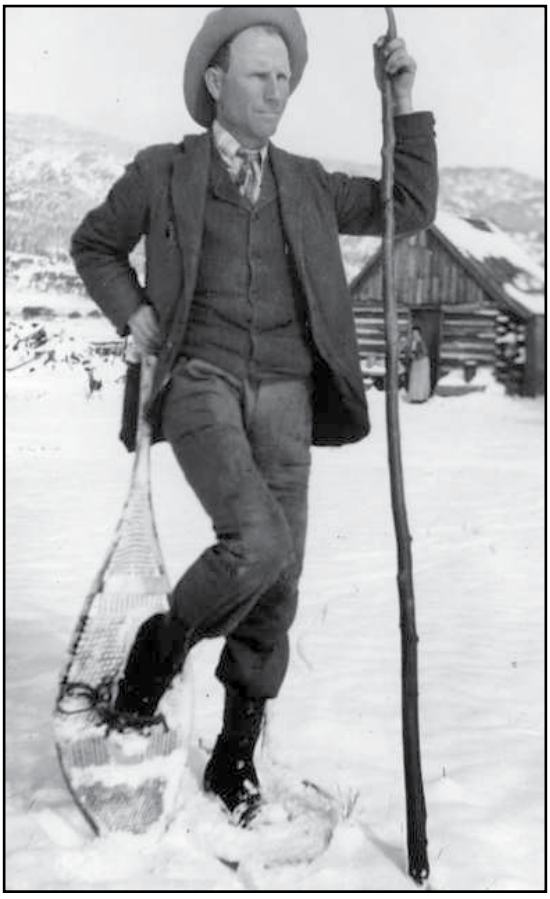
In contrast, evergreen trees such as lodgepole pine and subalpine fir have needle-like leaves, produce cones, and do not lose their leaves in the fall. Pine, fir, and spruce trees have a tapering shape which enables them to easily bear snow by distributing weight evenly among the branches. Not only does branch distribution help shed snow, needle shape is imperative in winter as well. Consider their thin needle-like shape, in contrast to the broad flat shape of the leaves of deciduous trees: needles are modified leaves which improve the ability of the tree to shed snow. Evergreen needles also have a thin waxy coating which enables the tree to conserve moisture instead of losing it to evaporation from the harsh winter winds. Some evergreen trees such as the limber pine, the only five needle pine in RMNP, contain a substance in their sap similar to antifreeze. These antifreeze proteins prevent ice crystals from forming in the extracellular spaces enabling the tree to keep the nutrients transported by the xylem and phloem moving throughout the tree. All evergreens enter a state of dormancy during winter where growth is curtailed; however, they do continue to photosynthesize even in the coldest of temperatures.

Heavy, spring snow blankets the evergreen trees in RMNP on a winter day.

The flora of RMNP depend on snow for winter survival. As snow accumulates over the course of the winter, the ground surface typically remains unfrozen. Snow will cover plants, roots, bulbs, and next year's buds, as well as drift against the trunks of trees. Snow is imperative for their survival since it prevents them from drying out and protects them from subzero temperatures and wind.

Human Adaptations in Winter

Over the years, humans have developed many strategies and adaptations to survive harsh winter conditions. Historically, the story of winter survival for humans is one of migration and toleration. Native American tribes such as the Ute and Arapahoe followed the seasonal migration of animals from the area which is now RMNP to the Great Plains during the winter months; this nomadic lifestyle enabled them to have an abundant food resource and seek shelter from the harsh Colorado winters.



Enos Mills, one of the founding fathers of RMNP, is pictured snowshoeing near his mountain cabin.

Today, humans are able to preserve and transport food to grocery stores, and lifestyles are more sedentary with permanent homes. Though clothing is still made from natural materials such as silk, leather, down feathers, cotton, and wool, synthetic materials have become more popular especially for winter survival. Synthetic materials such as polypropylene, polyurethane, capilene, GORE-TEX, and polyester have become more popular since technology has advanced to allow them to be light weight, but more importantly clothing made from these materials has the capability of wicking moisture, protecting against UV rays, and providing breathability (which prevents warm air generated by the body from becoming trapped). Undoubtedly human adaptations in winter will continue to evolve, but perhaps one of the best examples of ingenuity is the development of a particular mode of travel across the snow: the snowshoe.

History of Snowshoes

One of the earliest modes of travel across the snow were snowshoes; they have been used for thousands of years, making snowshoes/skis one of man's oldest inventions. Early hunters who needed to feed their families through the winter observed the feet of animals, such as snowshoe hares, that were able to travel easily through deep snow and tried to mimic them for themselves. Current research indicates snowshoes were developed in central Asia 6,000 years ago; as people migrated from east to west, they brought snowshoes with them. Adaptations were made along the way for different snow conditions: those who migrated to northern Europe and Asia eventually developed the ski, and those who crossed the Bering (Aleutian) Land Bridge into North America eventually adopted the snowshoe.

Snowshoes were once the main mode of travel used in North America, and the first snowshoes were nothing more than bent twigs with rawhide lacing. Ash became the wood of choice since it's a hardwood which can bend easilywithout cracking or breaking; however, birch, willow, and aspen were used to make snowshoes as well. In Colorado, Native Americans used snowshoes to hunt bison on the plains in winter. Hunters, trappers, surveyors, prospectors, explorers, and anyone needing to cross the country used snowshoes – they played an important role in taming the west.

While snowshoes were initially a tool for survival, their function began to change during America's Industrial Revolution. By the late 1800's, snowshoes began to be seen as a means of enjoyment, rather than survival. The first snowshoe clubs were founded in Canada and the northern United States in the late nineteenth century. Today some modern snowshoes are similar to the traditional wooden frames, but most are made of lightweight material such as aluminum, plastic, or synthetic fiber.

In RMNP, snowshoeing and cross-country skiing are popular recreational activities during winter because it's a wonderful way to explore and get a great workout. Snowshoeing can burn between 350-650 calories per hour – twice as many calories as walking.

For the most latest information on winter trails and trail conditions in RMNP, please visit: http://www.nps.gov/romo/planyourvisit/trail_conditions.htm.

Recreating Safely in Winter

Before embarking upon any adventure in the backcountry, especially during winter when conditions can change quickly and daylight hours are limited, it is important to be prepared. Preparedness in the backcountry is a key component of staying safe. Park rangers and many others skilled in outdoor survival refer to the crucial items that should be carried in the backcountry at all times as the Ten Essentials. The purpose of these essential items is to enable an individual to respond to an accident or emergency successfully, and be able to spend an unplanned night (or more) in the backcountry. The Ten Essential items include:

- Fire (flint and fire starter)
- Navigation (map and compass)
- Extra food and water
- Emergency shelter (emergency blanket or tarp)
- Knife/multi-use tool
- Sun protection (sunglasses, sunscreen, chapstick, etc.)
- First aid kit and duct tape
- Extra clothing
- Signal (whistle, bright colored clothing or mirror)
- Illumination (flashlight/headlamp)

Students explore the winter world of the park while snowshoeing near Bear Lake.

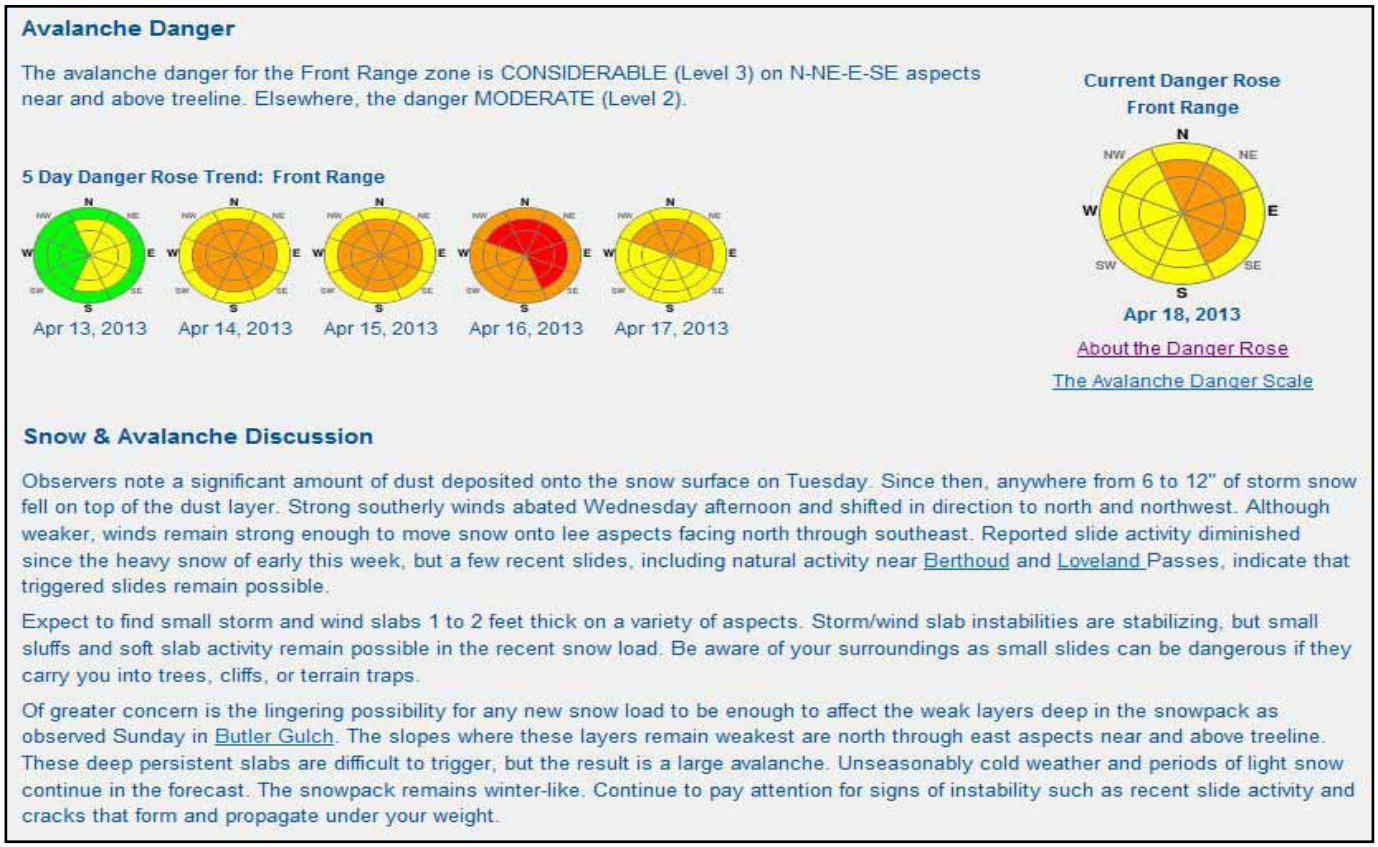
Along with the Ten Essentials, it is important to be prepared for backcountry travel in the park in all types of weather and conditions. Winter conditions can change rapidly and in unforeseen circumstances knowledge of these conditions is imperative.

Avalanches

An avalanche or snowslide can be defined as a mass of snow sliding down a slope; an estimated 20,000 avalanches occur in Colorado every year, having a variance of severity. The Colorado Avalanche Information Center (CAIC) classifies avalanches into two types: loose-snow and slab. Loose-snow avalanches, also known as point-releases, are characteristically small in size and occur when the surface snow isn't very strong and loses or lacks cohesion. These commonly occur in the spring as the surface snowpack quickly warms and loses strength. Almost all avalanches that cause injury or damage are slab avalanches. These quickly move large amounts of snow and happen when the stronger snow lies atop weaker snow – once the downhill stress becomes too much, it breaks loose from all sides and can reach speeds of twenty miles an hour.

Most avalanches occur on slopes between 30° – 45°.The steeper the terrain, the greater the stress acting upon the snowpack. The location and separation of snow layers also help determine avalanche risk and severity. When temperatures within the snowpack vary from top to bottom, different types of ice crystals form at different levels, making the snowpack weaker. An avalanche is likely to occur when four conditions are present in the environment: a steep slope, a slab, a trigger, and a weak layer.

A useful tool for avalanche preparedness is the Avalanche Danger Rose, developed by CAIC, to provide a graphic illustration of the backcountry avalanche danger. The Avalanche Danger Rose represents slope aspect and elevation, and the colors are representative of the danger rankings. The three circles represent elevation: the outside circle indicates below treeline, the middle circle indicates treeline, and the inner circle indicates above treeline.For more information on avalanches in Colorado or the Avalanche Danger Rose and Avalanche Danger scale, please visit: https://avalanche.state.co.us/index.php.



Hypothermia

In the backcountry of the park hypothermia is a condition to be aware of since conditions can change rapidly. Hypothermia occurs when the body loses heat faster than it can produce it, causing dangerously low body temperature. As body temperature drops, the heart, nervous system, and other organs are not able to function properly. Often someone experiencing hypothermia is not aware of their condition because symptoms begin gradually and their confused state hinders self-awareness. Because symptoms begin slowly, and if left untreated the condition can become severe, it is important to become familiar with the signs and symptoms of hypothermia. The four main signs of hypothermia can be easily remembered using the mnemonic device "umbles". These signs include: stumbles, mumbles, fumbles, and grumbles. These signs indicate changes in motor coordination and levels of consciousness.

Spring ice and snow at Fern Falls demonstrates the unpredictable and snow laden storms that provide a majority of Colorado's precipatation.

Basic first aid can be used to treat hypothermia in the field, but it is best to seek professional medical help as quickly as possible since severity can be difficult to gage. Below is a list of a few key things to remember:

- Be gentle – Sudden movements can cause severe pain.
- Do not apply direct heat – The application of direct heat such as hot water or heating pads can do extreme damage to the skin. Instead, use methods to slowly warm the body's temperature such as sharing body heat, or covering the individual in blankets, jackets, or dry clothing.
- Remove wet clothing and move the individual to a warmer location.
- Insulate the body from the ground using any material available such as clothing, space blanket, etc.

Frostbite

Another concern of winter travel is frostbite. Frostbite occurs when the skin and body tissue just underneath the skin freezes – skin becomes cold, numb, hard, and pale. Frostbite commonly affects smaller areas of exposed skin and the body's extremities such as the nose, ears, chin, cheeks, fingers, and toes. Many people unknowingly experience the first stage of frostbite, called frostnip, which irritates the skin but does not cause permanent damage. Frostnip can be recognized by skin that is reddened or white and waxy in appearance.

Mild forms of frostbite can be treated with first-aid measures, which include slowly warming the effected skin with warm water. Severe frostbite does require medical attention, as it can damage skin, tissues, muscle and bones and lead to complications, such as infection and nerve damage.

Winter Ecology Resources

Classroom Book List

These books are not endorsed by the National Park Service. They are intended to serve as classroom resources for students. Please be sure to preview books to ensure that they are appropriate for your classroom. This list is by no means inclusive of every book available on the topic.

Elementary School Level
Animals in Winter by Henrietta Bancroft and Richard G. Van Gelder

The Busy Little Squirrel by Nancy Tafuri

How and Why Animals Prepare for Winter by Elaine Pascoe

Migration by Robin Nelson

The Reasons for Seasons by Gail Gibbons

Secret Language of Snow by Terry Tempest Williams

Secret Life of a Snowflake: An Up-Close Look at the Art and Science of Snowflakes by Kenneth Libbrecht

Snowflake Bentley by Jacqueline Briggs Martin

Time to Sleep by Denise Fleming

Middle/High School Level
Life in the Cold: An Introduction to Winter Ecology by Peter Marchand

Winter: An Ecological Handbook by James C. Halfpenny

Wintering by Diana Kappel-Smith

Winter World: The Ingenuity of Animal Survival by Bernd Heinrich

Glossary

Adaptation – Structures or behaviors which help living things survive.

Annual – A plant which survives for only one growing season.

Biennial – A plant that does not produce flowers and seed until the second year, then dies.

Camouflage – The concealment of otherwise visible objects by use of disguise or protective coloring to blend in with the surrounding environment.

Chionophiles – animals that thrive in cold and snowy climates.

Chioeuphores – animals which are snow tolerating, but do not have specific adaptations for snow.

Chionophobes – animals which are not able to adapt to life in the snow.

Deciduous – The annual loss of foliage on trees and shrubs.

Dormant – The slowing down or suspension of normal physical functions for a period of time in order to survive adverse environmental conditions.

Ecology – The study of the relationship between organisms and their environment.

Energy – The strength required for prolonged physical and mental activity.

Evergreen – A tree, shrub, or plant that has foliage which persists and remains green throughout the year.

Hibernation – A state in which body temperature is lowered and heart and breathing rates slow down in order to conserve energy.

Hypothermia – A condition where the core body temperature becomes abnormally low.

Insulation – A material which prevents the loss of heat such as fur, fat, or feathers.

Intranivean – Within the snow.

Migration –The seasonal movement from one region to another.

Perennial – A plant which lives for more than three growing seasons.

Phenology – Periodic plant and animal life cycle events which are influenced by seasonal and interannual variations in climate and habitat factors.

Photoperiod – The length of time between sunrise and sunset.

Precipitation – Moisture received in the form of rain, sleet, hail, or snow.

Radiation – The transmission of energy through space/emitted from an object.

Snow – A molecule of dust and water vapor which is frozen into ice crystals.

Snowpack – The accumulation of snow layers indicating the depth of snow.

Snow Water Equivalent (SWE) – The amount of available/usable water contained within the snowpack.

Sublimation – Changing from a solid phase to a gas phase without passing through a liquid phase.

Subnivean – Under the snow.

Supranivean – On top of the snow.

Temperature – A measurement of the degree of warmness or coldness of the particles in a particular environment.

Torpor – A state of temporary dormancy in which physiological functions may be reduced to conserve energy.

Toleration – In animals, the ability to endure unpleasant or harsh environmental conditions.

Watershed – A landform defined by highpoints and ridgelines which descend into lower elevations and stream valleys, both below the ground and on the surface.

Wind – The natural movement of air created by differences in air pressure.

References

Ells, J. (2006). Rocky Mountain Flora. The Colorado Mountain Club Press.

Harpold, A., Brooks, P., Rajagopal, S., Heidbuchel, I., Jardine, A., & Stielstra, C. (2012). Changes in snowpack accumulation and ablation in the intermountain west. Wiley-Blackwell.

Herd, T. (2001). Discover Nature in the Weather: things to know and things to do. Stackpole Books.

Libbrecht, K. (2003). The snowflake: winter's secret beauty. Voyageur Press.

Schroeder, M., Buck, C. (1970). Fire weather: a guide for application or meteorological information to forest fire control and operations. U.S. Department of Agriculture.

Sprague, Abner. (1999). My Pioneer Life: the memories of Abner Sprague. Rocky Mountain Nature Association.

Stokes, D. (1986). A guide to animal tracking and behavior. Little, Brown & Company.

Williams, K. Atkins, D. (2003). Avalanche wise: your guide to avalanche safety in Colorado. Colorado Avalanche Information Center.