Glacier

National Park Service
U.S. Department of the Interior

Winter Ecology Teacher's Guide

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Acknowledgements

Thanks to all of the Glacier National Park Education Rangers and Interpretive Staff for help with this guide. It is a work in progress. Please direct corrections, comments, or additions to Laura Law, 888-5837, laura_law@nps.gov . Cover artwork is by Robin Peterson and is available as a color poster through the Glacier Natural History Association, 406-888-5756.

Dear Teacher,

A winter field trip to Glacier National Park offers unique opportunities for studying and experiencing plant and animal life in a different season. A fresh snowfall harbors many secrets. If you look closely you may see footprints and wing prints. Tracks, trails, and impressions in the snow are winter signs. They tell exciting stories that connect the past with the present. These signs are visible proof that the "dead of winter" is really full of life. It is this life that fascinates winter ecologists.

Winter ecology is the study of the inter-relationships between living things and their winter environment. Recent discoveries by ecologists about the incredible strategies living things have to allow them to survive in winter climates are truly fascinating and re-inforce the fact that we are all connected. A Glacier winter field trip provides an excellent opportunity for incorporating essential questions into your studies ("Do we Need Winter?" or "Do we need wild places?" or "Do we need snow?"). Maybe you just want to use the field trip to make abstract concepts from the classroom, concrete. In any case, this guide provides numerous lesson plans and background information to help you.

Please verify the confirmation letter dates for your field trip and meeting place. Snowshoes will be provided for your class and chaperones. You will not need to apply for a fee waiver if you have a ranger-led trip as we have taken care of that for you.

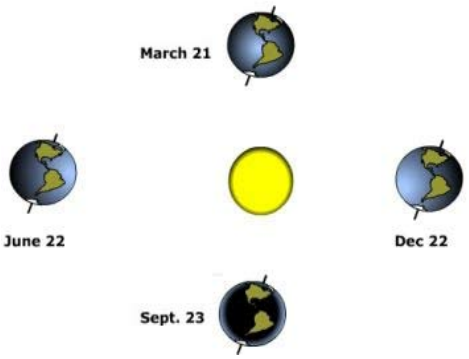
A word of warning is in order. Just as winter poses harsh conditions for wildlife, it does the same for humans. Make a point to read through the "Dressing for Winter" activities for you age group and impress upon your students and parents the importance of coming prepared. Cold toes and fingers or shivering bodies hinder the fun of outdoor learning and discovery. Dress warmly and in layers. Students and accompanying adults should have: warm socks, sweaters, long underwear, jacket, winter boots, warm hat, leg coverings (pants or gaiters), mittens or gloves. We look forward to seeing you this winter.

Glacier Education Staff

Glacier National Park's Education Goals:

- To provide opportunities for the students to form their own emotional and intellectual connections with park resources and values.
- To introduce students to the mission of the National Park Service and the significance of Glacier National Park.
- To provide a curriculum-based, outdoor education experience that is age appropriate and supplements classroom learning objectives.
- To introduce students to the value of protecting natural and cultural resources for current and future generations and to encourage actions we can all take to be good stewards of this special place.

What is Winter?
Winter is the season of the longest night, the shortest day, the least light, as well as the presence of snow, cold and wind chill. It is the slowest growing season for plant life. Food supplies dwindle and it is a hard time for animals. Winter poses many challenges to plants and animals. Winter Ecologist, James Halfpenny, refers to these challenges as the SCREW factors: snow, cold, radiation, energy, and wind. In northern **latitudes** winter is the longest and most difficult season of the year. **Temperature**, snow depth, snow density as well as the duration of winter (a deep snow pack and late season snow extend the winter season) determine the severity of winter and play a role in how many animals survive. Many animals will die during winter. **Winterkill** refers to the combined effects of bad weather, malnutrition, starvation, disease and predation. Winter is a time for economy: food is scarce and energy must be conserved. It is truly a time of survival of the fittest.



Winter solstice (December 21) is the shortest day of the year and the day winter "officially" begins. Interestingly enough, the earth is actually closer to the sun in winter (see diagram) not further away.

What Causes Winter?
As the earth travels around the sun, different regions receive more direct sunlight than others. The tilt of the earth on its **axis** is responsible for the different **seasons** in the northern and southern **hemispheres**. In the summer, when the North Pole is tilted toward the sun, the northern hemisphere gets more direct sunlight and the days are longer than during spring, fall and winter. In winter, the tilt is away from the sun and sunlight strikes the northern hemisphere at a lower angle. Latitude is what determines both the length of the day and the angle of the sun (Waterton/Glacier International Peace Park is pretty far north and straddles the 49th parallel along the Canadian border). The amount of sunlight striking the earth's surface (**solar insolation**) and the length of the day are determined by the position of the sun in the sky. The reduced amount of winter sunlight striking the earth due to shorter days and angle of the sun causes colder temperatures. As the land and its air mass cools, surface waters turn to ice and **precipitation** freezes to cover the land with snow.

At northern latitudes and in mountainous terrain, winter comes early and stays late. At higher **elevations** the **atmosphere** is thinner and holds less warmth. Consequently, it's colder, snow lasts longer, and the length of the growing season is greatly reduced. Elevations in Glacier range from less than 3,200 feet in the Lake McDonald valley to 6,646 at Logan Pass, to more than 10,000 feet on the tallest mountains in the park. In Glacier National Park, the seasons are jokingly referred to as "June, July, August and winter." There is some truth to this as the high country may be snow-free for only about 3 months of the year. It is not unusual to see visitors skiing at Logan Pass in June and occasionally even into July. Winter lasts a long time throughout most of the park.

It is worth noting that since the **Continental Divide** runs through the middle of Glacier National Park, the weather on the west and east sides of the park are different. The west side is

greatly influenced by Pacific Northwest weather patterns. These weather systems provide more rain, milder temperatures and (generally) moister snow than the east side receives. The east side of the park is influenced by continental weather systems characterized by less precipitation and strong, gusty winds. During winter, cold fronts moving down from Siberia and Alaska through Alberta along the **Front Range** can flow over the passes and settle in western valleys. Sub-zero temperatures can last for days or weeks. Eventually, a warm moist Pacific air mass will move in. As it moves over the mountains, the moisture condenses and precipitation occurs. The process of **condensation** releases heat that was stored in the moisture-laden air (thus the east side of the mountains is warmer than the west side at the same elevation). As this warm air moves down the east slope, it picks up speed and creates winds that can exceed 80 mph. These warm winds are known as a **"Chinooks,"** an Indian word for "snow eater." Chinooks can cause temperatures to rise from below zero to above freezing within hours.

Snow

Snow has many different "personalities" depending upon how much water, ice, and air it contains. Snow with high water content can easily be formed into snowballs. Powder snow is so fluffy and dry that it's nearly impossible to pack. Temperatures and wind can affect what happens to snow after it falls. It can be a light fluffy layer or it can harden into an icy surface. Snow crystals not only change as they fall through the air, but they continue to change within the snow pack over time, in a process know as **age-hardening.**

Let's consider the water content of snow first as this is an important resource for people. Rangers in Glacier National Park have been doing Snow Surveys to measure the amount of water in the snow pack for over 80 years. Snow surveys in the West date back to the early 1900s and the Department of Agriculture's cooperative snow survey program for predictions of meltwater runoff. This program is a federal, state, and local partnership directed by the Natural Resources Conservation Service or NRCS (http://www.nrcs.usda.gov/feature/highlights/SnoServ.html). To find out how much water will be available in summer, snow surveyors from NRCS and the other cooperating agencies collect data from some 1,600 snow courses several times each winter. They determine the depth and the water content of the snowpack and estimate the amount of runoff from the mountain watersheds. The information collected by the snow surveyors (and the automated telemetry system) is translated into water supply forecasts that NRCS State offices issue monthly from January to June in cooperation with the National Weather Service. Major sectors of the Western economy- agriculture, industry, and recreation- base their plans on these forecasts. Since Triple Divide Peak in Glacier National Park divides water flowing to the Columbia River Drainage (1), Hudson Bay Drainage (2), and Missouri River Drainage (3), the amount of snow that falls here (and its cleanliness) is crucial for people living in those three watersheds.

Now let's consider how temperature affects snow and thus animals. Fallen snow is not always the same temperature. When the bottom layers of snow are much warmer than the top layers, water vapor creates a bottom or in-between layer that is granular and resembles sugar. This type of snow allows small animals like mice, voles and shrews to readily tunnel through it. Because it contains a lot of air it also is good insulating snow for grouse to hunker down in on a cold night. Animals that paw through snow like moose, deer and elk can easily uncover grasses.

But air temperatures and wind can also alter snow crystals over time to form a hard, compacted snow mass with an even temperature throughout. This type of snow is difficult for mice to burrow through. (Yet, this same snow allows snowshoe hares and deer to reach up higher in shrubs and trees in search of food.) Compacted snow such as this can cause a build-up of carbon dioxide in the lower layers as a result of decaying vegetation. Many of the small "mouse holes" seen on the surface are actually vent holes that allow carbon dioxide to escape. Without them, mice and other **subnivean** (under the snow) dwellers could die.

Why does temperature affect snow this way? Melting and refreezing changes the physical characteristics of the snow. It causes snow crystals to reshape and form a very solid layer. The strength of the snow varies, depending upon whether it is in the melt or freeze stage. Some animals can travel on the surface, while others not as well adapted, will fall through and flounder, becoming easy prey for **predators**. An icy crust allows small animals to move with ease, but may cut a deer's legs, allowing bacteria and infection to spread in an animal already in a weakened condition.

What about the depth of the snow? How does that affect wildlife? When snow gets deep, deer will **yard up** (stay in one location) since bounding through snow requires a lot of energy. Deer have such small feet in relationship to their size, they sink through snow. By yarding, they pack down a network of trails that permits them to reach areas containing winter food. At the same time, there are risks associated with it. During long, hard winters, there is the risk of **overbrowsing** their winter range. And there is an increased risk of spreading diseases when many animals are confined to a relatively small area. Moose and elk can "plow" through deep snow. Moose are especially well adapted for it with their long legs. However, moose will frequently follow already established trails, while elk tend to follow in trails made by a strong lead animal. These modes of travel are known as **trailing**, and they are a means of reducing energy output. Many other animals take advantage of already established trails. Even snowshoe hares establish trails or "bunny runs" as they travel to and from their feeding areas. By using trails, winter animals can help minimize their energy output.

The depth, density and hardness of the snow can help or hinder animals depending upon the situation. A build up of snow on branches of trees may break and snap or bend young trees. Heavy snow on trees can restrict tree travel for pine martens and squirrels, making it more difficult to catch prey or to escape predators. Willows and alders bent by the weight of heavy snow provide food and shelter for snowshoe hares. Where the branches of spruce and fir catch

falling snow, snow depth becomes unequal on the forest floor. In open areas snow is deeper than beneath trees. Trees with full crowns collect most of the snow on branches. The small amount that reaches the ground quickly melts or evaporates leaving a "snow shadow" or **tree well**. Many small animals avoid tree wells during the coldest part of winter since they offer little insulation or protection but if the branches are heavy enough with snow and press close enough to the ground, wind breaks are formed and tree wells become cozy hideouts for animals like snowshoe hares. As winter merges into spring, tree wells are the first places that juncos and other returning birds search for food.

How Do Organisms (living things) in Glacier Survive Winter?
Adaptations: Migration, Hibernation, Resistance (Toleration)
Organisms, or living things, all have adaptations - structures or behaviors that help them to survive in their environment. Winter ecologists classify organisms according to how they experience winter and how they have adapted to it over time. The commonly used system based on the Greek work "chion" for snow has three levels: **chionophobes=** "snow fearers" have been unable to adjust to life in the snow and are usually found in warmer regions (black vultures, palm trees); **chioneuphores=**"snow tolerators" have adusted their life to winter and can survive but have no special adaptations (shrew, red vox, vole); **chionophiles=** "snow lovers" possess definite adaptations for life in winter and whose geographic distribution is generally limited to winter-dominated regions (spuce tree, mountain goat, snowhoe hare, ptarmigan, and weasels).

An even more basic classification system for how animals cope with winter is based on their main adaptation strategy for winter survival: **migration**, **hibernation**, or **resistance**/toleration (Marchand, 1996). Basically, living things either leave to find an area that is more suitable for them in winter (migrators) or they stay and are not active (hibernators, or organisms that have periods of torpor), or they stay and are active (resistors/tolerators). The following is generalized information about how different groups of organisms deal with winter.

Plants in Winter
By the end of summer or early autumn many plants have died back. **Annuals** will have produced seeds that have fallen to the ground and will germinate next year while the "mother" plant dies. Other seeds, housed inside plump, juicy berries will be eaten by birds, bears or other animals. Since the seeds are not digested, they will be "planted" in new locations within the droppings of these animals. The stems and leaves of **biennials** will die their first winter, but their roots will remain alive while the second year plants produce seeds to ensure survival. **Perennials** die back to the ground each year, but their roots live through winter and the plant will grow back each spring.

The leaves of **deciduous** trees and shrubs change color as daylight hours wane. Soon the leaves will be shed. Lowered temperatures will retard plant growth. **Leaf scars** are sealed with a corky layer and next year's **buds** are covered with scales to conserve moisture. Winter is similar to drought as water is unavailable when it is frozen as ice or snow. Woody shrubs and trees survive the winter in a state of **dormancy**. Evergreen trees and shrubs have thin or small needle-like leaves with waxy coatings to conserve moisture. The conical shape of many **evergreen** trees

makes them more resilient to heavy snow loads. Since their branches slope out and downward, the weight of snow pressing down allows snow to fall off. If enough snow falls from the branches it can pull the branches until they touch the ground and make a wall of snow and branches around the base of the tree. These tree wells can become shelter for wildlife out of the wind. Evergreen trees will photosynthesize at the first available light in spring.

Insects in Winter

Just as many plants go through a resting phase in winter, many insects time their particular life cycle stage best suited to withstand cold, drought-like conditions and lack of food. During this time, activities and/or development discontinue until conditions become favorable in spring. Individual species of insects overwinter at different stages of their metamorphosis.

Douglas Fir Beetle Larvae in Gallery

Insects comprise the base of the food chain and the absence or presence of their populations has a large effect on food availability for other organisms. Chickadees feed largely on insects and have the ability to hang upside down on branches to look for insects hiding on the undersides of leaves and branches. It is interesting to think about what happens to insects, an important food source in winter.

Wooly Bear Caterpillar (larval stage)

Insects that have incomplete metamorphosis (egg, nymph and adult) usually overwinter in the egg stage. For insects that develop through complete metamorphosis (egg, larva, pupa and adult), the egg and pupa are the most likely stages for overwintering since they are immobile and they have a protective coating that helps them withstand the cold. But some insects like the woolly bear caterpillar overwinter as a larva. The woolly bear stops eating in late summer and finds a sheltered place under leaves and grass. In spring, it forms a cocoon and emerges as an Isabella moth.

Insects that overwinter as adults usually find a sheltered place: under leaves, in crevices in trees, under bark, rocks, plants, in buildings, or they descend into the ground and remain dormant. Staggered timing of life cycles ensures that food will be available when they reach the eating stage. Insects react to cold temperatures by slow, stiff movements and a lowered metabolic rate. They lose a high percentage of water and produce glycol, a substance that acts as a kind of antifreeze. We think of these organisms as hibernating to avoid winter, but they actually have complex strategies to resist severe cold stress. On warm days adult insects move around as their bodies warm up sufficiently. The table on the next page lists some of the common insects and their overwintering strategies.

How and Where Some Insects Over-Winter

Insect	Species	Overwintering Stage	Special Preparation	Active or Inactive	Where?
Ants	Carpenter	Adult	Produce glycerol	Inactive	In trees or logs
Aphids	Most	Egg	None	Inactive	In bark crevices or base of twigs
Bumblebees		Queen	Pre-fertilized eggs inside queen	Inactive	Underground, under leaves or logs
Butterflies	Monarch	Adult	Migrate	Semi-active	Mexico or CA
Butterflies	Painted Lady	Adult	Lose body moisture	Inactive	Under bark
Butterflies	Swallowtails	Pupa	Form chrysalis	Inactive	Attached to stems or on the ground
Crickets	Most	Egg		Inactive	In the ground
Dragonflies	Some	Egg		Inactive	On the bottom of a pond
Dragonflies	Some	Nymph		Semi-active	On the bottom of a pond
Flies	Cluster & House flies	Adult		Inactive except when warm	In crevices of buildings or cracks in hollow trees
Grasshoppers	Most	Egg		Inactive	In the ground
Beetles		Larva (grubs)		Inactive	In the ground
Honeybees		Adult	Store food	Semi-active	Hive in a tree or man-made box
Ladybug	All	Adult	Cluster together	Inactive	Under leaves and grasses

Galls

Galls form when insects lay their eggs on plants. A swollen lump on the stem or leaf of a plant may be a gall. Galls can be a variety of sizes, shapes, and colors, some up to the size of a baseball! Most galls form on plant leaves but they can also form on branches, twigs, buds, flowers, fruits, and even roots. Some insects lay their eggs on the plant surface and others make a hole in the plant and insert their eggs inside. Not everything is known about gall formation but in response to the egg-laying, the plant either produces new cells or enlarges existing cells around the area. The newly formed gall provides some protection to the insect eggs (and larvae when they hatch) from the sun, wind, rain, and predators, but not fool proof. There are other insects that invade galls looking for food. Winter is a good time to look for galls since there are fewer leaves on plants.

Animals in Winter
Hibernation
Animals that spend the winter in Glacier National Park are either active or dormant. Dormancy ranges from short periods (**torpor**) to long periods **(hibernation**). Skunks and badgers, for instance may undergo periods of torpor as an energy saving measure during times of extremely cold weather. Hibernators generally sleep through the winter although they may awaken and move around. Hibernation can be defined as a physical state where an animal's body functions slow down in order to conserve energy through a season of no food and water, and cold temperatures. The extent to which the metabolism slows in order to be considered a "true hibernator" is debatable. Hibernators such as Columbian ground squirrels and marmots have drastically reduced body temperatures. A ground squirrel's temperature may drop to 39 degrees Fahrenheit compared to its usual 90 degrees Fahrenheit temperature. Reduced temperatures slow other processes so pulse and respiration rates drop. Breathing may be once every 4 to 6 minutes. At this slow pace, a minimum of energy is expanded and the animal's fat layers can usually meet their slight demand. Many hibernators also curl up into a ball to conserve heat. Ground squirrels and marmots therefore, are considered "true hibernators."

Whether animals, like bears and chipmunks, hibernate or not depends on your source and definitions. Living things do not follow definitive rules. Thus, there is a continuum between the "true hibernation" of ground squirrels and marmots in which all bodily functions are greatly slowed, the deep sleep of bears and chipmunks, and the occasional sleep of raccoons and gray squirrels. Hibernation is the extreme end of the continuum. Bears are said to not truly hibernate because although their bodily processes are slowed, they do not have the reduced body temperatures of other "true hibernators." But bears develop thick coats of fur and have less surface to mass ratios than smaller hibernators so they stay warmer. Bears' metabolism drops by half and their digestive system tightens into a knot, with the limited waste products reprocessed into the bloodstream in the form of proteins. Bears, if not true hibernators, are certainly close. Bears sleep for months without eating, drinking, urinating or defecating. It has been said that while bears may not be true hibernators, they are "digestive hibernators" (www.bobpicket.org).

Migration
When we think of migration, we generally think of birds. Some of the birds that spend summers in Glacier may fly hundreds or even thousands of miles to their wintering area. As birds migrate to warmer climates, they alter their food source and wait for spring or summer to return to their home territory. These amazing migratory treks vary in length; some may span the length of the globe. **Day length** is believed to be the major factor in telling birds it's time to move on. Winter in Glacier National Park is difficult. The food supply has diminished, the length of day and the time in which to locate food is reduced and the amount of energy needed to stay warm is increased.

While 92 birds are listed as common residents of Glacier in summer, only 28 birds are listed as common winter residents (see Glacier National Park Bird Field Check List 1990 in reference section). The Clark's Nutcracker is an example of a bird that migrates from its summer home up in the mountains to lower elevations during winter.

Clark's Nutcracker

Cold, wind, and blowing snow of the high country offer challenges greater than most animals can adequately cope with. For animals that remain active during winter, lower elevations offer easier access to food and more protection from the elements. Animals that move from areas of higher elevations to those that are lower with less snow and more food are considered "altitudinal migrators." Elk and mule deer are two other examples of animals that move from higher elevations in summer to lower elevations in winter.

While migration may seem like an easy option, it places a major strain on these animals. Huge energy reserves are required to make these seasonal journeys and migrators often face competition with native species once they arrive at their wintering site.

Resistance (or Toleration)

To many animals, winter means staying and enduring the challenges of the season and resisting its stresses. Because many organisms cannot simply flee from the cold Glacier winters, they have found numerous ways to survive the harsh climate. There are many fascinating adaptations in the animal world that help them resist winter's hardships.

Birds that resist winter stresses have numerous techniques for survival. When temperatures drop, birds will fluff out their feathers. Feathers are good **insulators**, and fluffed out feathers create a thick layer of stable air around the body. Many small birds **huddle** together at night to reduce heat loss. Others **roost** in tree cavities. Grouse hunker down in deep snow on cold nights, and a scaly projection on their toes helps them to walk on snow. Some birds, including grouse, will store large quantities of food in their **crops** late in the day to carry them through cold winter nights. Gray jays are known to store food on branches of trees or on the ground. Chickadees have an amazing ability to hang upside down on branches as they search for insects. This maneuver allows them to locate food when the upper surface of branches is snow covered. And woodpeckers continue to feed on insects deep within trees.

Pika

High in the alpine, the pika will remain active all winter in its den hidden among rockslides. It will feed on "hay" made up of grass that was cut, dried and stored during summer. It has distinctive adaptations that allow it to survive the long and extreme winter conditions. Its small round ears lay flat along its head; an inconspicuous tail and short legs reduce surface exposure

and heat loss; and fur insulates the soles of its feet and provide good traction. Pikas may look like rodents but they are related to rabbits.

Mountain goats are the largest mammals remaining active in the high country year-round. Their heavy wool **undercoats** and long hollow **guard hairs** provide protection from the cold and wind. Mountain goats can subsist on **lichens** and **mosses** if they cannot find adequate browse. In winter goats move to more south or southwest facing slopes where the winter sun melts snow more quickly and prevailing winds blow the snow away, exposing lichens and vegetation.

The Ptarmigan is the only bird that remains at or above treeline throughout the winter. This alpine cousin to the grouse changes its brown plumage to white as autumn light diminishes and winter snow begins to blanket the mountains. Feathered feet act as snowshoes which allow it to walk on snow. Sharp claws help it to scratch for food beneath the snow. Ptarmigan will feed on willow buds and the needles of subalpine fir. Warmth and protection from winds and sub-zero temperatures is attained by diving into the snow.

Prior to the actual onset of winter, animals that resist winter stresses have physiological responses that are cued in by the reduced daylight hours. Less daylight trigger a response that is registered in the "master control" gland (**hypothalamus**) in the brain. The hypothalamus then secretes **hormones** that activate other systems throughout the animal's body. Animals react in various ways. Moose, elk and deer begin to **rut**. The interval between the mating season and giving birth ensures the young will be born in the spring when food is abundant. Another reaction to shorter days is the urge to eat more thus building up layers of fat that will help animals make it through winter. Beavers and red squirrels **cache** extra food. Animals that remain active all winter will grow a thicker coat of fur. Deer, elk and moose have **winter coats** comprised of hollow hairs that trap air for better insulation. Other animals develop thick **undercoats**.

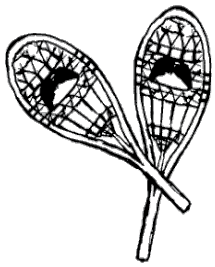
Snowshoe hares, weasels and ptarmigan in Glacier National Park turn white. The absence of the pigment melanin, means there are more air spaces within the hairs and thus it has greater insulation value. Snowshoe hares' white winter pelage has 27% better insulative qualities than the summer brown coat (www.bobpickett.org/winter_adaptations.htm). **Photoperiod** triggers hormonal changes that are also influenced by cold and snow. These hormones cause changes in hair color. Weasels undergo a complete molt. Each hair is lost and a new white hair replaces it. Only the tip of the hair turns white on snowshoe hares, while the base remains gray. Timing is critical. A white snowshoe hare or weasel (ermine) makes an easy-to-spot target for a predator. Snowshoe hares as their name implies, have snowshoes: extra fur on the bottom of their large feet in winter helps distribute their weight so they can move on top of the snow with ease.

For animals that remain active in winter, snow is a mixed blessing. It can offer shelter and protection. Snow acts as insulation, holding in earth-warmed air and keeping out cold air. Snow creates a stable environment beneath it (**subnivean** layer) in which temperatures may range from about 20 degrees Fahrenheit to 30 degrees (F), while air temperatures can fluctuate from 30 degrees (F) below zero to 45 degrees (F) above zero. The subnivean world allows plants, insects and animals to escape from temperature extremes and wind. This is important for small animals like mice, voles and shrews. Since their body surface is large in proportion to their size,

they lose heat rapidly and it takes considerable time (and energy) to replace it. Their small size does not allow them to carry a thick enough coat to withstand continual exposure to cold. The bark of trees and shrubs, seedheads from plants flattened by snow, and leaf litter/detritus provide much of the food for these small insects and animals. The tracks of mice, voles, and shrews indicate they do spend time on top of the snow (**supranivean** layer) in search of food but these forays can make them vulnerable to predators.

Humans in Winter

Although humans do not have the capability of hibernating like bears or marmots, we are able to migrate or resist. American Indian tribes relate how in the past, groups followed seasonal animal migrations in order to have access to more food or to find shelter from the wind during the winter months. Today, we don't have to move to find food, but the infamous "snow birds" from the northern states (and Canada) do move (migrate) in droves in December to southern states and remain there until the end of winter to escape the cold. Each IndianTribe- the Blackfeet, Salish, Kootenai and Pend d'Oreille in this area- had well established systems for obtaining and making warm clothing out of native materials, and for caching and storing food to last throughout the winter. Today, all of us wear clothing made of native materials - animals (leather and fur), feathers (down) and plants (wool and cotton), but we also have clothing made from synthetic materials like polypropylene or capilene. We all still must obtain food throughout the winter but we can get it from the local grocery stores and have systems in place for growing, harvesting, and transporting the food to stock the stores so we are not so dependent on what we've cached or stored at home. People have, and will continue, to use many different strategies to cope with winter. Snowshoes are another good example.



Snowshoes

The use of snowshoes dates back over a long period of human history. Archaeologists estimate that the first "foot-extenders" used for easier snow travel originated in Asia about 6,000 years ago. Perhaps those first snowshoes came about when someone watched how easily the snowshoe hare and lynx could travel across the surface of the snow. These animals have very large feet in relation to their body size. Bigger feet allow an animal to spread its weight over a larger surface area which helps to keep it on top of the snow. Eskimos living in arctic regions did not require the use of snowshoes since most of their travel occurred on wind packed snow or on sea ice. It is the Athabascan Indians of the American and Canadian west coast and the Algonquin Indians of the Ottawa and St. Lawrence River valley areas who are generally credited with bringing snowshoes to perfection. For American Indians living in forested temperate areas, as well as the multitude of people who came to North America and moved west, snowshoes were a necessity for getting around in the winter. Having, or being able to fashion yourself, a pair of snowshoes in areas where snow was deep was just as important to survival as having an axe or a flintlock rifle. Snowshoes. along with the innovations discussed above, are just some of the technological innovations that humans have developed over time to help them to survive winter. By observing and learning how other organisms cope with winter stresses, humans have been able to continue to develop new techniques and strategies to make our lives easier in northern climates. It will be intriguing to see the discoveries and changes that happen in the next century as more information on the interrelationships between living things and their winter environment come to light.

What Causes Winter?

Materials:
* Globe model
* Flashlight or lamp
* Apple or styrofoam ball
* Paper
* Chopstick, knitting needle or skewer

Vocabulary
Seasons, summer, fall, winter, spring, orbit, rotate, revolve

Methods
Students observe a model of how the earth rotates on its axis and revolves around the sun and then use their own bodies to create models of the movements.

Objectives
-Students can state 2 things we get from the sun (light and heat) and that they are less in winter.
-Name the four seasons and the twelve months.
-Create models to demonstrate why winter occurs.
-Demonstrate how the sun's rays strike the earth differently in winter.

Background
The winter season is caused by the tilt of the earth and the resulting variation in the amount of solar radiation received at any point on the planet. In winter, the earth is closer to the sun than in summer. When the north pole is angled away from the sun, the solar radiation is spread out over a greater area, resulting in less radiation per given unit area. During the summer, it is more concentrated. This is why near the equator, there is little difference in solar radiation received at any given time during the year. The earth spins on its axis, or rotates. One complete rotation takes 24 hours. At the same time it is rotating, it also travels around the sun, revolves. It takes one year for the earth to go all the way around the sun. During half that time the top of the earth tilts toward the sun and the bottom of the earth tilts away from the sun so the Arctic is in daylight while the Antarctic is in darkness. For the other six months of the year, the Arctic is in darkness while the Antarctic is in daylight.

Procedures
1. Use the mounted globe to review with students that the earth is rotating and that is what causes day and night.

2. Push the skewer, chopstick, or knitting needle through the center of the apple and hold the apple beside the lamp. Tilt it slightly and keep it tilted as you move it around the lamp. Remember, you need to be rotating the apple on its axis (the knitting needle) while you make it revolve around the lamp.

3. Point out how the light from the lamp shines on different parts of the apple depending on which side is tilted toward the lamp. When the top of the apple is toward the lamp it is always lit up, while the bottom of the apple is dark. This is like the the Arctic in summer and the Antarctic in winter. You may want to put a sticker on the apple to represent Montana to orient students while they watch it rotate and revolve.

4. Discuss how less sunlight affects different areas of the earth. What is the temperature right now in Florida or South Texas (they could check on the internet)? What about here? How does the sun hitting us at an angle affect our climate? Does that influence the kind of plants and animals that live in Florida or Texas versus Montana?

Evaluation
Have students use their bodies to model how the earth moves in relation to the sun.

Extension
-Use pictures from calendars and see if students can match them to the correct seasons.

-Provide students with a map of the world and in small groups, ask them to identify where winter occurs. See if they can come up with several hypotheses to answer: "Why does winter occur in these areas?" "How is life (plants and animals) in these "winter" areas different than in places which don't experience winter?"

-Make a KWL chart about what students know about winter, what they want to know about winter, and when you're done with the unit, what they've learned.

-To demonstrate how the sun's rays strike the earth differently in winter, take a flashlight and hold it against a card (or graph paper) that is perpendicular to the light. Trace the outline of the rays on the card. Now, hold the card at an angle leaning away from the flashlight and trace the outline. This simulates how the tilt of the earth on its axis in winter causes a reduced angle of sun's rays and, therefore, less radiation received per unit area. The same amount of light is coming out of the flashlight both times, but with the angled card, the amount is spread out over a larger area, so less per unit area.

Dressing for Winter

Vocabulary:
Radiation, convection, conduction, respiration, evaporation, insulation, wicking

Method:
The teacher, a volunteer (or an outdoor clothing retailer) models dressing in 3 layers and describes the purpose behind each layer and type of material.

Objectives:
-Students will be able to choose appropriate clothing for winter activities.
-Students will explain what the 3 clothing layers should be for outdoor winter activities and why each layer is needed.

Materials (clothing can be brought in by teacher or assigned to students to bring in).
* Wool or synthetic balaklava or ski hat
* Wool or synthetic gloves or mittens
* Nylon mitten shells
* Water and wind resistant nylon parka and pants
* Down, pile or other insulating parkas and pants
* Wool shirt and pants
* Wool, polypropylene, capilene or other synthetic longjohns
* Wool socks
* Boots
* Sun glasses or ski goggles are helpful

Background
Heat is lost from the body in five ways. It is radiated from the body in the form of infrared radiation. It is lost through convection as the air immediately adjacent to the body is warmed and then disturbed by wind. It is similarly lost through respiration as cool air is taken into the lungs, warmed and then exhaled. Heat loss also occurs by conduction when the body comes in direct contact with some cooler surface, such as the ground, cold pots, snow, rocks, etc... And finally, heat is lost when moisture on the body's surface evaporates - an exothermic chemical reaction. Because an active snowshoer, skiier, or hiker can sweat four to six liters of perspiration in a day, evaporative heat loss has special implications for clothing selection.

in order to prevent radiation and conduction, some clothing articles must be capable of providing the wearer with "insulation," a thermal barrier of trapped dead air space that conducts heat away form the body as slowly as possible. Because the body and outdoor elements are continuously exposing insulating clothing to moisture, it is a valuable asset for clothing to insulate even when it is wet.

Procedures
1. For younger students, make a transparency of the winter-dressed student and point out the things they need to remember to bring to be prepared for a day of snowshoeing. Then give them the Gabby stick figure handout and see if they can dress Gabby to be ready for a day at Glacier in the winter.

2. For older students, the day before, explain to the students that you will be coming in tomorrow with clothing to show them how to dress for winter wilderness activities. Explain to students that knowing how to dress for winter weather is the first step to having a great time outdoors and being safe.

2. At the beginning of the activity, come in dressed for a winter day. Take off each item of clothing one at a time and talk about its advantages (and possibly disadvantages). Discuss the fabric it is made from and why. (Another option is to bring in a backpack or bag with the clothing in it and have different students come up and pull out an article and decide if they are appropriate - make sure to include cotton jeans, a baseball cap, a goofy t-shirt, & perhaps some other article that students will chuckle about).

3. Emphasize that he most basic rule is **layering** as it helps with 3 important outcomes: 1) Keeping moisture away from the skin; 2) Creating insulation to help keep the body core warm; 3) Protecting against the "elements" - wind, snow, rain.

4. Protective layers of outer clothing should repel precipitation so that it does not soak through to the inner layers. These must also stop the wind to protect the wearer from convection heat loss, and allow ventilation to minimize evaporative heat loss. Explain the basic types of nylon: taffeta, lycra, rips-stop, and cordura. Discuss its tight weave and wind resistance, as well as its inability to absorb water into the fibers of the cloth. Explain Goretex and describe its advantages and disadvantages. Discuss the difference between water resistant and water proof.

5. For the middle layers, compare the basic types of insulation used in outdoor clothing: down, polarguard, holofil, qualofil, and thinsulate. It's best if you can have at least two different parkas so the students can feel the differences between them for themselves. Middle insulating layers should "breathe" easily.

6. Inner layers of clothing should be of materials that "wick" moisture away from the skin. (Cover the bottom of a drinking glass with a small amount of water to represent sweat on your skin. Then stand a strip of wool or candle wick in the glass touching the water to show students the idea of moving water from the bottom of the glass to the material="wicking"). Finally, all layers of clothing should dry rapidly, preferably from body heat alone. Compare wool, polypropylene, capilene, and thermax. Describe advantages and disadvantages of each. Emphasize the structure, the feel, the look, and even the smell of the materials. This is also a good place to discuss cotton and why it is not a prominent component of outdoor clothing (i.e. it actually absorbs water into the individual fibers, causing the fabric to stay wet for a long time).

7. Certain basic essentials are just as important as a warm jacket and a pair of snowpants. Sixty percent of your body heat escapes through your head if you are not wearing a hat. It is an essential in the winter (not a ball cap but a lightweight wool or fleece will do fine).

8. Gloves and/or mittens protect your hands from being cold- especially useful when participating in snow sports. A lot of body heat escapes through the hands just as it does through the head. Another area to keep warm is your feet. A pair of wool socks or polypropylene will keep feet warm even if they get wet. Stay away from cotton as stated above.

9. On a sunny day and even cloudy days, wear sun glasses. They protect your eyes from the sun's UV rays that penetrate even in the winter. The sun also can penetrate the skin, so sunscreen is always an important consideration.

10. Dressing in layers allows you to add or subtract layers of clothing depending on the weather and temperatures. When you go to the mountains, remember that weather conditions close to home are generally very different from conditions in the mountains. For every 1,000 feet of elevation gain, the temperature drops 3.5 degrees Fahrenheit.

11. For review on the 3 layers, have students go to the interactive website www.winterfeelsgood.com and dress the snowmonsters.

Evaluation
Ask students to list and describe each clothing layer and its function.

Extension
Conduct an experiment where students (and teachers!) wear one wet **cotton** sock all day on one foot, while the other foot has one wet **wool** sock on all day. Which foot stays warmer?

Is this student ready for a winter field trip to Glacier? Circle the words for what they remembered. Draw in pictures for the things they need.

Winter Hat

Drink with lid that closes

Winter Coat

Scarf (optional)

Gloves or Mittens

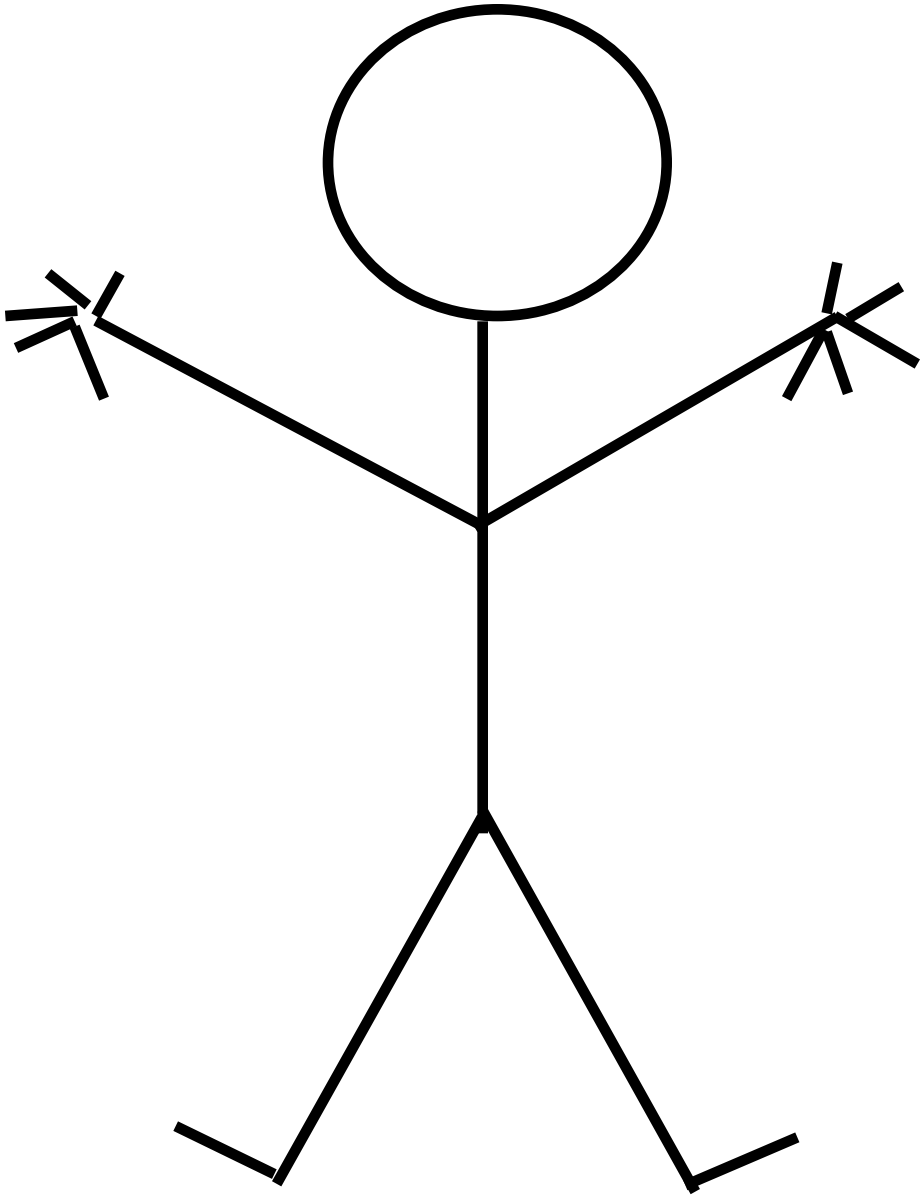
Snowpants

Lunch and snack

Warm, waterproof boots with socks

Dressing for a Winter Field Trip to Glacier

Help Gabby stick figure dress to go snowshoeing in Glacier National Park. Gabby needs: long sleeve shirt, long pants, socks, snow boots, socks, snow pants, a winter coat, gloves or mittens, a warm hat, and a yummy lunch with a resealable drink and snack.



When your teacher says you have Gabby ready, take your drawing home to remind YOU and your family what you need for your Glacier field trip.

What is Wild?*

Materials:
* 3 large writing papers
* Magazines (to cut up)
* Crayons
* Glue
* White board or chalk board

*from the Wilderness Land Ethic Curriculum, Arthur Carhart National Wilderness Training Center.

Vocabulary:
Wilderness, habitat, national park, protection

Method:
Students participate in a guided imagery exercise and take a trip to an imaginary "wild" place.

Objectives:
-Students will identify similarities and differences between their home and wild environments.
-Students will demonstrate awareness of wilderness as a place not developed by or for humans.

Background
In 1974 President Nixon recommended to Congress most of glacier National Park be designated as Wilderness. Congress has not acted on that proposal but 95% of the park has been managed as wilderness since 1974. (Presently, all developed areas are excluded from proposed wilderness.) Many children have never visited wilderness, though they may have images from stories or movies of what such places would look like. Drawing on students' own experiences and perceptions, these activities introduce the concept of wilderness by comparing wild places to developed places. The levels of distinction students make will vary with their experience, age, and the location of your community. A good definition of wilderness for young children is that of a place influenced by the forces of nature, where people visit, but do not live. The Wilderness Act of 1964 defines wilderness "in contrast with those areas where man and his own works dominate the landscape, as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Rod Nash, wilderness historian, believes that wilderness is so heavily weighed with meaning of a personal, symbolic, and changing kind that it is difficult to define.

Procedure:
1. Share with your students your own definition of "wildlands" or "wild place." You might also want to ask them to share their perceptions of these words with you. For older students, ask them to write down five or more words they associate with wilderness. Write all the words on the board. Explore the feelings associated with the word "wild." How does the word make you feel? Then add "erness". Wilderness areas are places that are wild. Glacier is considered a wilderness. If possible, show students photos from the photo gallery at the Glacier website at www.nps.gov/glac or look at the webcams for a live view of Glacier. You can also take an eHike up to Avalanche Lake to experience some of Glacier's wilderness.

2. Tell students that in preparation for your field trip to Glacier National Park, you are going to take an imaginary trip today to a place that is wild. Create your own story or use the following scenario to stimulate students thinking. Students could quietly act out the story you describe.

You may even wish to arrange chairs as the seats of a school bus and have students "climb aboard."

"Imagine we are all going to put on our warm clothes, and pack our backpacks with our lunches and drinks for the day in the wild. We are going to travel in our magic school bus...everyone aboard and take a seat! We'll drive through town and past neighborhoods until we can't see highways, stores or gas stations. We drive a long time. It is such a long way, that everyone goes to sleep! The bus keeps moving until finally it stops at the edge of a wild place. You can hear a few quiet sounds. It smells clean and looks all white. Before you open your eyes, make a picture in your mind of what you might see in this wild place."

3. On one paper labeled "wild" write down images as students share them. Encourage students to be specific in their descriptions. Also have available a paper labeled "developed" and record things students saw as they were leaving their school/city. For example, people belong in both places, as well as plants and animals. But the types of plants and animals may differ and the numbers of them and/or people may be different.

4. Review the words generated in the above activity and use magazines and the animal drawings in this guide to make collages of things that might be found in a wild place as well as things found in developed areas around cities and towns. Remember to point out that we all share the same air, water, soils, and scenic views that are exchanged between wild and developed areas.

5. Have them think about how Glacier National Park has been designated to be a wild place and some of the reasons why we need wild places (peacefulness, home for wild animals, place to study nature, clean water source, etc...).

Evaluation
Have students share ways their home is different and similar to a wild place.

Extension
-Come on a field trip to Glacier National Park in winter!
-Look at maps and see what other wilderness areas exist in northwest Montana. What about other areas of the state?
-Borrow the "Wilderness Trunk" from Flathead National Forest to find more resources and lessons about wilderness.
-Download "The Wilderness Land Ethic Curriculum" from the Carhart Training Center website at http://carhart.wilderness.net/
-Look for more storybooks in your library about wilderness.

Surviving Winter in the Wild*

Modified from the Wilderness Land Ethic Curriculum, Arthur Carhart National Wilderness Training Center.

Materials:
* Animal drawings from guide
* Index cards
* Magazines with animal pictures
* Yarn
* Paper for collages
* Colored paper for bingo option

Vocabulary:
Wild, domestic, tame, pet, habitat, national parks, wilderness

Method:
Students role play a day in the life of a pet animal and then sort pictures of a variety of animals into "wild" or "domestic" categories with the option of making collages of each category. They will think about how "wild" animals are different from domestic animals and why wild animals need "wild" places to live. Materials for animal clue cards, bingo, and a 20-question-like game are given to extend the activity and learn more about the animals that live in Glacier.

Objectives (students will be able to):
-- describe the basic needs of all living things.
-- define differences and similarities between wild and domestic animals.
-- state in their own words why wild animals need wild places to live.
-- learn about some of the wild animals that live in Glacier National Park.
-- name one way (adaptation) plants and animals have to survive winter in Glacier.

Background:
Students often have a special interest in animals. They are familiar with animals in zoos, nature films, and their own pets. They often have the misconception that the rangers in Glacier National Park feed and take care of the animals that live here just like they do for their pets. In fact, the rangers take care of the animals' **habitat** and then the plants and animals can survive on their own. Wild animals are very different from pets. A pet is a domesticated animal kept for companionship or amusement. A domestic animal is one whose breeding is largely controlled by humans. Evolution of a domesticated species therefore results mainly from artificial selection, with natural selection playing only a subsidiary role. The process of domestication implies the separation (partial or complete) of a breeding stock from its wild forebears.

This has extremely significant consequences in terms of raising animals in captivity. Domestic animals have been bred (over thousands of years, possibly 10,000 years in the case of dogs) to have characteristics that make them compatible with people. Some of these characteristics are physical (amount and distribution of meat, size, shape changes, coat characteristics); others involve selecting for "personality" traits that are desirable (docility, tractability, etc.).

Almost without exception, animals that have been successfully domesticated come from wild stock that is very social (usually living in social groups). The herd social structure tends to provide the correct basic characteristics that are selected for compatibility with people. So, animals like raccoons largely lack the basic personality characteristics to become good domestic animals.

The following animals meet the definition of domestic as presented above: dog, cat, sheep, goat, cattle, pig, donkey, horse, camel, llama, alpaca, ferret, guinea pig, rabbit (one species), chicken, turkey. A tame animal has been brought from wildness into a domesticated state. People need to provide for their pets and domestic animals because they have not been bred to care for themselves in the wild.

The activities in this lesson move students from an understanding of the basic needs of all living things to a recognition of the differences between the ways wild and domestic animals meet these needs, to an increased awareness of the importance of preserving wild places and undeveloped areas that maintain a diversity of wild species.

Procedure:
1. Ask students to think of their favorite pet or a pet they know (if they don't have a pet). Tell them they will act out this pet as you describe the activities it goes through each day. Begin with all children as animals sleeping. In your description include waking up, stretching, playing, drinking, exercising, interacting with others, eating, keeping warm, and having a bed or shelter. Conclude with the students going back to sleep.

2. Have students share the pets they chose and what they did during the day.

3. Next, ask them to think about some of the things they needed when they were pets, and make a list on your paper. Focus student's attention on categories of food, water, shelter, and living space.

4. Explain that these are the same basic needs of plants, people, wildlife, and domestic animals although they meet their needs in different ways.

5. Compare the students' pet animals to wild animals, reminding students that wild animals have the same basic needs, but they take care of themselves in wild places, i.e., predators hunt and grazers find grass and run from predators. Come up with your own definitions for wild and domestic with older students. Have students act out a wild animal walking, hunting, eating, etc. Discuss animals that are predators, hunters or grazers. Show them an overhead of the "Adapatations" blackline master of the different parts of the beaver (or the hemlock tree) that help it to survive in the wild. Older students can fill in the student page as you point out the different adaptations.

6. Show pictures of other animals or name a few and have students verbally categorize them as wild or domestic. Tame or captive animals may be confusing category. Tame animals are defined as "animals brought from wildness into a domesticated state". To help distinguish them, ask the questions: in their natural home, would there be people taking care of them? Could people take care of them in a wild place?

7. Have students collect pictures of animals both wild and domestic or use photocopies of the animals drawings in the back of this guide, or have them draw their own. Then see if students can divide the pictures:

Make two circles of yarn on the floor labeled "wild" and "domestic" and have students place their pictures in the appropriate circle and explain why. You could also make two large class collages of these categories.

8. Use the following questions in your discussion: What are some of the differences between the two groups? Similarities? What about domestic compared to tame animals? If you are out camping and find a den of baby raccoons, what should you do? What is "best" for the animals? (It is generally best to leave wild animals where you find them, due to the difficulty in meeting their needs in a domestic setting, i.e. they can no longer be wild and meet their own needs, more information on this can be found at http://www.isleauhaut.net/maskd/domestication.htm)

9. Have students share their understanding of how wild places are important for the survival of wild animals. In a sharing circle or as a written activity, have students fill in the blanks: I would like to be a _____ (animal). I need _____ (adaptation) to help me to survive winter.

Evaluation, Extensions and Other Options
Use the wild and domestic page following this activity to have students circle which animals are wild and which are domestic. Then draw a Glacier animal or domestic animal they are familiar with.

Animal Clue Cards or Riddles
Have students learn about what kinds of wild animals live in Glacier National Park and the surrounding areas of northwest Montana. Students can create wildlife clue cards for Glacier animals by using the drawings at the end of this guide or finding their own pictures. Paste the drawing to one side of an index card and on the other side, use information from the resource section to make clues about the animal. See if students can "stump" the class with their animal clues. Example: "I look like a pet you might have at home, but I am not a pet. I am a very good hunter and can smell small animals through the snow (Coyote)." or "I am small but I can make a loud noise. I look kind of like a small rabbit and I live in the high mountains where I stay active in winter. I eat the grasses that I have stacked up all summer (Pika)."

Bingo Game Option: Cut out the animal pictures and paste them to bingo cards. Again write clues (or use the animal cards at the back of this guide) about each animal. The teacher then reads the clues for the animal and the students cross off the matching animal picture for that clue on their bingo card to try to get 3 in a row.

"Who Am I?" Game Option: Attach the name or picture of a Glacier animal to the back of each student. Do not let them see the animal. They then have to ask yes/no questions of others who can see what their picture is and try to guess the animal (similar to 20 questions). Help prepare students by giving them example question such as "Do I have fur?" "Can I swim?" "Do I hibernate?"

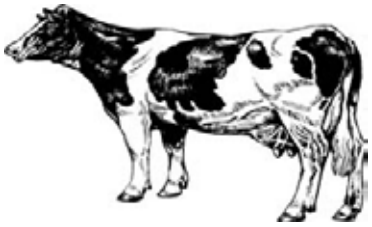
Wildlife Species Report Option: Ask students to identify, draw, and report on a wildlife species that lives in Glacier National Park and tell how it survives winter.

Below are wild and domestic animals. Circle the animals that are wild. Could some be both? Then draw a picture of a wild animal that lives in Glacier National Park and a domestic animal that you or a friend has at home.









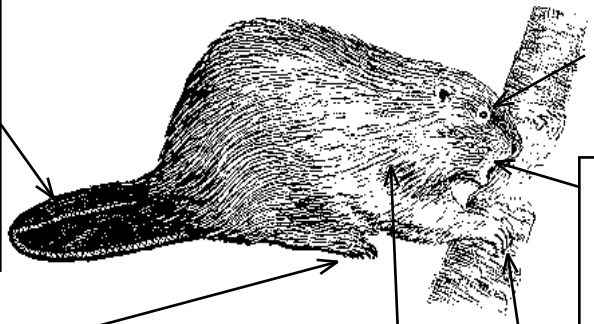
A Glacier wild animal	A domestic animal I know

Adaptations

Beaver

-Tail for slapping water for alarm
-Propeller for swimming
-Kickstand for propping up next to tree while chewing
-Place to store fat

Eyes on top of head to be able to see what's above and extra set of eyelids that are clear to use while swimming.



Sharp teeth never stop growing, used to get to cambium food layer of trees and to cut down trees for lodges, dams, and to store in piles outside their lodges for food in winter.

Hind feet are webbed and help with swimming but not so good for travel on land.

Thick fur with shorter undercoat for warmth and longer, guard hairs to help repel water keep beavers warm and dry all winter. Beavers have more hairs per square inch than any other land mammal.

Front feet are dextrous like hands, for grasping materials.

Western Hemlock

Easily identifiable by the leaning top. Western Hemlocks are found west of the continental divide in Glacier National Park and are at the eastern most extent of their range

Ever green needles have waxy coating to help conserve moisture. They can photosynthesize if water is available in winter (not frozen). Evergreens save energy in spring as leaves do not have to grow back like deciduous trees. Spruce Grouse feed on conifer needles in winter.

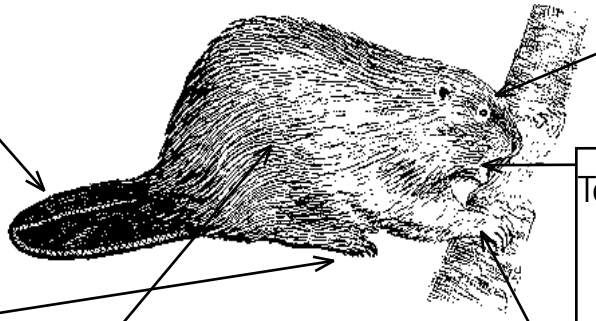
Branches slope out down allowing snow to fall off. They are also flexible if loaded with snow, they will bend and not break.

Woody shrubs and trees survive winter in a state of dormancy. Extra sugar in their cells protects them from freezing.

Tree well does not fill with as much snow because branches inhibit snow falling there. When snow falls off branches, a wall of snow can build up around the base of the tree and provide shelter from wind. It can also be colder when not enclosed and insulated by snow since cold air sinks and stays low to the ground at times in winter.

Adaptations - Student Page _____

Beaver



Tail

Eyes

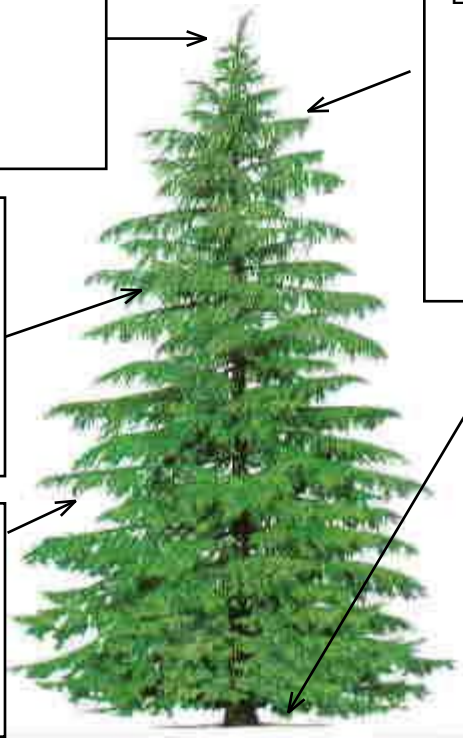
Teeth

Hind Feet

Fur

Front Feet

Western Hemlock



Identification

Evergreen Needles

Branches

Tree Well

Freezing Prevention

Who Eats Who?

Materials:
* Scissors
* Animal Drawings in back of guide
* Glue
* Colored paper

Vocabulary:
Food chain, food web, energy flow, producer, consumer, detritus, herbivores, carnivores, omnivores, predator, prey, leaf litter, decay, decompose

Methods:
Students make a paper chain and attach the sun as well as the appropriate plants and animals to make a Glacier food chain.

Objective
-Students will be able to make a food chain or food web of Glacier organisms.

Background:
In winter insolation in Northwest Montana is reduced. Less sunlight hitting the earth means less energy for plants to convert into food. Less plant food means less energy for all of the things that feed on plants: insects, fungi, grazers, birds, etc. In order to cope with the reduced amount of energy available, organisms have adaptations. They can stay and resist the winter reduced energy/food supply; migrate and go somewhere to find a better energy/food supply; or become inactive by hibernating or going into periods of torpor.

This activity helps students think through the concept of food chains and reduced energy to support basic life functions in winter. By thinking about what animals eat or where they get their food energy, they can infer which ones will be able to find food in the winter and which ones won't.

Procedure
1. Show students the food chain example on the following page. Discuss how energy from the sun is converted from radiant energy into chemical energy by plants (through photosynthesis). When plants are eaten by insects, mice, deer, etc., the energy gets passed to that animal. Just like when we eat cereal for breakfast (or too much sugar) we get lots of energy. Wild animals in Glacier National Park need to be able to not only find water and shelter during the winter, but enough food to help them have energy to stay warm and move around.

2. Photocopy the animal drawings and line art pages from the back of this guide. Have students research where each animal gets its food energy (or help younger students find out who eats who by using the table included here).

3. When they know what eats what, have them cut 4 strips of paper from the colored paper. (They can fold the paper lengthwise once, and then again to make 4 sections) Have the students glue both ends of the paper strips together to make a ring. Then have them loop the next ring through the first, so that they create a "chain."

4. Make sure they start with a picture of the sun on the first link of their chain (they could draw it). Then the next link has to be an organism that uses the energy from the sun to make food (a plant or producer). Then the third link should be something that would eat that plant/producer, a consumer (like a deer). The fourth link will be something that eats the deer for energy (wolf, coyote, mountain lion, bear).

Evaluation
When the students "food chains" are done. Have them predict whether the animal at the top of their food chain would be able survive in Glacier in winter. Ask them if that animal's food is available in winter so that it would have energy to stay warm and be active? Do they think it resists (stays and remains active), migrates (leaves), or hibernates (becomes inactive to conserve energy)? If there is no food, it is more likely that animal migrates or hibernates.

Extension
-Students can combine their food chains into food webs by attaching an animal link from their chain to an animal it eats in another person's food chain. A third person can then see if they have an animal or plant that might be eaten by one of the organisms in the first two chains and attach those links.

-Make picture cards of plants and animals that live in Glacier. Make sure you also have one of the sun. Give each student a card and have them stand in a circle so everyone can see each others' cards. Start with the sun and hand them the end of a ball of string. They are going to pass the ball of string to something that depends on them to get/make food (should be a producer). Then that person has to pass the ball of string onto someone who depends on them for energy. Keep going in this way and see if you can get everyone connected in your "food web." Discuss how in winter there is less sunlight so fewer plants and have all the people who are plants set their string down. What happens to all the things connected to them now? This can lead into a discussion of hibernation and migration or even to a discussion of endangered species.

-Play a musical chairs game to show the hardships insects face in winter and why good shelter is important for protecting insects and other organisms. Label the backs of chairs with different types of shelter: snag, tree bark, soil, under rocks, leaf litter, building cracks, a live tree, etc. Cover the labels with lift-up flaps. One chair should have a picture of a woodpecker under its flap. Children are insects and when the music stops, they must find a suitable habitat (empty chair). Once in the chair lift up the labels to make sure it is a safe habitat. Insects with no chairs or who find woodpecker are eliminated. Remove 2 chairs, change the woodpecker picture to another chair & repeat.

-Visit the Glacier Natural History Association bookstore or look through the "Educator's List" at the end of this guide for more materials to teach about food chains and food webs - animal playing cards, matching games, and even a forest food chain game are available for sale.

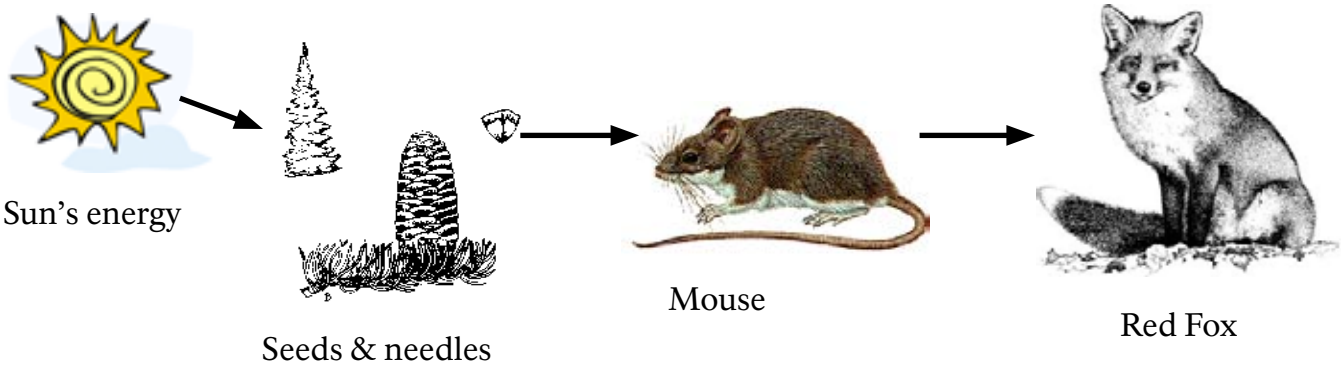
-Have students complete the following sentence, "If I were an insect I would spend the winter _____."

Who Eats Who?

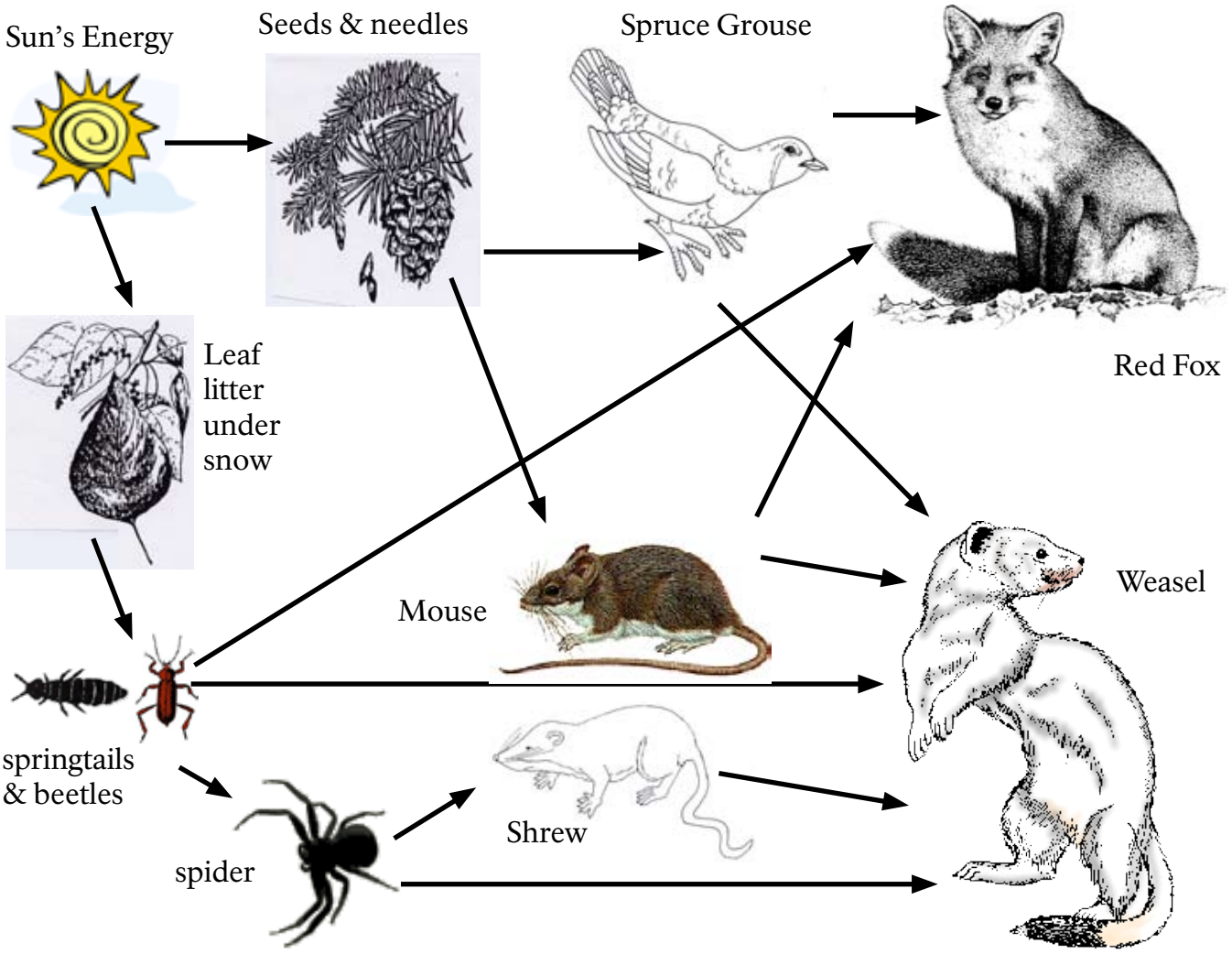
Animal/Plant	Eats	Is Eaten By
Grizzly bear	Rodents, Insects, Elk calves, roots, pine nuts, grasses, large mammals, carrion, berries	
Black bear	Rodents, insects, elk calves, pine nuts, grasses, other vegetation, berries, carrion	Wolves, Grizzly bears, Mountain lions, humans
Elk	Grasses, sedges, shrubs, aspen bark, aquatic plants	Wolves, Grizzly bears, Mountain lions, humans
Red Fox	Grasshoppers, beetles, crickets, berries, nuts, grains, mice, rabbits, birds, turtles, eggs, and even dead animals like road-kills	Bobcats, lynx, mountain lions, and wolves
Beaver	Grasses, sedges, inner tree bark	Wolves, bears, scavenger species, humans
Fungi	Decompose carrion and dead plant matter	Some small mammals
Bighorn Sheep	Grasses, shrubby plants	Coyotes, wolves, humans
Mountain lion	Elk, mule deer, small mammals	
Snowshoe hare	Shrubs, conifer needles	Lynx, foxes, bobcats, Great horned owls, coyotes
Buds and twigs		Elk, beaver, snowshoe hare, moose, deer
Fruits		Bears, birds, foxes, insects, coyotes, deer
Aspen		Elk, beavers, insects
Grasses		Elk, deer, bears, moose, rodents, insects
Snakes	Small rodents, tadpoles, fish, salamanders, frogs, worms, insects	Fish, birds, carnivorous mammals
Birds	Seeds, insects, berries, fish	Other birds, carnivorous mammals, snakes and squirrels, and weasels (bird eggs)
Aquatic insects	Other aquatic insects, aquatic plants, detritus	Fish, birds, amphibians
Eagle	Fish, carrion, ducks	

Animal/Plant	Eats	Is Eaten By
Ground squirrel	Fungi, roots, leaves, bird eggs, buds, insects, seeds, carrion, nuts	Weasels, coyotes, badgers, hawks, foxes, owls
Deer	Shrubs, grasses, aspen, conifers	Wolves, bears, coyotes, mountain lions
Terrestrial Insects	Plant material, other insects, blood (mosquitoes, ticks)	Rodents, weasels, foxes, martens, coyotes, fish, bears, birds
Pika	Grasses, lichens, sedges, conifer twigs	Coyotes, pine martens, hawks
Weasel	Rodents, Snakes, Ground squirrel, Insects, Birds, Frogs, Eggs	Hawks, owls, foxes, coyotes, humans (trapped for fur)
River otter	Fish, frogs, young muskrat	Humans (trapped for fur)
Pine marten	Rodents, eggs, hares, insects, shrews, berries, carrion, birds	Owls, humans (trapped for fur)
Shrew, Moles	Insects	Owls, coyotes, foxes, hawks
Mice	Seeds	Owls, coyotes, foxes, hawks
Yellow-bellied marmot	Grasses, seeds	Coyotes, foxes, bears
Coyote	Small mammals, carrion, Ground squirrels, Birds, Deer	Wolves
Cutthroat trout	Small fish, fish, eggs, small rodents, frogs, algae, insects	Bald eagles, Lake trout, osprey, otters, humans
Wolf	Hoofed animals (90%), beaver, hares	

Glacier Food Chain



Glacier Food Web



Hibernate, Migrate, or Resist?

Materials:
* Cards with the words hibernate, migrate, resist
* Pajamas
* Suitcase
* Winter coat and boots
* Optional: Playing cards of North American animals from www.heritageplayingcards.com

Vocabulary
Hibernate, migrate, resist, torpor, dormancy (advanced: chioneuphore, chionophile, chionophobe)

Method
Students cut out and color pictures of Glacier animals and place them in the correct table or behind the correct sign for which winter survival strategy the animal uses.

Objectives
-Students will be able to list 3 winter survival strategies (adaptations) used by Glacier animals.
-They will be able to sort/group different animals into each of the 3 strategies.

Background
Organisms, or living things, all have adaptations - structures or behaviors that help them to survive in their environment. Winter ecologists classify organisms according to how they experience winter and how they have adapted to it over time. The commonly used system based on the Greek work "chion" for snow has three levels: chionophobes= "snow fearers" have been unable to adjust to life in the snow and are usually found in warmer regions (black vultures, palm trees); chioneuphores="snow tolerators" have adjusted their life to winter and can survive but have no special adaptations (shrew, red vox, vole); chionophiles= "snow lovers" possess definite adaptations for life in winter and whose geographic distribution is generally limited to winter-dominated regions (Spruce trees, mountain goats, snowshoe hares, ptarmigan, and weasels).

An even more basic classification system for how animals cope with winter is based on their main adaptation strategy for winter survival: migration, hibernation, or resistance/toleration (Marchand, 1996). Basically, living things either leave to find an area that is more suitable for them in winter (migrators) or they stay and are not active (hibernators, or organisms that have periods of torpor), or they stay and are active (resistors).

Procedures
1. Discuss with students how winter affects people. Ask them if they do anything different in winter from summer. They should mention they wear different clothes, play different games and more inside than outside, and they eat different foods - like hot cocoa, soups, and hot cereals. Point out that animals also change what they do in winter - some leave, some stay but sleep a lot, and some stay but eat different food and behave differently - they might even change color!

2. Assign 3 students to be experts on each of the 3 adaptations - hibernate, migrate, and resist- and give them the the props for their adaptation (suitcase for migrate, winter coat for resist, and pajamas for hibernate). You may also want to give them a copy of the table at the end of this activity.

3. Read a book from the library or use the animal playing cards (or cut out the animal drawings at the back of this guide) to discuss what different animals do in winter. Use the table on the following pages for a reference.

4. Then give each student an animal picture and have them go stand, or hand their picture to the correct "expert" with the adaptation for their animal.

5. Review their choices and give more information as needed. You may also want to create a large table with 4 column headings: Organism/Animal; Migrates; Hibernates; Resists. and have students place the animal pictures in the correct columns. Discuss how some animals do both and some animals (bears) don't lower their temperatures as much as others (ground squirrels and marmots) so they are not considered "true hibernators" by all biologists. Torpor is another word used to refer to animals that have shorter periods of dormancy in the winter.

Evaluation
Put animal pictures on the bulletin board and beneath each make a lift-up flap from sturdy construction paper. Label the outside with the animal's name and the inside with what it does in winter. See if students can guess the adaptations correctly.

Extension & Additional Activities
- Create a winter mural that includes pond, woods, field, and trees with holes. Use photocopies of the animal drawings and have each child choose an animal. They should decide whether the animal could live here in the winter and where it should go. They should tape the animal to the winter mural in an appropriate habitat for that animal. Have them explain why that place was chosen (availability of food and /or shelter, etc.). In the spring, the mural could be "updated" and show how the animals move into their spring habitats.
- Use the Glacier National Park Bird Checklist (at the end of this guide) to find the birds that are known to nest in the park. Then see which of these are not present in winter (they migrate somewhere else). Students can pick one of these birds and research where it gets its food energy and what type of habitat it prefers. They should find out where their bird goes when it leaves Glacier for the winter and report on why it goes to where it does. They may even want to map out its migration route and calculate mileage and flying time to compare with driving a car that same distance. A good reference is the website "Journey North; a Global Study of Wildlife Migration and Seasonal Change" at http://www.learner.org/jnorth/
- Watch the movie "Winged Migration"
- Hold a festival or event for International Migratory Bird Day, http://www.birdday.org/
- Participate in Project Feeder Watch, http://www.birds.cornell.edu/pfw/
- Many more ideas are available from the "Flying Wild" Curriculum, http://www.flyingwild.org/involved.htm
- Research what happens to animals that hibernate. Measure student respiration & pulse rates and compare them to the rates of animals that are hibernating.

Animal*	Adaptation	Winter Habitat	Winter Food Sources
Bats	Migrate to go hibernate	Caves, mines	
Badger	Resists	Underground dens	Ground squirrels, pocket gophers
Bear, black	Hibernates	Shelter between roots, under fallen trees, in caves	
Bear, grizzly	Hibernates	Digs hole into mountain side	
Beaver	Resist	Pond, lodge door below ice	Bark and twigs, poplar & birch
Bighorn sheep	Resists	Woods and fields	Bunchgrasses and shrubs
Bobcat	Resist	Woods, brushy areas	Rodents
Chipmunk	Resist	Below frostline in burrow	Cached seeds and nuts
Coyote	Resist	Fields and woods	Small or medium-sized animals
Deer, white-tailed	Resist	Sheltered woods, usually evergreen	Twigs, evergreens, buds, apples
Deer, mule	Resist/migrate	Lower elevations from summer	
Eagle, bald	Migrate/Resist	Along water bodies	Fish and other carrion
Elk	Migrate/Resist	From high elevations to lower	Aspen buds, bark
Fish	Resist	Lakes & streams	Aquatic insects, algae
Fox, red	Resist	Open, timbered and farmland	Mice, rabbits, insects, fruit, carrion
Frogs, turtles, salamanders	Hibernate	Burrow down into the mud	
Harlequin Duck	Migrates	Pacific Ocean	
Hare, snowshoe	Resist	Brushy areas, woods	Buds, bark, own droppings
Hummingbirds	Migrate		
Loon	Migrate	As far South as Baja	
Lynx, mountain lion	Resist	Woods and fields	Deer, hares, rodents, coyotes, raccoons
Marmot	Hibernate	Alpine burrows	
Moles	Resist	Tunnels below frost line	Insects, spiders, slugs, seeds
Mice, voles	Resist	Tunnels under snow in fields	Seeds, roots, stems
Moose	Resist	Forests	Twigs, bark, saplings
Mountain goat	Resist	Alpine wind swept slopes	Lichens, mosses, grasses, conifer trees
Muskrat	Resist	Cattail lodge in marsh	Roots, stems, clams, snails, dead fish
Otter, river	Resist	Near water	Fish, amphibians, crustaceans
Owl	Resist/Migrate	Meadows, where prey is found	Small rodents
Pika	Resist	Alpine meadows under rocks	Hay stored from summer
Ptarmigan	Resist	Alpine meadows in snow	Seeds and buds
Shrew	Resist	Under leaves and grasses	Insects, small animals, nuts, berries
Skunk, striped	Resist/Inactive	In cavities or holes in the ground	Insects (esp. larvae), small mammals, ground squirrels
Snake, garter	Hibernate	Underground	
Squirrel, Ground	Hibernate		
Squirrel, Red Tree	Resist	Coniferous Woods	Cone seeds, nuts, seeds
All Weasel Family	Resist	Fields and woods	Small animals, insects, amphibians
Wolf	Resist	Follow prey	Elk, deer, moose

* More information on Montana wildlife can be found at http://fwp.mt.gov/wildthings/default.html

Snug in the Snow

Materials:
* Storybook Who Lives in the Snow? by Jennifer Berry Jones
* Shoebox - one for each group
* Cotton, paper, or styrofoam pieces
* Scissors
* Chalk or tempera paint and brush
* Twigs, dried weeds, evergreen sprigs, cones
* Clay or copies of animal drawings from back of guide

Vocabulary
Subnivean, supranivean, intranivean, carbon dioxide.

Method
Students make shoe box models of how small animals live under the snow in winter. An additional option is to conduct an experiment with jello to see if it solidifies faster on top of the snow or under the snow.

Objectives
-Students will be able to name one animal that lives under the snow in winter
-Students will give one reason small animals stay under the snow in winter.

Background
Many small animals rely upon a blanket of snow for winter survival. Mice, voles and shrews live in this subnivean (below the snow) world by tunneling through snow and feeding on seeds of plants, bark from trees and shrubs, and even storing small amounts of food. These small animals' tracks are often seen across the surface of snow. When they are on top of the snow, they are vulnerable to predators such as ermine (weasel), hawks and owls. Many of the "mouse holes" seen on the snow surface are actually vent holes to allow carbon dioxide from decaying plants to escape so these small animals don't suffocate. Snowshoe hares and grouse take advantage of the snow by snuggling into it for protection from cold and winds. Snow also allows the hares to reach higher up on trees and shrubs to feed.

Procedure
1. Read the story Who Lives in the Snow? by Jennifer Berry Jones. With older students, review the following vocabulary words for snow with your class: subnivean (below the snow), supranivean (above the snow), intranivean (within the snow), predator (hunts and kills other animals for food), prey (animals killed by predators for food), and insulation (material or combination of materials which retard the flow of heat). Discuss the animals students may already know about like deer and elk that resist and stay active in Glacier National Park all winter. How do they stay warm all winter (thicker coats, moving to sheltered forested areas, etc...). Discuss how for smaller animals who have a harder time keeping their bodies warm, living under the snow provides extra warmth.

2. Ask students if they have heard the saying "a blanket of snow." What does a blanket do? Tell students that you are going to make models of how small animals live under the snow in winter.

3. Have students lay a shoebox on its side and whiten the inside with chalk or tempera paint.

4. Cut away the roof and replace it with a piece of white paper or cotton cut to size (styrofoam could also be used). Allow paper or cotton to extend about 1/4 to 1/2 inch beyond the surface it is replacing. Hold it in place with toothpicks, tape, or glue.

5. Decorate the top with twigs, dried weeds, and bits of evergreen.

6. Make animals out of clay or playdough and place them where they belong, either above or below the snow. Option: You may use the line drawings provided at the back of this guide for the students to color, then place them where they belong in the diorama.

Evaluation
Ask the students to pretend they are one of the characters in their diorama and have them write a story about life in a subnivean world. Is it dark/light? Cold/warm? Quiet/noisy? Cozy/lonely?

Extension
Stir until dissolved, one tablespoon of gelatin into 1 cup of hot water, then fill film canisters half full and cover them. Divide students into small groups and ask them to choose a shady, exposed area for 1 canister, and a deep snow place to bury the other canister. Mark where the canisters are buried and make sure they are labelled. You may want to place thermometers next to each. When the surface ones begin to gel, check the buried ones. Which ones gelled first? Check the thermometers and see how they compare. Why might small animals want to stay under the snow on a cold day?

Snow Characteristics

Materials:
* Household thermometer
* Clipboard
* Paper
* Pencil
* Shovel

Vocabulary
Insulation, snow crystal, snowflake, condensation, water cycle

Methods
Students take temperatures at different depths in the snow and compare them to the air temperature. Variations for students to see where in the snow jello will solidify fastest, and for catching and classifying snowflake shapes are presented.

Objectives
-Students will discover the insulating effect of snow and understand that temperature varies according to snow depth.

Background
With this activity, students will become aware of temperature variations above the snow and below the snow as well as physical characteristics of the snow and its affects on wildlife in Glacier National Park. Snow acts as insulation and provides an environment that has relatively stable temperatures. Small animals such as mice, voles and shrews spend most of the winter under a protective blanket of snow. Snowshoe hares, grouse and ptarmigan snuggle into the snow which provides protection from wind and temperature extremes. Large animals such as deer, elk, moose, mountain goats and bighorn sheep move to south and southwest facing slopes because they are warmer (and snow melts off more quickly making walking and locating food easier). Temperatures within a snow pack can vary depending upon the consistency of the snow. Snow consistency as well as snow depth can either assist or impede the movement of animals.

Procedure:
1. Place a large drawing of a thermometer on a piece of paper, cardboard, or chalkboard so students can visualize it. Be sure everyone knows how to read a thermometer.
2. Divide students into teams to take and record temperatures. (Be sure that all students have a chance to take some of the temperatures).
3. Go outside and have each team use the shovel to dig a "pit" in the snow at different locations in your test area. Have them take temperatures at the following locations: the air temperature; the temperature at the surface of the snow and every few inches below the surface down to ground level if possible. Have them record their temperatures in a table such as this so that teams can compare their findings:

Depth in snow	Observations of layer - hard, soft, fine, coarse...	Team 1 Temperatures	Team 2 Temperatures	Team 3 Temperatures
Air				
Surface of snow pit				
4 in. below surface				
8 in. "				
12 inches below				

4. Return to class and compare temperatures and layer observations. Discuss how the temperatures are the same or different and why. How might these differences affect animals struggling to survive in the winter? Did anyone notice any difference in the snow layers as they took the temperatures? What do they think could have caused that?

Evaluation
Have student groups prepare a graph depicting the data they collected. Have the groups present their information to the class and explain temperature variations they observed.

Variation: Place equal amounts of water (or jello) in cups with lids and bury one cup in the snow and put the other cup on the surface of the snow. Which solidifies faster and why? (It is best to start with cold water in the cups and place them outside early in the day).

Additional Activities for Learning About Snow
•Is Snow Clean? Collect fresh snow in a clean, empty plastic container with a lid (such as a yogurt or margarine container). When the container is full, put the lid on and bring it inside. Allow the snow to melt. Hold a paper towel or coffee filter over an empty bowl. Stir the melted snow and pour it slowly into the bowl. Is there dirt collecting on the towel or filter? A magnifying glass can give you a closer look. There will be dirt collecting on the filter because every snowflake forms on a speck of dust or salt (see diagram on facing page). As the snowflakes fall, they collect more dirt from the air.

•Flakes Up Close On a day that it is snowing, take your students outside. Tape a small piece of chilled dark material or dark construction paper onto the arm of each child. Give everyone a hand lens. Look closely at the snowflakes that fall on the material. Encourage students to share their findings. Check out http://snowflakebentley.com for some great snowflake images.

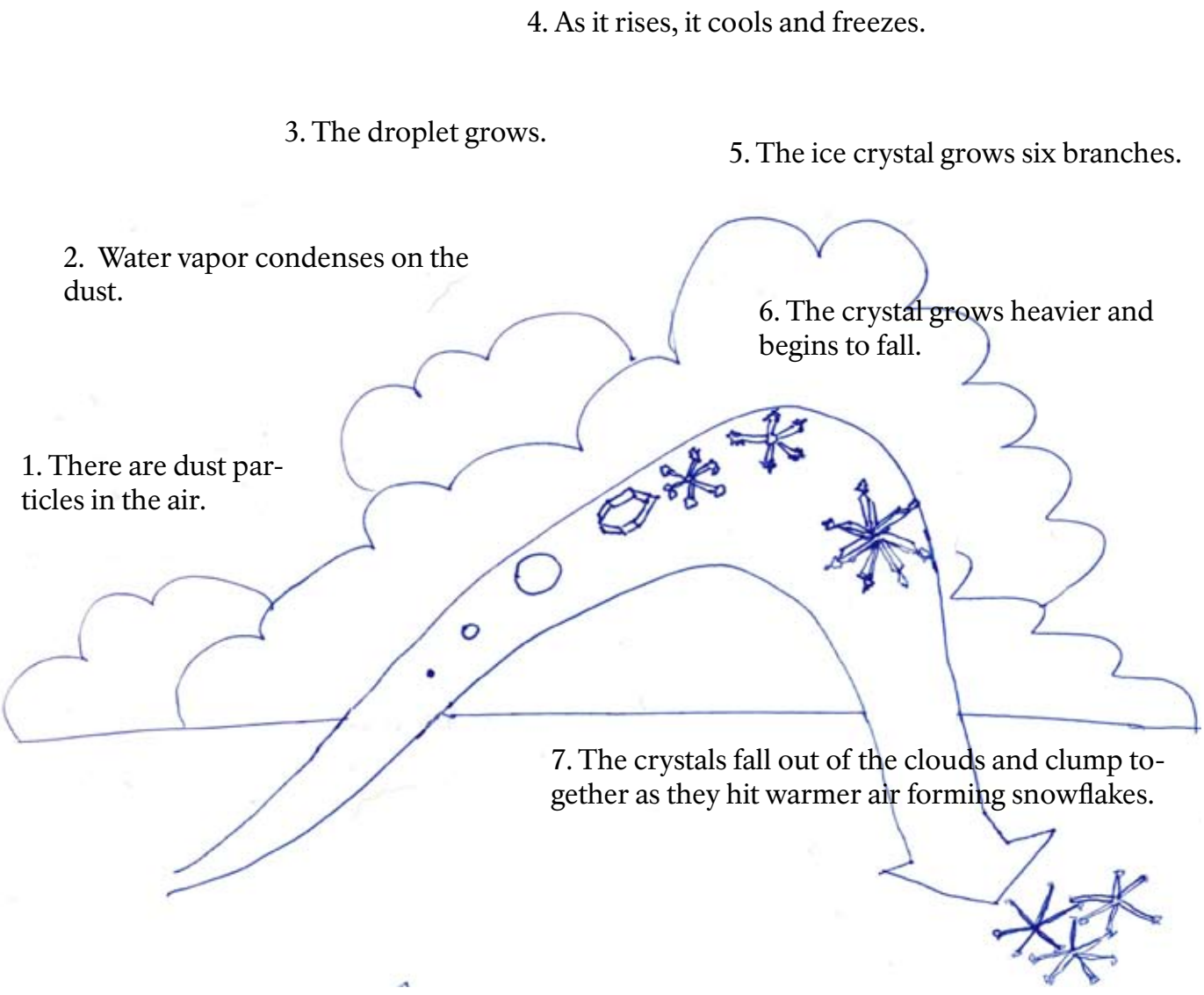
•Permanent Impressions: Chill a piece of glass (a microscope slide works well) and spray it with chilled hair spray or chilled clear lacquer. Take the students and the sprayed glass (carried on a piece of cardboard) outside. Catch snowflakes onto the glass as they fall and they will make imprints on the glass. Leave the slides in the cold until the lacquer dries and then look at your shapes under a microscope. Use the classification guide on the next page to see what shapes your snowflakes are in. You could record how many you get of each type and then find the percentage of each.

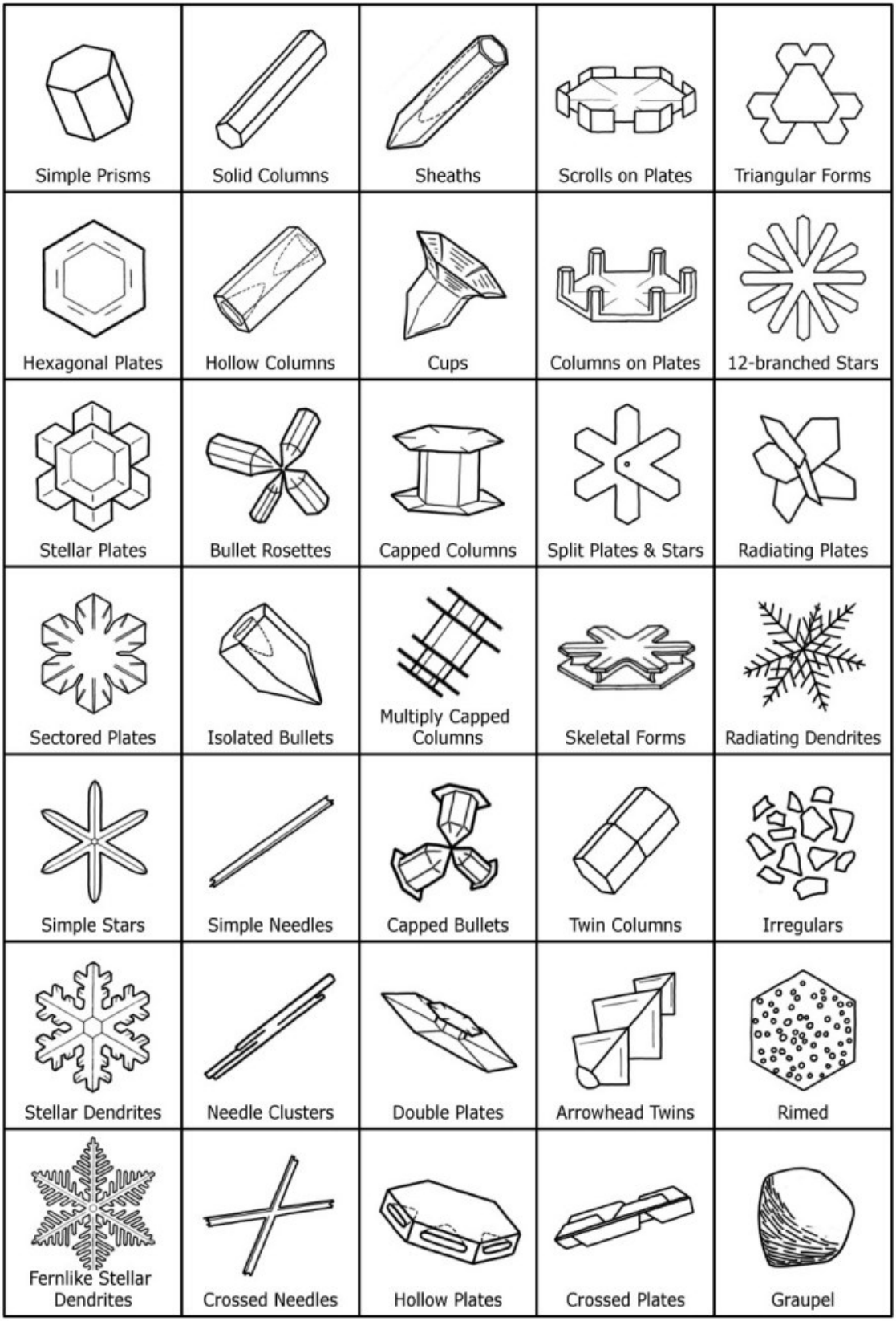
• Snow Riddles: Have students make riddles with snow vocabulary. Examples: What kind of sheet can't be folded? A sheet of ice; Where did the snow dance? At the snowball; Where do snowmen keep their money? In snowbanks!

In 1951 the International Commission on Snow and Ice produced a fairly simple and widely used classification system for solid precipitation. This system defines the seven principal snow crystal types as plates, stellar crystals, columns, needles, spatial dendrites, capped columns, and irregular forms. To these are added three additional types of frozen precipitation: graupel, ice pellets, and hail. The classification system on the next page is one by Libbrecht who has been studying snow crystals for years and prefers a more complex system, www.snowcrystals.com

Birth of a Snowflake

from Discover Nature in Winter





Types of Snowflakes ... SnowCrystals.com

How Much Water is in this Snow?

Materials:
* "Locating Glacier National Park" map
* "How Much Water is in this Snow?" student worksheet
* Snow
* Snow sample containers for each pair of students - 1000 cc size or empty cans/ baby food jars that you know the volume of, or that students can calculate the volume for

Vocabulary
Snow survey, snow sample, density, mass, volume, percent, snow water equivalent (SWE), watershed

Methods
Students collect snow samples and calculate how much water there is in the snow. (percent density). They discuss how snow density is used to calculate "snow water equivlaent (SWE)" to forecast our annual water supply.

Objectives
-Students will be able to calculate snow density and understand how that is used to find the snow water equivalent (SWE) for water supply forecasts.
-Students will be able to explain why mountain snowpack is important to our water supply.
-Students will be able to relate how the mountain snowpack in Glacier is a resource for everyone in the United States.

Background
Glacier National Park works with the Natural Resource Conservation Service (NRCS) to collect data on mountain snowpack. The NRCS is a federal agency within the U.S. Department of Agriculture that provides products and services that enable people to be good stewards of the nation's soil, water, and related natural resources on non-federal lands. The NRCS continuously monitors mountain snowpack and climate. They use data gathered from manual surveys conducted by park rangers and other trained personnel along with automated information from the SNOTEL (SNOwpack TELemetry) network to forecast water supplies.

Major sectors of the economy — agriculture, industry, recreation, and government — base their water management plans on NRCS water supply forecasts, climate products, and drought risk assessments. NRCS snow surveyors measure mountain snowpack and forecast seasonal runoff in streams and rivers. This information is used to make sound water management decisions. Glacier National Park contains the head waters for three major watersheds in North America that meet at Triple Divide Peak. The Columbia River Drainage, the Missouri River Drainage, and the Hudson Bay Drainage. (See the information and background section about snow at the begining of this guide). The NRCS website has excellent and extensive information about conducting snow surveys as well as the current water supply forecasts at http://www.nrcs.usda.gov/feature/highlights/SnoServ.html . In addition, the NRCS Agricultural Information Site Bulletin 536 has a clear explanation of the importance of mountain snow to water forecasting and the steps for conducting snow surveys. View the site bulletin at http://www.wcc.nrcs.usda.gov/factpub/aib536.html.

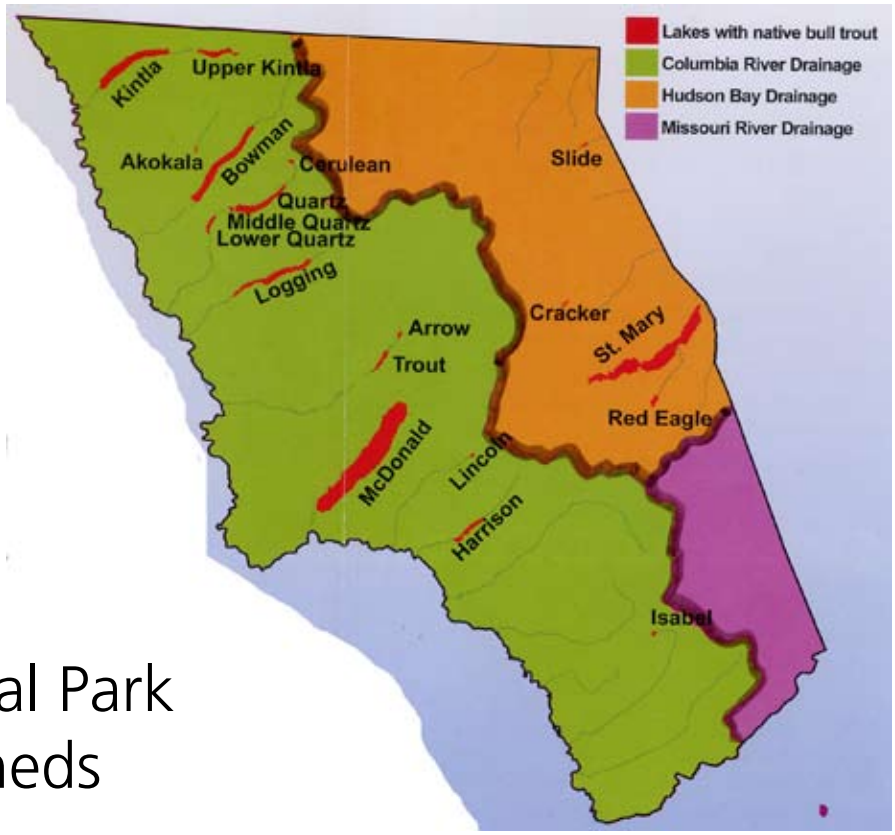
Procedure

1. Tell your group that they are going to follow similar procedures and calculations that rangers and NRCS personnel use to measure how much water is in the snow. But first, you want to discuss why it's important to know this and who it affects. (It's not just important to skiers and winter recreationists?)
2. Show students the map, "Locating Glacier National Park in Northwest Montana". Work together to label: their hometown, the rivers, the lakes, and the three watersheds. Make sure students understand the significance of having the headwaters of these three large watersheds for North America fall within Glacier National Park. Why would a community, or a nation, decide to keep the watershed headwaters undeveloped and in a protected area? Once students understand the significance of the watersheds, challenge them to think about how mountain snowpack in Glacier National Park contributes to those watersheds. You may even want to visit the SNOtel website at this point to see how much snow there is in Glacier right now. Go to the National Weather Surface Forecast Office website http://www.wrh.noaa.gov/mso/newlcl.php. Then scroll over the map surface observation map in the area of Glacier and find the yellow, SNOtel symbols for Flattop Mountain or Many Glacier. Those links will take you to the atuomated data about the most recent weather observations, including snow depth, for that site. Compare the snow depths and weather observations with where you live. Students may be amazed at the difference!
3. So now that students understand the importance of mountain snowpack as a water resource, it's time to calculate how much water is in the snow.
4. For younger students, a simple way to do this is to just collect the snow samples as described below and then bring the samples inside and add energy (heat) to change the snow from a solid to a liquid. Students can record observations of their sample container full of snow, and predict by writing it down, or by moving a rubber band on the outside of the container, what the water level will be when all the snow melts. How was their prediction? Can they imagine how deep the water would be outside if all the snow turned from a solid to a liquid right now?
5. For older students, the first step to find out how much water is in the snow is to understand what density represents, and to be able to calculate the density of the snow. Students will need to use a container of known volume to get a snow sample, and then find out the mass of the snow. A 1000 cc container makes the calculations really simple but if none are available, making students calculate the volume of a cylinder like a baby food jar or empty tomato paste can adds an additional math challenge.
6. Use the "How Much Water is in this Snow?" worksheet at the end of this lesson to help students walk through the steps of calculating snow density and percent density.
7. The density of new snow ranges from about 5% when the air temperature is 14° F, to about 20% when the temperature is 32° F. After the snow falls its density increases due to gravitational settling, wind packing, melting and recrystallization. Depending on the location, typical snowpack values can range from 10-20% in the winter to 20-40% in the spring.
8. To accurattely calculate snow water equivalent (SWE) you need to know not only the density of the

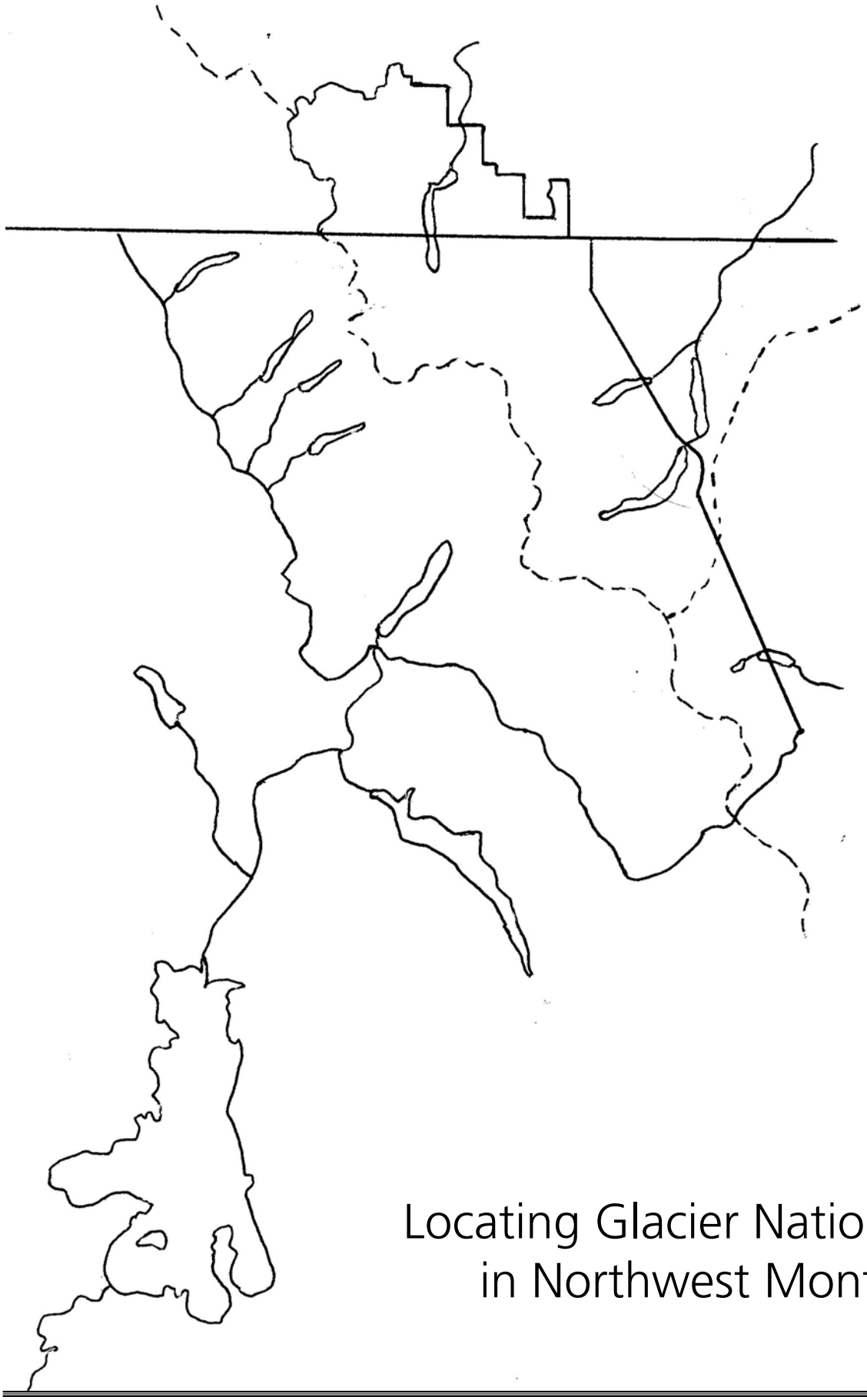
snow, but how deep the snow OF THAT SAME DENSITY is. This can be tricky since once snow hits the ground, its density is constantly changing. NRCS staff have a special snow tube they use for getting snow samples which collects snow from the entire snow column from the surface all the way to the ground, see website at http://www.wcc.nrcs.usda.gov/factpub/aib536.html . They also get multiple samples along a snow survey course and they return to that same course multiple times on a regular schedule throughout the winter.

Evaluation
Compare the students' measurements and calculations for snow density. Were they all the same? Different? Why or why not? Can students correctly label the three watersheds that meet in Glacier National Park and give one reason mountain snowpack is important to people living within those watersheds? Challenge students to think about what would happen if the precipitation at Glacier National Park did not fall as snow, but as rain. How would that affect our water supply (even if it were the same amount of precipitation)?

Extension
Have students calculate how much water they use per day and compare it with the average per capita use for United States residents. Then compare the average U.S. per capita water use with other countries. The snow that accumulates in Glacier National Park throughout the winter is an extremely valuable source of water for people and animals. When the snow melts, it flows down through the streams to the lakes and replenishes the water supplies that we all depend on. What are some things we can all do to help ensure that we have enough clean, fresh water?



Glacier National Park
Major Watersheds



Locating Glacier National Park
in Northwest Montana

How Much Water is in this Snow?

Name_____

1. Mass of snow sample container empty = _____

2. Mass of snow sample container with snow = _____

3. Subtract line 1 from line 2 to get the mass of just the snow = _____

4. Volume of your snow sample container (get the volume from your teacher or calculate it yourself with the formula your teacher provides) =

_____

_____

_____

5. Snow Mass (#3) = Snow Density
Volume of Container (#4)

6. Snow Density (#5) X 100 = Percent of water in your snow sample.

7. Compare your answer for snow density to other students' results. Did everyone get the same snow density? Why or why not? Where in the snowpack does the snow seem to be the most dense (top, middle, or bottom)? Do you think you would get the same results tomorrow?

8. Water supply forecasters use snow density to calculate what the depth of water would be if all the snow melted right now. They call this the **snow water equivalent** or **SWE).** To get SWE, the snow density (not the percent) must be multiplied by the depth of the snow. Can you calculate SWE for your snowpack? What would you have to do to make it accurate?

Tracks Along the Trail- Winter Signs

Materials:
* Track Maker Copy Page and animal information pages
* Scissors & glue
* Index cards, drawing paper, colored paper, butcher paper
* Markers, paints, crayons, pencils
* Picture Book, In the Snow: Who's Been Here?
* Optional: Animal Tracks of Glacier National Park or other field guide to animal tracks & signs

Vocabulary
Observations, tracks, bounders, gallopers, walkers, waddlers

Methods
Students identify patterns from their own tracks and then look at those made by animals. They make "track cards" to use for matching, classifying, sorting, and a variety of activities.

Objectives
-Students will be able to identify shapes and patterns of different animal tracks.

Background
As you travel outside through the forests and neighborhoods, snow becomes like pages in a book. Stories are revealed by tracks, trails and impressions in the snow. These are winter signs. If you are lucky enough to see wildlife while on your travels, please remember to keep your distance. Any extra effort an animal puts out in order to "escape" from you could mean the difference between life and death. Snow is a great writing board for stories about animals. Wildlife viewing is often a matter of luck or being in the right place at the right time. Tracks, whether they're fresh or a few days old, are evidence of wildlife presence; and the tracks reveal much about the private lives and habits of the animals that made them. Scientists often use tracks to learn about wildlife routines.

Some of the tracks that may be found on a winter outing in Glacier National Park are shown on the Track Maker Copy Page. Tracks can be difficult to identify at times, depending upon snow type, how old they are and temperature/snow conditions since the tracks were made. Also other types of wildlife signs may be left by wildlife including: scat, beds, chewed twig ends, gnawed-on bark, animal lodges and bank dens, hair, feathers, blood, and urine markings.

Procedure
1. Start with a discussion of what a "track" is and how it can tell a story. Read the story book In the Snow: Who's Been Here? Discuss how snow is like a magic powder, revealing signs and tracks that couldn't be seen before the snowfall. Students may relate to this by noticing how their dogs sniff the ground at what looks invisible before the snowfall, but after a snowfall, can see that where the dog has been sniffing has lots of squirrel tracks or deer tracks, or maybe the neighbor's cat's footprints! Maybe they can see footprints in their driveway and realize that the newspaper carrier walked that way.

2. For younger students, you can have them trace and make copies of their own feet or sole

"rubbings" of the bottoms of their shoes. Cut out the tracings and label one side. Then mix up the tracks and see if students can identify whose tracks are whose! Go outside with pairs of students and have one partner hide their eyes while the other tries to make tracks in the schoolyard. See if their partner can follow the correct tracks to find them!

3. It's important to recognize tracks in order to know what wildlife is present and what areas & habitats different animals are using. A number of concepts and activities can be done to teach students about how tracks tell us about wildlife by creating "tracks cards." Make photocopies of the "Animal Cards" and "Track Maker Copy Pages" for each student. Have students cut out each track and glue it to one side of an index card or a colored piece of paper. On the other side of the card, they can glue the information about that animal (and maybe even a picture from the animal drawings section). A variation would be to put the animal information and/or picture on a separate card. Half of the students can each be given the track picture, and half get the animal information cards. Then they have to find the person with their "match."

- Math: See if students can find patterns in the tracks - which animals have 2 toes? 3 toes? 4 toes? 5 toes? Now read the information about the animals, are the ones with the same number of toes related? (ungulates=2; birds = 3; weasels=5, etc...). Use the tracking field guide books to find more animals with the same number of toes. Measure the stride (distance between two tracks made by the teacher). Does the stride change as the animals starts running? Try this with your own stride.
- Math: Have them use graph paper and information on scale drawings to proportionally double the size of the tracks that are shown at 1/2 their actual size. Discuss how size relates to winter survival. Animals with big feet (lynx, snowshoe hare) can walk on top of the snow.
- Art & Science & Math (shapes): Explain that an animal's track is unique and can reveal a lot about where it lives and what it does for a living. For example, the webbed hind feet of the beaver are adapted for swimming while the large furry hind feet of the snowshoe hare are for travelling on top of deep snow. Tracks in the snow are often the best way to determine that winter animal activity is taking place in an area. Becoming a skilled "tracker" takes patience and a lot of time out in the snow observing. Each animals' track is different in shape, size, and design (depending on its function -see the background information section or field guide book). Having students study the tracks on the "Track Maker Copy Page" and then use their imagination to create animals, designs, or even snowflakes will help them internalize track shapes and remember some of the functional reasons for those shapes (see sample page of "Track Art").
- Language Arts & Science: Have the students make "A day in the life of _____" track story. They need to trace and cut out multiple track copies of two of the animals that would be considered predator and prey (ie. pine marten and red squirrel; Lynx and snowshoe hare; coyote or mountain lion and deer or elk, etc...) and then research and think through what those animals might do in one day. They should write out their story first and then illustrate it with the tracks on a large piece of butcher paper. They can show the predator chasing its prey and perhaps the prey goes into a hole or up a tree. Students then present their story to the class, or see if the class can "read" what happened in their story. Alternatively, stories can be made on window shades and rolled open as the story progresses. Sponge stamps or stencils can be used instead of paper cut-outs of tracks.
- Science: A variation on the track cards could be made in order to play "Track Jeopardy" with the categories being the number of toes in the track and the clues being the animal information cards.

- Physical Education: Make a "Track Twister" game by using fabric paint on an old sheet with big squares with each of the different tracks. Make a spinner that tells the caller what track to call out and what part of the body each student has to reach over and touch that track with (hand, elbow, foot, nose, etc...). This could require some real acrobatics!

Evaluation
Students successfully complete one of the activities listed above.

Extension
Go outside and look for tracks! Keep a journal of the tracks that have been seen and draw a map of them. Try to find patterns in the animal's movements over time, are they going back to the same tree? Do they always follow the same trail? How often do the same tracks appear?

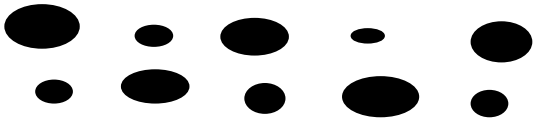
Learn track patterns - explain to students that animals walk in four basic track patterns (the repeating design their footprints make in the snow). Make a single large oval on eight 3x5 index cards. Cut four of the 3x5 cards in half and make a single small circle on each of them. (A total of 16 track pattern cards). Use these cards to demonstrate the four basic track patterns below. Lay them on the floor to imitate the different patterns. You can name the animal or pattern type and then see if the students can lay down the cards correctly or once the cards are layed down, ask a volunteer if they can try to walk in this pattern with feet on the first two prints, and hands on the next two.

Walking (felines, canines, ungulates) Move right hand and left foot at same time (and likewise their left hand and right foot). As hand moves forward, foot goes onto the spot where their hand just was.

Galloping (rabbits, snowshoe hares, squirrels, chipmunks, mice, voles, shrews) - larger hind feet land in front of the smaller front feet.

Bounding (weasel family- otter, mink, marten, fisher, weasels) Front feet hit first, and then the back feet land where the front feet were (direct registering).

Waddling (heavy-set mammals such as beaver, porcupine, muskrat, raccoon, skunk, bear)- weight shifts to the right as both the left hand and foot move forward at the same time. Then shifts to the left as the right hand and foot move in their turn.



Track Makers Copy Page

Mule Deer ½ Life Size

Spruce Grouse ½ Life Size

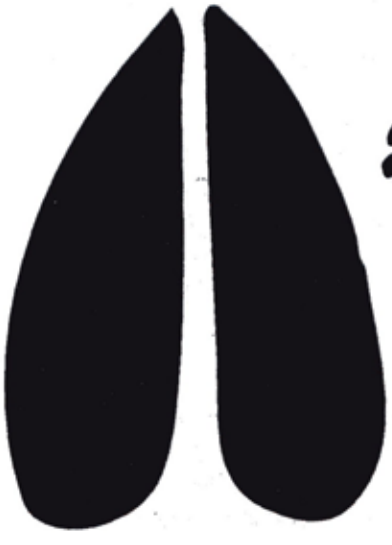
Deer Mouse
Life Size

Coyote ½ Life Size

Elk ½ Life Size

Mt. Lion ½ Life Size

Red Squirrel
½ Life Size



Moose ½ Life Size

Lynx ½ Life Size

Track Makers Copy Page

Snowshoe Hare ½ Life Size

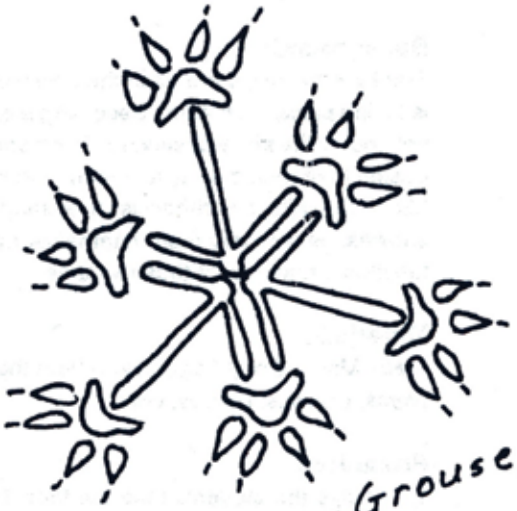
Beaver ½ Life Size

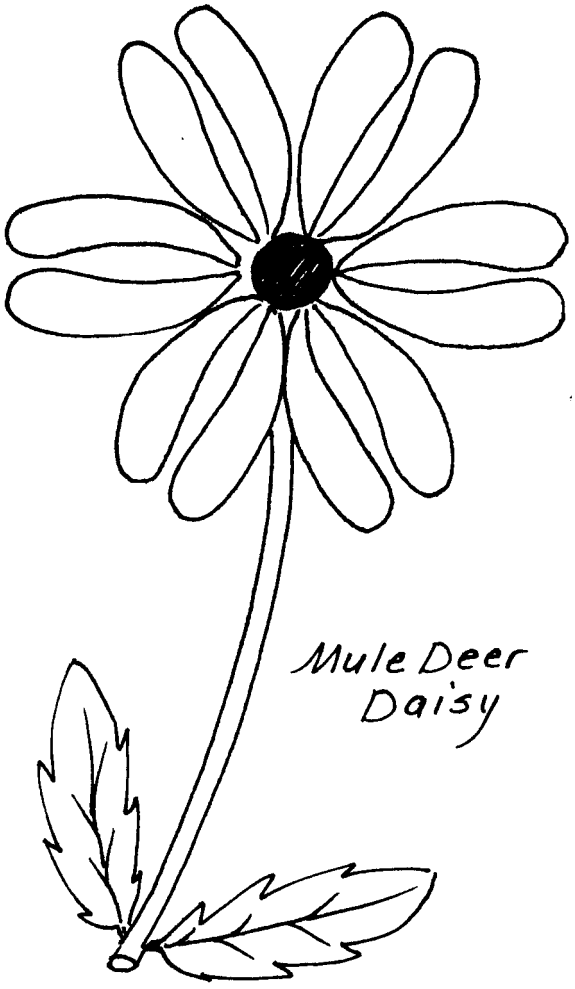
Short-tail Weasel ½ Life Size

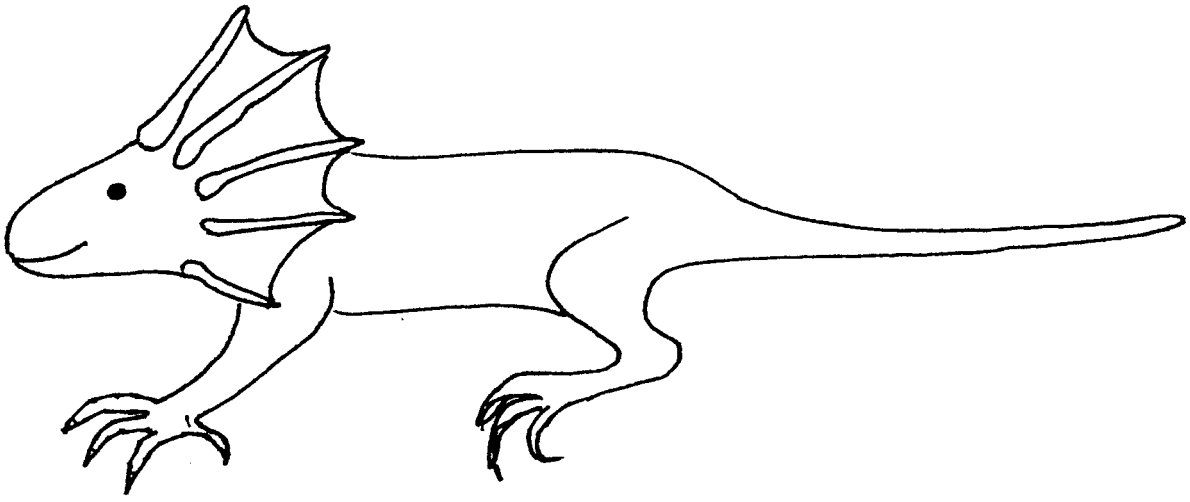
Mink ½ Life Size

Marten ½ Life Size

Track Art Examples







Animal Cards

Snowshoe Hare
These tracks are unmistakable: large snowshoe-like hind feet appear ahead of the front feet indicating the hare is moving. This forest edge dweller takes advantage of the snow in order to feed higher up on shrubs and trees where it goes after buds and tender twigs. Snowshoe hares often use the same trails to and from feeding areas creating "bunny runs." Look for tracks leading to hiding places beneath snow-bent shrubs or snow laden branches that touch the surface of the snow.

Weasel
This animal is also known as an ermine when its coat is white (changes from brown to white for winter camouflage and warmth). They may be found in both forest and meadow habitats. Small rodents are their primary food and weasel tracks may suddenly disappear down a mouse hole and resurface a short distance away. Their movement is typically bounding. Since their legs are short a body drag may be visible in deep snow.

Moose
Moose tracks are larger and more pointed than elk tracks. Because of their long legs they are able to move through deep snow. Moose tend to spend much of their time in the forest. During winter they feed heavily on shrubs. Often, large branches are broken when moose pull them down to feed on the tips. Look for droppings, rubs, and beds.

Deer
Both the whitetail and mule deer can be found in the lower elevations of Glacier National Park during winter. It is not possible to tell the difference by looking at tracks. However, mule deer have more of a tendency to bound on all four feet. Other signs to look for are: rubs on trees, scat, and places where deer have bedded.

Red Squirrel
You're more likely to hear their chattering call before seeing them in the forest. While they spend much of their time in the trees, tracks can be found on snow where a bounding track pattern may lead to a cache of pine and fir cones. Look for places where they have been feeding (called middens). Middens can be identified by the piles of cone scales left after the squirrel has removed and eaten the seeds.

Elk
Elk will often winter along river bottoms and south facing slopes where grasses and forbs might be more accessible. As snow depth increases, elk will browse on twigs. Look for rubs on trees- they will be higher up on the tree and appear more ragged than deer rubs; trees or shrubs where they've been browsing; teeth marks on aspens; scat; beds; and places where trailing has taken place.

Animal Cards

Beaver
Watch for freshly cut trees, wood chips on the snow and beaver slides (places where branches have been dragged). Beavers cut trees for many reasons: food, building material and to keep their teeth from getting too long. There are several active beaver lodges in Glacier. When you find them, listen carefully. You may be able to hear the beavers inside. On very cold days it is possible to see what appears to be smoke rising from the top of an active lodge. This is actually condensation resulting from warm air escaping from the lodge. Muskrats may be seen near beaver lodges.

Mink
This member of the weasel family is semi-aquatic. Fish, muskrats, birds, and mice are among its favorite foods. Look for its tracks close to the water's edge. Sometimes they will slide down a bank or dive into snow and emerge a short distance away.

Lynx
Lynx have large feet that are densely covered by hair in winter. These natural snowshoes help them travel over snow to pursue their main food, the snowshoe hare. Lynx are rarely seen.

Coyote
Coyotes feed on small mammals and carrion. Look for tracks indicating a coyote has been "mousing." If you locate the site of a winter killed animal, you will most likely find tracks of this scavenger as well as wing prints from ravens and magpies.

Grouse
Both the ruffed and spruce grouse may be found in the lower elevations in winter. The spruce grouse spends much of its time feeding and roosting up in the trees. The ruffed grouse spends more time on the ground feeding on buds of shrubs. Tracks may lead to a "snow tunnel" - a place where the grouse scratched or dove into the snow and tunneled a short distance to spend the night in a "snow roost."

Mice, Voles, Shrews
These small mammals spend much of the winter under the security of a blanket of snow which provides a relatively warm and windless environment. Tracks on the snow may indicate they have gone in search of food. As snow melts, you might find their grass nests.

Pine Marten
This member of the weasel family spends much of its time in trees. The pine marten feeds on red squirrels, insects, birds, and berries. Like other members of the weasel family, its tracks are distinctly "paired." If the tracks you are following suddenly disappear, it indicates the marten has jumped onto a tree.

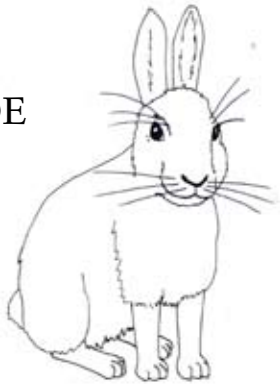
Mountain Lion
The chances of seeing these secretive animals are slim, but watch for their tracks. Their primary food is deer. If you find "cat" tracks, look for scrapes where scat or urine has been covered. Occasionally, tail drag marks may be seen.

Animal Card Drawing Page

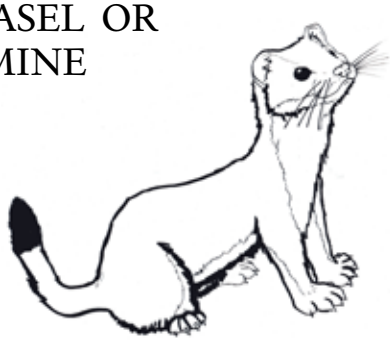
WHITE-TAILED DEER

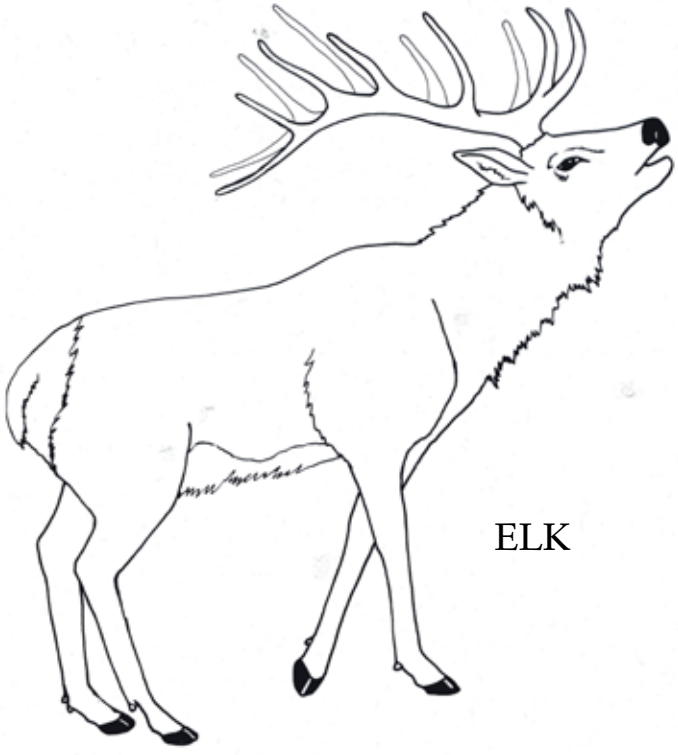
TREE SQUIRREL

SNOWSHOE HARE



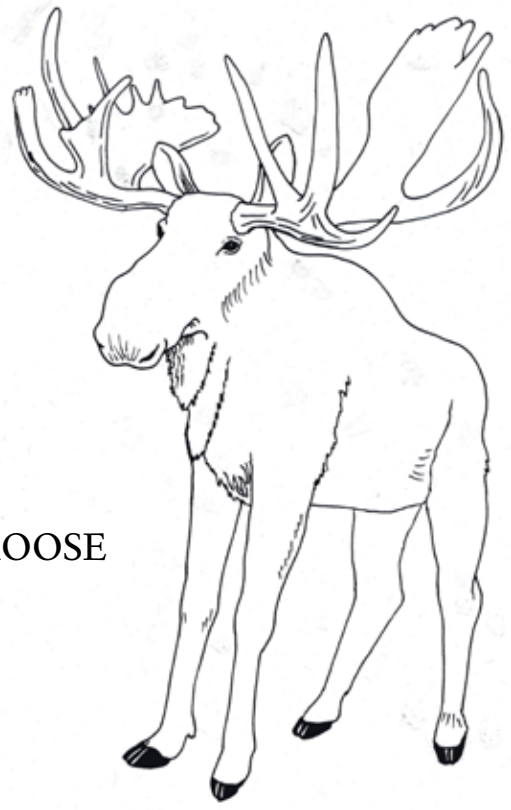
SHORT-TAILED WEASEL OR ERMINE



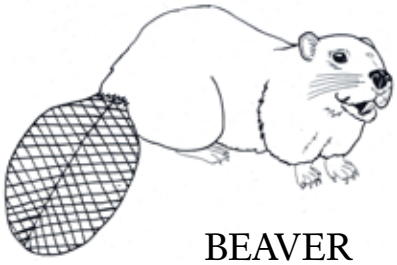


ELK

MOOSE



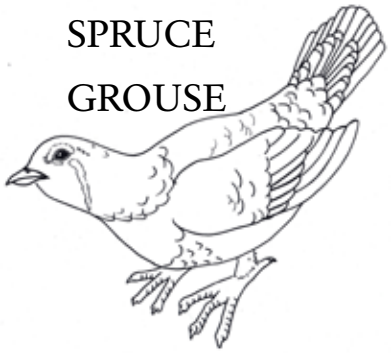
Animal Cards Drawing Page

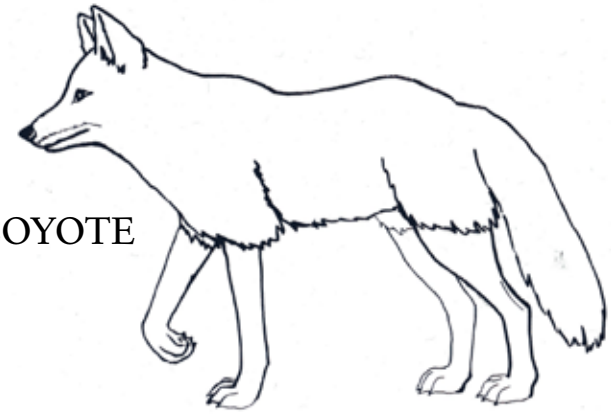


BEAVER

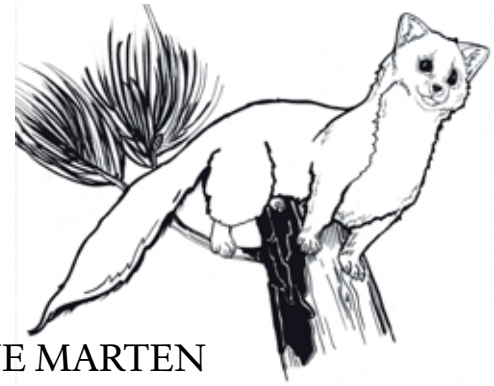
MINK

SPRUCE GROUSE



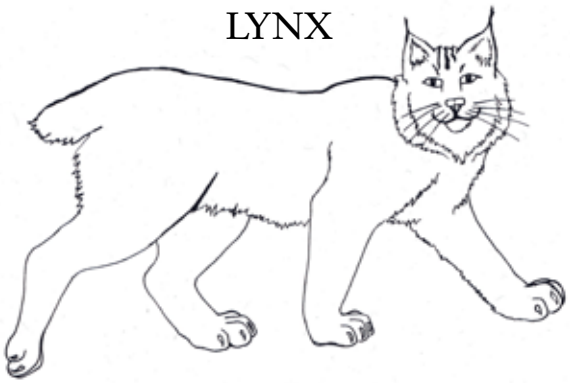


COYOTE

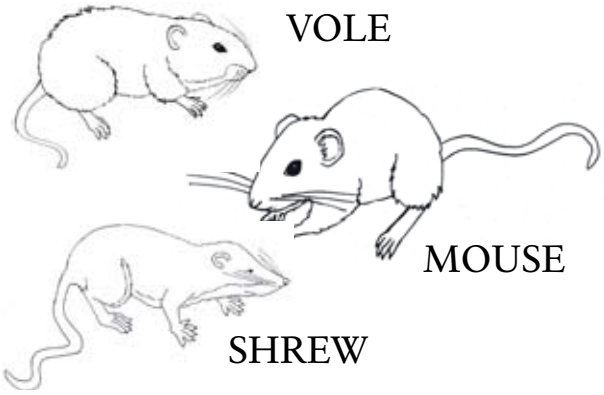


PINE MARTEN

LYNX



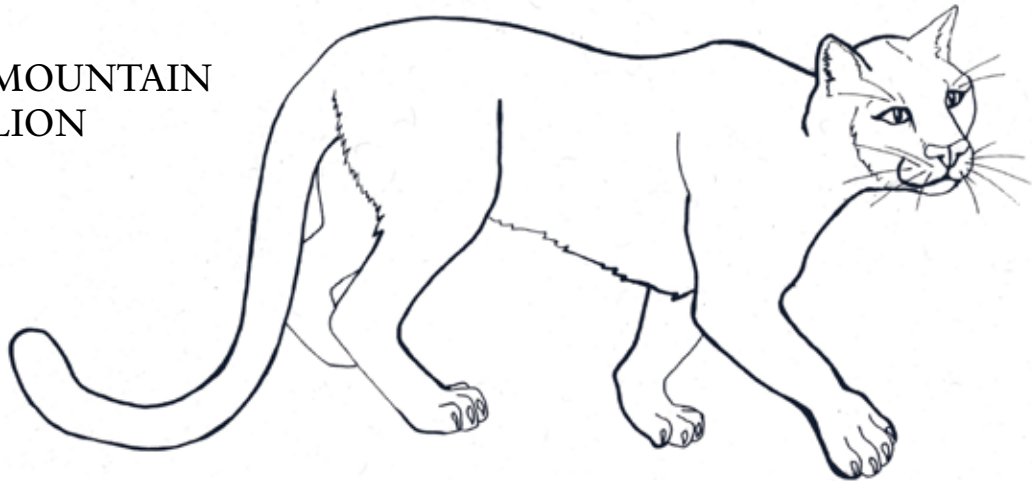
VOLE



MOUSE

SHREW

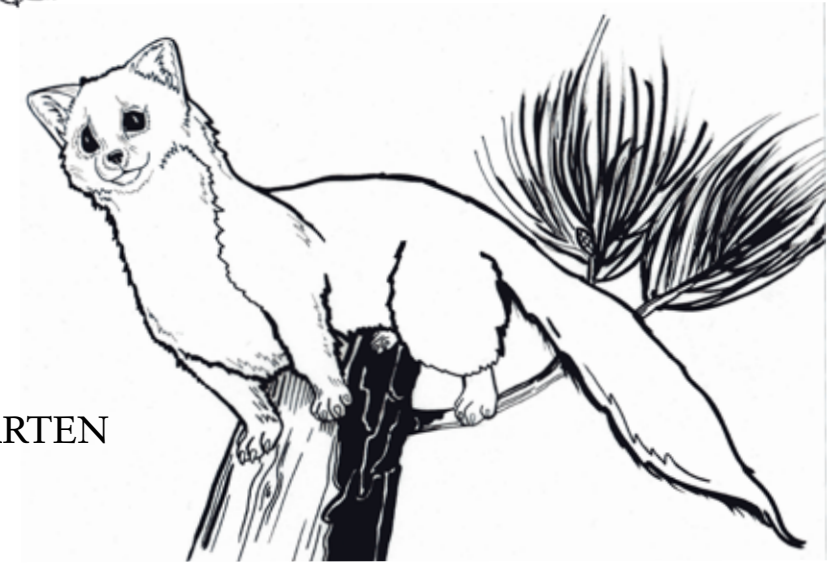
MOUNTAIN LION



MINK

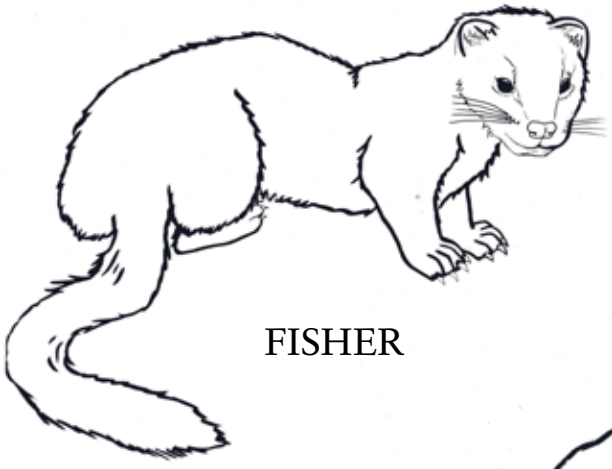
LONG-TAILED
WEASEL

SHORT-TAILED WEASEL
OR ERMINE



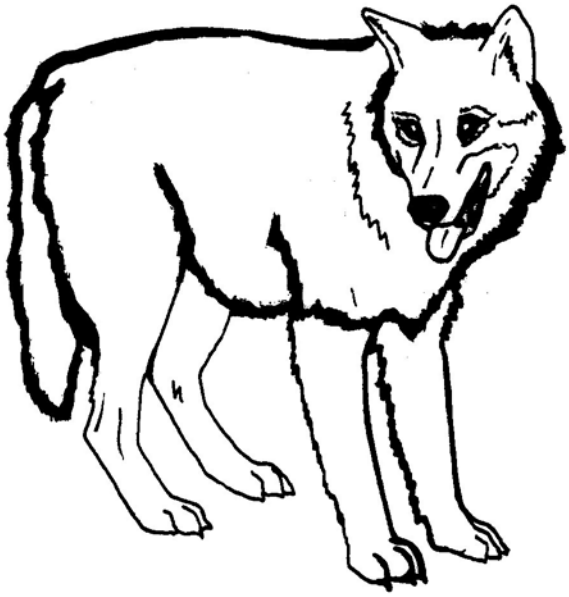
PINE MARTEN

Illustrations by Helen Seay



FISHER

WOLVERINE



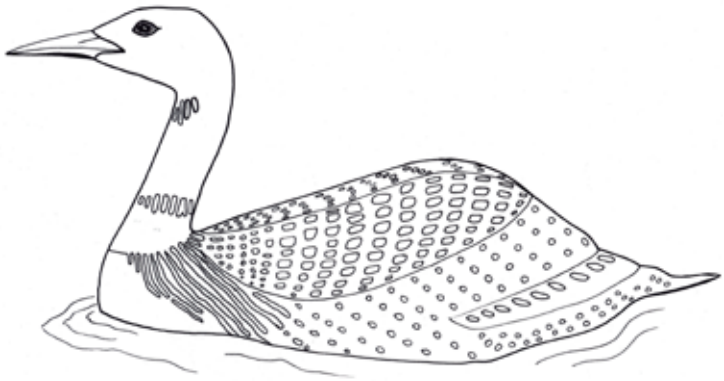
WOLF

WOODPECKER

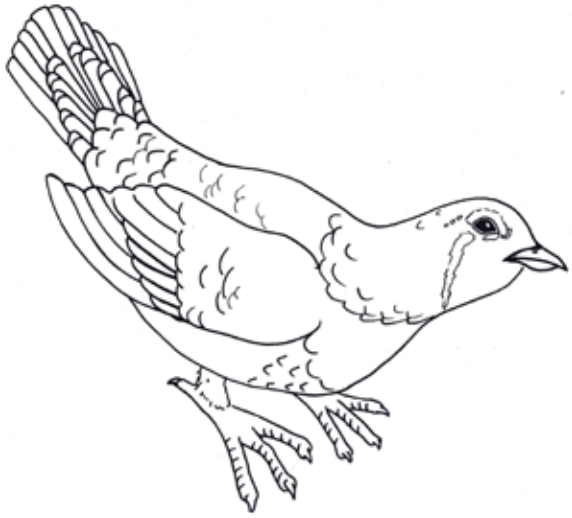
MOLE

LONG-
EARED BAT

LOON

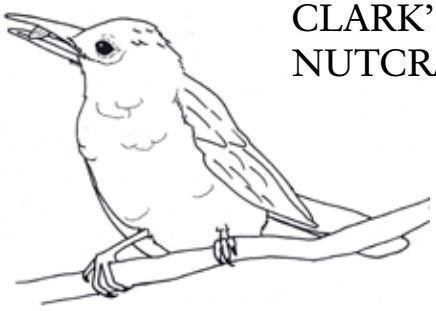


COLUMBIAN
GROUND SQUIRREL



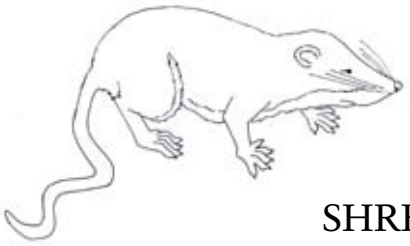
SPRUCE GROUSE

MEADOW VOLE



CLARK'S
NUTCRACKER

MOUSE

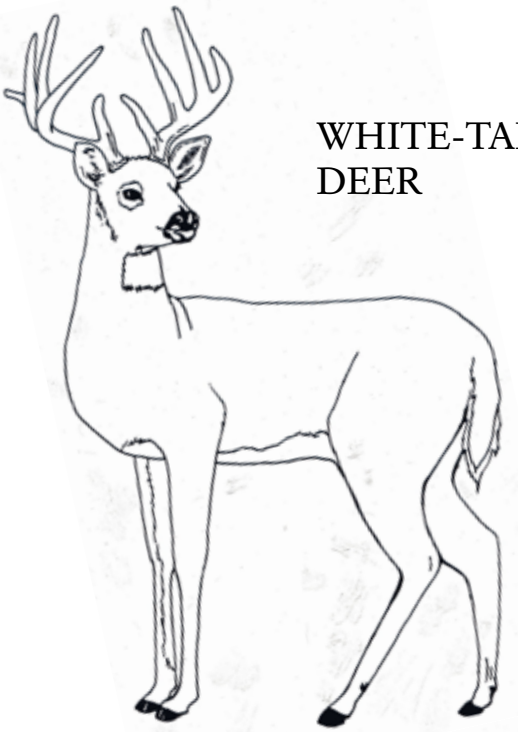


SHREW

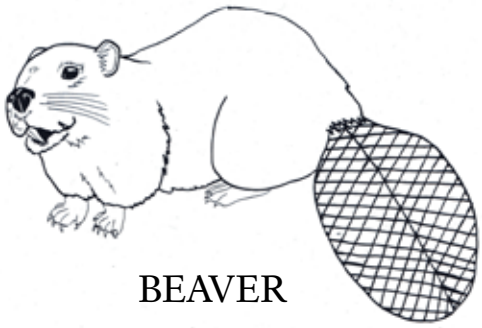
MOUNTAIN GOAT

GOLDEN-MANTLED
GROUND SQUIRREL

POCKET GOPHER

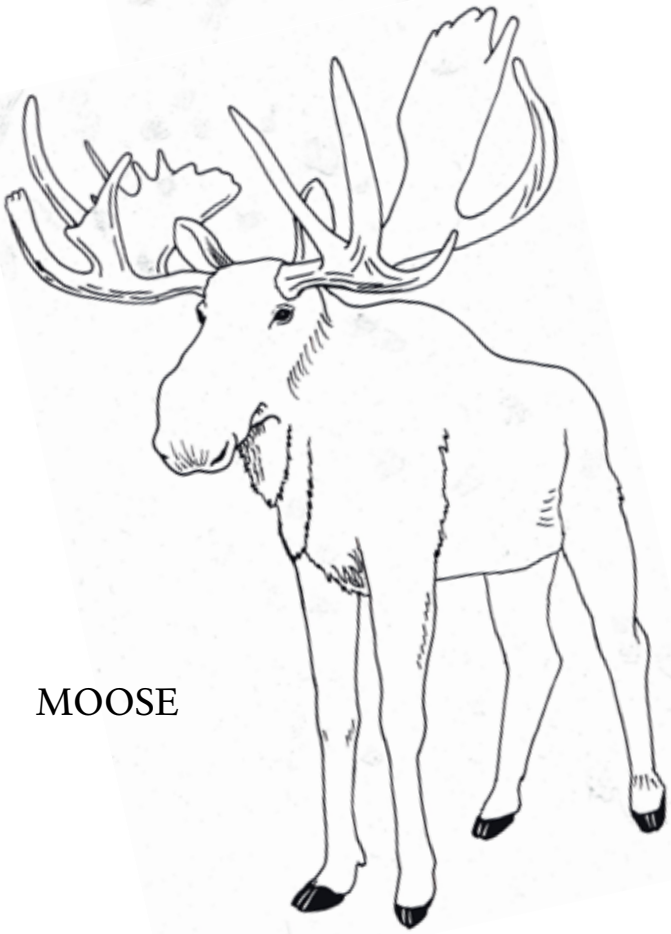


WHITE-TAILED DEER



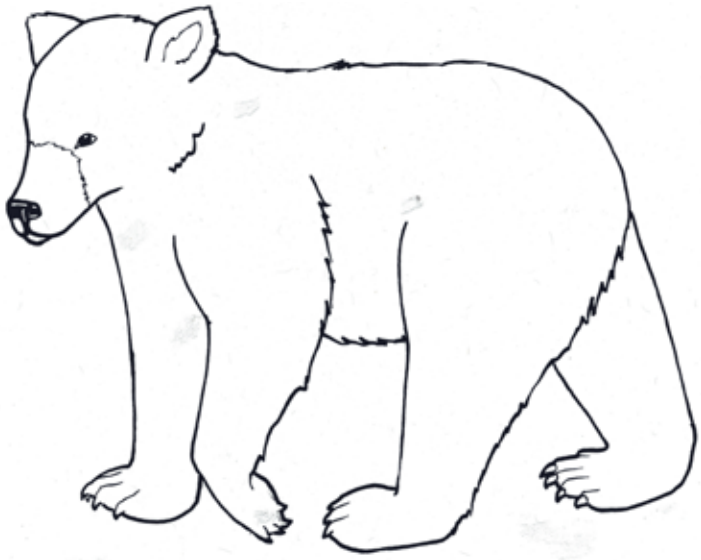
BEAVER

FOX

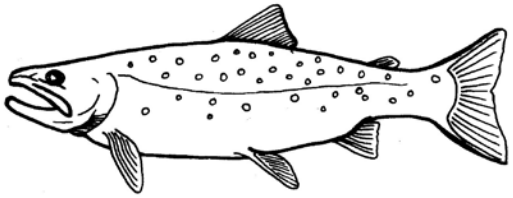


MOOSE

BIGHORN SHEEP



BLACK BEAR

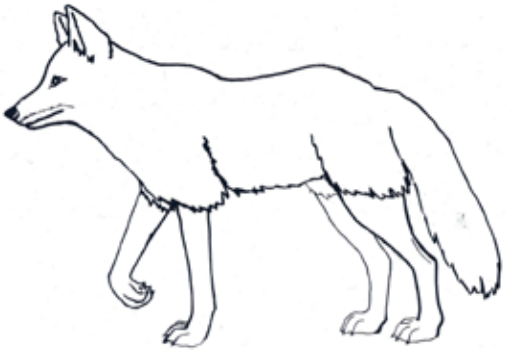


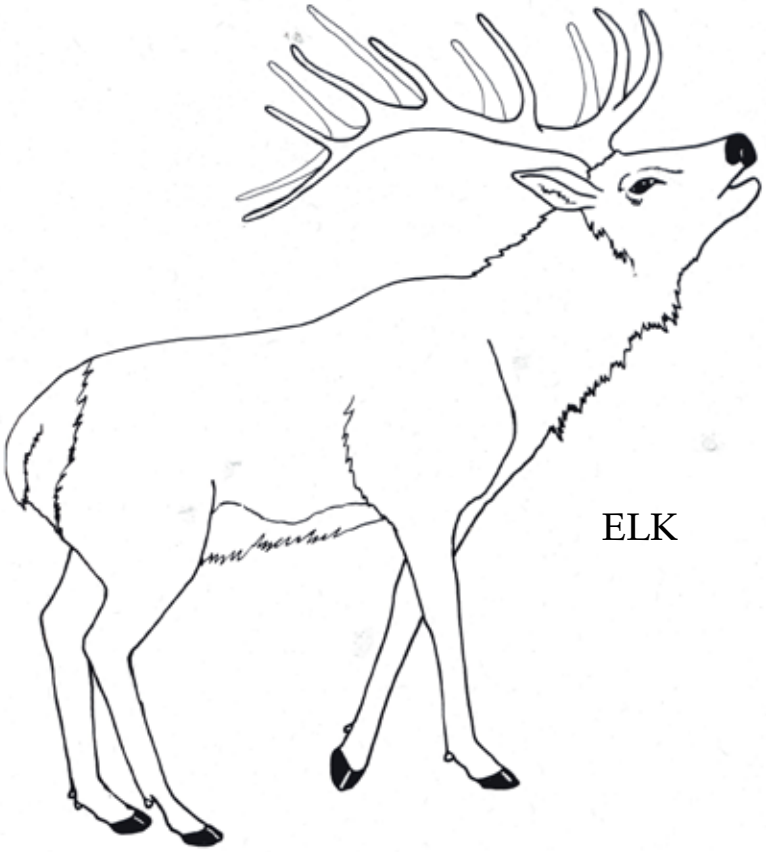
BULL TROUT

GREAT HORNED OWL

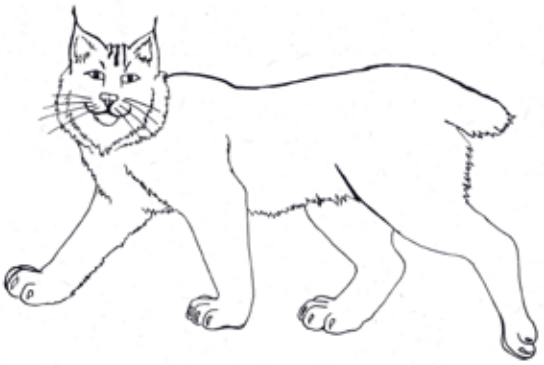
GRIZZLY BEAR

COYOTE

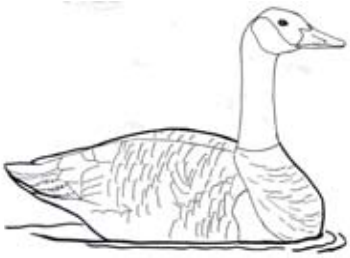




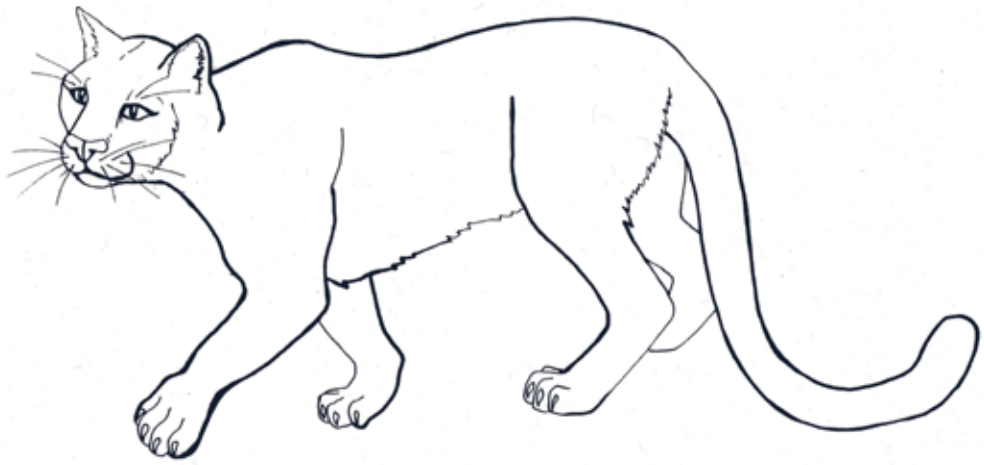
ELK



LYNX



CANADA GOOSE



MOUNTAIN LION

GREAT BLUE HERON

BEETLE

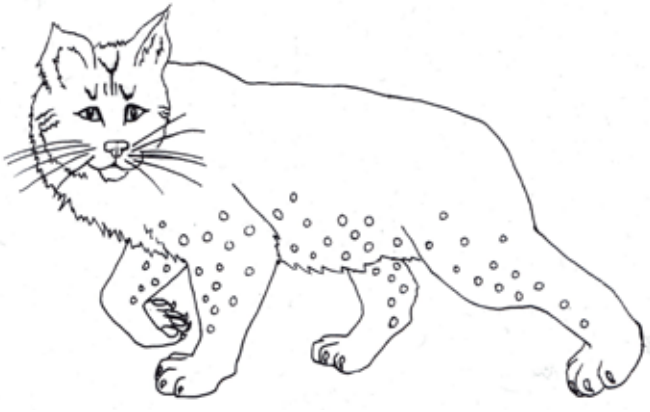
HUMMINGBIRD

PIKA

FROG

SNAKE

BOBCAT

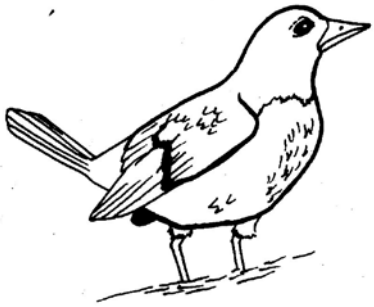


DRAGONFLY

TREE SQUIRREL

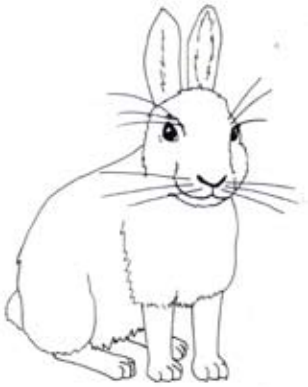
HOVER FLY

SNOW FLEA



DIPPER

RIVER OTTER



SNOWSHOE HARE

SNOWY OWL

SPIDER

BALD EAGLE

Birds of Glacier National Park Field Check List

Common names conform with the A.O.U. Check List of North American Birds (6th edition, 1983). List compiled and revised by David S. Shea, November 1971, April 1976, December 1977, February 1983, January 1990, April 1995, and March 2004.

E-occurs on east side of the Park (East of Continental Divide)
W-occurs on west side of the Park (West of Continental Divide)
A-occurs in alpine areas

ab-- abundant c-- common u --uncommon r-- rare a --accidental i -- introduced • -- known to nest in the Park

S -Spring (March-May) S -Summer (June-August) F -Fall (September-November) W -Winter (December-February)

	S	S	F	W
LOONS				
Common Loon • E, W	u	u	u	r
Yellow-billed Loon W	a			
Pacific Loon W			r	
Red-throated Loon W			a	
GREBES				
Red-necked Grebe E, W	u	u	u	r
Horned Grebe E, W	c	u	u	u
Eared Grebe E, W	u	u	u	
Western Grebe E, W	u	u	u	r
Pied-billed Grebe E, W	r	r	r	r
PELICANS, CORMORANTS				
American White Pelican E, W	r	r		
Double-crested Cormorant E,W			r	r
HERONS, BITTERNS				
Great Blue Heron • E, W	u	u	u	r
Great Egret W	r			
Black-crowned Night Heron W		a		
American Bittern • E, W	r	r		
SWANS, GEESE, DUCKS				
Tundra Swan E, W	c		c	
Trumpeter Swan E, W	r		r	r
Canada Goose • E, W	c	c	c	u
White-fronted Goose W			r	
Snow Goose	u	r	u	
Ross' Goose E, W		r		
Mallard • E, W	c	c	c	c
Gadwall E, W	u	u	u	r
Northern Pintail E, W	u	u	u	r
Green-winged Teal E, W	u	u	u	
Blue-winged Teal E, W	u	u	u	
Cinnamon Teal E, W	u	u	u	
Eurasian Wigeon W	a	a	a	
American Wigeon E, W	c	c	c	r
Northern Shoveler E, W	u	u	u	r
Wood Duck • E, W	u	u	u	r
Redhead E, W	u		u	r
Ring-necked Duck • E, W	c	u	u	
Canvasback E, W	r		r	
Greater Scaup W	a			
Lesser Scaup E, W	u	u	u	r
Common Goldeneye • E, W	c	c	c	u
Barrow's Goldeneye • E, W	c	c	c	r
Bufflehead E, W	c	c	c	u
Long-tailed Duck W			a	
Harlequin Duck • E, W	u	u	r	
White-winged Scoter E, W	u		u	
Surf Scoter W			r	
Ruddy Duck E, W	u	r	u	
Hooded Merganser • E, W	u	u	u	r
Common Merganser • E, W	c	c	c	u
Red-breasted Merganser • E, W	r		r	
VULTURES, HAWKS, EAGLES				
Turkey Vulture E, W	u	u		
Northern Goshawk • E, W	u	u	u	u
Sharp-shinned Hawk • E, W	u	u	u	r
Cooper's Hawk • E, W	u	u	u	u
Red-tailed Hawk • E, W	c	c	c	
Red-shouldered Hawk W			a	
Broad-winged Hawk E, W	a		a	
Swainson's Hawk • E, W	r	r	r	
Rough-legged Hawk E, W	r		r	r
Ferruginous Hawk E, W		r		
Golden Eagle • E, W, A	c	c	c	r
Bald Eagle • E, W	u	u	u	u
Northern Harrier E, W	u	u	u	
Osprey • E, W	u	u	u	
Prairie Falcon • E, W, A	u	u	u	r
Peregrine Falcon E, W	r	r	r	
Merlin E, W, A	r	r	r	
Gyrfalcon A			a	a
American Kestrel • E, W	u	u	u	

	S	S	F	W
GROUSE, PTARMIGAN				
Blue Grouse • E, W, A	c	c	c	c
Spruce Grouse • E, W	c	c	c	c
Ruffed Grouse • E, W	c	c	c	c
Willow Ptarmigan A		a		
White-tailed Ptarmigan • A	u	u	u	u
Sharp-tailed Grouse E		r		
Ring-necked Pheasant W, i	r			
Gray Partridge W, i	r			
CRANES				
Sandhill Crane • E, W	r	r	r	
WRAILS, COOTS				
Sora • E, W	u	u		
American Coot E, W	c	c	c	
SHOREBIRDS				
Killdeer • E, W	c	c	c	r
Semipalmated Plover E, W	a	a		
Black-bellied Plover E, W	a		a	
Black Turnstone E	a			
Common Snipe • E, W	c	c	u	
Long-billed Curlew E, W	u			
Upland Sandpiper E	r			
Spotted Sandpiper • E, W, A	c	c	c	
Solitary Sandpiper E, W	u	u	u	
Willet E, W	r	r		
Greater Yellowlegs E, W	r			
Lesser Yellowlegs E, W	r	r		
Pectoral Sandpiper E, W	r			
Baird's Sandpiper E, W	r	r	r	
Least Sandpiper W			r	
Semipalmated Sandpiper W		r	r	
Western Sandpiper W	r		r	
Sanderling W			r	
Long-billed Dowitcher E, W	r			
Marbled Godwit E, W	r			
American Avocet E, W	u		u	
Wilson's Phalarope E, W	u		u	
Red-necked Phalarope E, W	r	r	r	
GULLS, TERNS				
Glaucous Gull W			a	
Glaucous-winged Gull W			a	
Herring Gull E, W			r	
California Gull E, W	c	c	c	
Ring-billed Gull E, W	c	c	c	
Franklin's Gull E, W	u	u		
Bonaparte's Gull E, W	r		u	
Black-legged Kittiwake W			a	
Forster's Tern E, W			r	
Common Tern E	r		r	
Caspian Tern E	r	r		
Black Tern • E, W	u	u		
PIGEONS, DOVES				
Band-tailed Pigeon W			a	
Rock Dove E, W, i		r		r
Mourning Dove E, W	u	u	u	
OWLS				
Western Screech Owl • E, W	r	r	r	r
Great Horned Owl • E, W	u	u	u	u
Snowy Owl E, W			r	r
Northern Hawk Owl • E, W	r	r		r
Northern Pygmy Owl • E, W	u	u	u	u
Burrowing Owl W	r			
Barred Owl • E, W	u	u	u	u
Great Gray Owl • E, W	r	r	r	r
Long-eared Owl • E, W		r	r	
Short-eared Owl E, W		r	r	
Boreal Owl • E, W	r	r	r	r
Northern Saw-whet Owl • E, W	r	r	r	r
NIGHTHAWKS, SWIFTS				
Common Nighthawk • E, W	u	u		
Black Swift • E, W, A	r	r		
Vaux's Swift • E, W	u	u		
White-throated Swift E, W, A	r	r		
HUMMINGBIRDS				
Black-chinned Hummingbird W	r	r		
Broad-tailed Hummingbird E, W	r	r		
Rufous Hummingbird • E, W, A	c	c		
Calliope Hummingbird • E, W, A	c	c		
KINGFISHERS				
Belted Kingfisher • E, W	u	u	u	r
WOODPECKERS				
Northern Flicker • E, W	c	c	c	r
Pileated Woodpecker • E, W	c	c	c	c
Red-headed Woodpecker E		a		
Lewis' Woodpecker E, W	u	u		
Red-naped Sapsucker • E, W	c	c	u	
Williamson's Sapsucker • E, W	r	r		
Hairy Woodpecker • E, W	c	c	c	c
Downy Woodpecker • E, W	c	c	c	c
White-headed Woodpecker W			a	
Black-backed Woodpecker • E, W	r	r	r	r
Three-toed Woodpecker • E, W	c	c	c	c
FLYCATCHERS				
Eastern Kingbird • E, W	u	u		
Western Kingbird E, W	u	u		

	S	S	F	W
Scissor-tailed Flycatcher W	a			
Ash-throated Flycatcher W				a
Say's Phoebe E, W			r	r
Willow Flycatcher • E, W	u	u		
Least Flycatcher E, W	r	r		
Hammond's Flycatcher • E, W	c	c		
Dusky Flycatcher • E, W	u	u		
Cordilleran Flycatcher E, W	r	r		
Western Wood Pewee • E, W	u	u		
Olive-sided Flycatcher • E, W	u	u		
LARKS				
Horned Lark • E,W,A	r	r	r	r
SWALLOWS				
Violet-green Swallow • E, W, A	c	c	u	
Tree Swallow • E, W	a	b	a	u
Bank Swallow • E, W	u	u	u	
Rough-winged Swallow • E, W	u	u	u	
Barn Swallow • E, W	c	c	u	
Cliff Swallow • E, W, A	c	c	u	
JAYS, MAGPIES, CROWS, RAVENS				
Gray Jay • E,W	c	c	c	c
Blue Jay E, W	r		r	
Steller's Jay • E, W	c	c	c	c
Black-billed Magpie • E, W	u	u	u	u
Common Raven • E, W, A	c	c	c	c
American Crow • E,W	u	u	u	r
Clark's Nutcracker • E, W, A	u	u	u	u
CHICKADEES				
Black-capped Chickadee • E, W	c	c	c	c
Mountain Chickadee • E, W	c	c	c	c
Boreal Chickadee • E, W	u	u	u	u
Chestnut-backed Chickadee • E, Wu	u	u	u	u
NUTHATCHES, CREEPERS				
White-breasted Nuthatch • E, W	r	r	r	r
Red-breasted Nuthatch • E, W	c	c	c	c
Brown Creeper • E, W	c	c	c	u
DIPPERS, WRENS				
American Dipper • E, W	c	c	c	u
House Wren • E, W	u	u		
Winter Wren • E, W	c	c	u	r
Marsh Wren W	a			
Rock Wren • E, W,A	u	u	u	
MOCKINGBIRD, CATBIRDS				
Northern Mockingbird W			r	
Gray Catbird • E, W	s	s	f	w
Sage Thrasher W	a			

	S	S	F	W
THRUSHES, BLUEBIRDS, SOLITAIRES				
American Robin • E, W	a	b	a	b
Varied Thrush • E, W	c	c	c	u
Hermit Thrush • E, W, A	c	c	c	
Swainson's Thrush • E, W	a	b	a	b
Veery • E, W	u	u	u	
Eastern Bluebird E	a			
Western Bluebird E, W			r	
Mountain Bluebird • E, W, A	c	c	c	
Townsend's Solitaire • E, W, A	c	c	c	
KINGLETS				
Golden-crowned Kinglet • E, W	a	b	a	b
Ruby-crowned Kinglet • E, W	c	c	c	
PIPITS				
Water Pipit • E, W,A	u	u	u	
Sprague's Pipit E				r
WAXWINGS				
Bohemian Waxwing E, W	r		r	r
Cedar Waxwing • E, W	c	c	c	
SHRIKES				
Northern Shrike E, W	r		r	r
Loggerhead Shrike E, W	r	r	r	
STARLINGS				
European Starling • E, W, i	u	u	u	r
VIREOS				
Cassin's Vireo E, W	c	c		
Red-eyed Vireo • E, W	u	u		
Warbling Vireo • E, W	c	c		
WARBLERS				
Black-and-white Warbler E	a			
Tennessee Warbler E, W	r	r		
Orange-crowned Warbler • E, W	u	u		
Nashville Warbler E, W	r			
Parula Warbler W	a			
Yellow Warbler • E, W	c	c	u	
Cape May Warbler E,W	a	a	a	
Yellow-rumped Warbler • E, W	c	c	u	a
Townsend's Warbler • E, W	c	c		
Bay-breasted Warbler W	a			
Blackpoll Warbler E, W	r			
Ovenbird E			r	
Northern Waterthrush • E, W	c	c		
MacGillivray's Warbler • E, W	c	c		
Common Yellowthroat • E, W	c	c		
Wilson's Warbler • E, W	c	c		
American Redstart • E, W	u	u		

BLACKBIRDS, ORIOLES	**S**	**S**	**F**	**W**
Bobolink E, W			r	
Western Meadowlark • E, W	u	u	u	
Yellow-headed Blackbird E, W	r			
Red-winged Blackbird • E, W	c	c		
Bullock's Oriole • E, W	r	r		
Rusty Blackbird E, W			r	r
Brewer's Blackbird E, W	r	u	u	r
Common Grackle E			r	
Brown-headed Cowbird • E, W	u	u	u	
TANAGERS, GROSBEAKS				
Western Tanager • E, W	c	c	r	
Rose-breasted Grosbeak E,W	a			
Black-headed Grosbeak • E, W	r	r	r	
Evening Grosbeak • E, W	c	c	c	c
Pine Grosbeak • E, W	u	u	u	u
BUNTINGS, FINCHES, SPARROWS				
Indigo Bunting W			r	
Lazuli Bunting • E, W	u	u		
Lark Bunting E, W			r	
Snow Bunting E, W	u		u	u
Cassin's FinchE, W	u	u	u	
House Finch W			r	r
Gray-crowned Rosy Finch • E, W, A	u	u	u	u
Common Redpoll E, W	u		u	u
Hoary Redpoll W	r			
Pine Siskin • E, W, A	c	c	c	u
American Goldfinch E, W	r	r	r	
Red Crossbill • E, W	c	c	c	c
White-winged Crossbill E, W	u	u	u	u
Green-tailed Towhee E			a	
Spotted Towhee E,W	u	u		
Savannah Sparrow • E, W	c	c		
LeConte's Sparrow • E, W	r	r		
Vesper Sparrow • E, W	u	u	u	
Lark Sparrow W	r			
American Tree Sparrow E, W	r		r	r
Chipping Sparrow • E, W	c	c	u	
Clay-colored Sparrow • E, W	u	u		
Brewer's Sparrow • E, W	u	u		
Field Sparrow W			a	
Harris' Sparrow E, W	r		r	
White-crowned Sparrow • E, W, A	c	c	c	
Golden-crowned Sparrow E, W	c	c	c	
White-throated Sparrow E, W			r	r
Fox Sparrow • E, W	c	c	u	
Lincoln's Sparrow • E, W	u	u	u	
Song Sparrow • E, W	u	u	u	r
Dark-eyed Junco • E, W	a	b	a	b	a	b	u
McCown's Longspur E,W	r		r	
Lapland Longspur E, W	u	u	u	
Chestnut-collared Longspur E, W	u			

Mammals of Glacier National Park*

*Common and scientific names from R. S. Hoffman and D. L. Pattie, A Guide to Montana Mammals, 1968. Compiled by David S. Shea, November, 1971 and revised August, 1986, and April, 1995.
E Occurs east of the Continental Divide, Spruce-fir forest, aspen, bunchgrass meadows
W Occurs west of the Continental Divide, Cedar - hemlock - yew - lodgepole - fir - western larch forest, some meadows
A Occurs in alpine areas, Above upper edge of continuous forest, open areas, makes up about 1/3 of park along Continental Divide.
l Occurs only rarely in the park.

ORDER INSECTIVORA - SHREWS
Pygmy shrew (Sorex hoyi) W
Dry, open coniferous forests
Masked shrew (Sorex cinereus) E W
Coniferous forests, meadows, ponds and stream edges
Vagrant shrew (Sorex vagrans) E W A
Moist forests and grasslands, marsh and stream edges
Montane shrew (Sorex monticolus) E W
Higher elevation coniferous forests
Northern water shrew (Sorex palustris) E W
Stream edges

ORDER CHIROPTERA - BATS
Little brown bat (Myotis lucifugus) E W
Coniferous forests, often around buildings, caves, nocturnal
Long-eared bat (Myotis evotis) E W A l
Coniferous forests, meadows, nocturnal
Long-legged bat (Myotis volans) E W A
Coniferous forests, meadows, nocturnal
Big brown bat (Eptesicus fuscus) E W
Coniferous forests, often around buildings, caves, nocturnal
Silver-haired bat (Lasionycteris noctivagans) E W
Coniferous forests, meadows, nocturnal
Hoary bat (Lasiurus cinereus) E W l
Coniferous forests, mostly nocturnal

ORDER CARNIVORA - CARNIVORES
Bobcat (Lynx rufus) E W l
Open forests, brushy areas
Lynx (Lynx lynx) E W
Coniferous forests
Mountain lion (Felis concolor) E W
Coniferous forests
Raccoon (Procyon lotor) E W l
Open forests, stream bottoms
Black bear (Ursus americanus) E W A
Forests, slide areas, alpine meadows
Grizzly bear (Ursus arctos) E W A
Forests, slide areas, alpine meadows
Red fox (Vulpes vulpes) E
Grasslands, open forest
Coyote (Canis latrans) E W A
Forests, grasslands
Wolf (Canis lupus) E W
Coniferous forests
Striped skunk (Mephitis mephitis) E W
Open forests, grasslands
Badger (Taxidea taxus) E W
Grasslands
River otter (Lontra canadensis) E W l
Rivers, lakes
Wolverine (Gulo gulo) E W A
Coniferous forests, alpine meadows
Least weasel (Mustela nivalis) E W l
Open forests, grasslands
Short-tailed weasel (Mustela erminea) E W A
Coniferous forests, meadows
Long-tailed weasel (Mustela frenata) E W A
Open forests, meadows
Mink (Mustela vison) E W
Creek and lake edges
Marten (Martes americana) E W A
Coniferous forests
Fisher (Martes pennanti) E W l
Coniferous forests

ORDER LAGOMORPHA - PIKAS, RABBITS, HARES
Pika (Ochotona princeps) E W A
Rockslides
Snowshoe hare (Lepus americanus) E W
Coniferous forests
White-tailed jackrabbit (Lepus townsendii) E l
Grasslands

ORDER RODENTIA - RODENTS
Porcupine (Erethizon dorsatum) E W A
Coniferous forests
Beaver (Castor canadensis) E W
Streams, lakes
Northern pocket gopher (Thomomys talpoides)EW A
Meadows

Yellow-bellied marmot (Marmota flaviventris) E l
Open rocky foothills, talus slopes
Hoary marmot (Marmota caligata) E W A
Rocky areas, alpine meadows
Least chipmunk (Eutamias minimus) E W A
High open forests, brushy, rocky areas, alpine meadows
Yellow pine chipmunk (Eutamias amoenus) E W
Open forests, brushy, rocky areas
Red-tailed chipmunk (Eutamias ruficaudus) E W
Open forest, brushy, rocky areas
Golden-mantled ground squirrel (Spermophilus lateralis) E W A
High open forests, rocky areas
Columbian ground squirrel (Spermophilus columbianus) E W A
Open woodlands, grasslands, alpine meadows
Thirteen-lined ground squirrel E l (Spermophilus tridecemlineatus)
Grasslands
Richardson ground squirrel (Spermophilus richardsoni) E l
Grasslands
Northern flying squirrel (Glaucomys sabrinus) E W
Coniferous forests, nocturnal
Red squirrel (Tamiasciurus hudsonicus) E W
Coniferous forests
Western jumping mouse (Zapus princeps) E W A
Grasslands, alpine meadows
Bushy-tailed wood rat (Neotoma cinerea) E W A
Rocky areas, old buildings
Deer mouse (Peromyscus maniculatus) E W A
Forests, grasslands, alpine meadows
Muskrat (Ondatra zibethicus) W
Streams, lakes, marshy areas
Northern bog lemming (Synaptomys borealis) W l
Coniferous forests
Red-backed vole (Clethrionomys gapperi) E W
Coniferous forests
Montane heather vole (Phenacomys intermedius)EWA
Coniferous forests, alpine meadows
Water vole (Arvicola richardsoni) E W A
High elevation stream and lake edges
Long-tailed vole (Microtus longicaudus) E W
Coniferous forests, grasslands
Meadow vole (Microtus pennsylvanicus) E W
Open forests, meadows, along streams, marshy areas.

ORDER ARTIODACTYLA - EVEN-TOED UNGULATES
White-tailed deer (Odocoileus virginianus) E W
Coniferous forests, meadows, creek and river bottoms
Mule deer (Odocoileus hemionus) E W A
Open forests, meadows, often at high elevations
American elk (Cervus elaphus) E W A
Open forests, meadows
Moose (Alces alces) E W
Coniferous forests, lakes, slow streams, marshy areas
Bighorn sheep (Ovis canadensis) E W
Open mountainous areas
Mountain goat (Oreamnos americanus) E W A
High peaks and meadows

Vocabulary

Acclimatization - Seasonal or long-term physiological adjustment, usually in response to temperature changes.
Adaptation - Structures or behaviors that help living things survive in their environment.
Age Hardening - Process of snow crystals changing within the snow pack over time.
Altitudinal Migrators- Animals that move seasonally from higher or lower elevations to the opposite.
Anti-Freeze - Substance that lowers the temperature at which something normally freezes or retards or prevents freezing.
Atmosphere- The layer of gases that surrounds the earth.
Bird Crop- A pouch in bird's throat: a pouch in the throat of many birds in which they store food before regurgitating it to feed their young.
Blizzard- A violent snowstorm with winds blowing at a minimum speed of 35 miles (56 kilometers) per hour and visibility of less than one-quarter mile (400 meters) for three hours.
Bud- A small protuberance on the stem or branches of a plant, containing the rudiments of future leaves, flowers, or stems; an undeveloped branch or flower.
Day Length - Duration of the period from sunrise to sunset.
Dormant - Not actively growing: in an inactive state, when growth and development slow or cease, in order to survive adverse environmental conditions.
Cache - A hiding place used especially for storing provisions (food).
Cocoon - A protective case of silk or similar fibrous material spun by the larvae of moths and other insects that serves as a covering for their pupal stage.
Camouflage - To conceal by the use of disguise or by protective coloring or garments that blend in with the surrounding environment.
Chinook - Indian word for "snow eater" that refers to a warm dry wind that descends from the eastern slopes of the Rocky Mountains, causing a rapid rise in temperature.
Chioneuphore - Organisms that have adjusted their life to winter and can survive although they have not developed any special adaptations for survival.
Chionophile - Organisms that possess definite adaptations for life in a winter environment.
Chionophobe - Organisms unable to adjust to live in the nivean environment.
Climate- The meteorological conditions, including temperature, precipitation, and wind, that characteristically prevail in a particular region.
Condensation - Change of a substance from the gaseous (vapor) to the liquid state.
Continental Divide - The Continental Divide is a ridge of high ground that runs irregularly north and south through the Rocky Mountains and separates eastward-flowing from westward-flowing streams.
Conduction - Transfer of heat from one substance to another by molecular collisions, in other words by direct contact (such as heat lost by touching cold solids and liquids).
Constructive Metamorphism - The process in which ice crystals favorably situated in the snowpack grow by accretion of water onto their surfaces.
Convection- Transfer of heat by a moving fluid (such as wind or water passing over object).
Deciduous - Shedding or losing foliage at the end of the growing season: deciduous trees.
Depth Hoar - Brittle ice crystals, often hollow and cuplike, formed in warmer layers of the snow pack as a result of continuous vapor loss from their surfaces.
Destructive Metamorphism - The process in which new-fallen snow crystals lose their delicate structure by a redistribution of internal energy, and coalesce into rounded ice grains.
Earth's Axis - The Earth's axis is an imaginary line drawn through its center from its North Pole to its South Pole.
Ecology - Study of the interrelationships between living things and their environment.
Elevation - The height to which something is elevated above a point of reference such as the ground or sea level.

Evergreen - A tree, shrub, or plant having foliage that persists and remains green throughout the year.
Front Range -The Front Range is on the eastern edge of the Rocky Mountains and on the western edge of the Great Plains.
Germinate - To begin to sprout or grow.
Glacier- A body of ice that flows under its own mass due to gravity.
Guard Hairs - Coarse hairs that form the outer fur and protect the underfur of certain mammals.
Hemisphere - Either the northern or southern half of the earth as divided by the equator or the eastern or western half as divided by a meridian.
Hibernation - A physical state where an animal's body functions slow down in order to conserve energy through a season of no food, water, and cold temperatures.
Hormones - Chemical messengers sent throughout the body.
Huddle - To crowd together, as from cold or fear.
Hypothalmus- That region of the brain which regulates temperature-control mechanisms in the body.
Hypothermia - A condition in which the body core temperature falls below that considered normal for a warm blooded animal.
Insolation - Incoming solar radiation
Insulation- Materials which retard the flow of heat (fat, fur, feathers, etc.).
Intranivean - Within the snow.
Latitude - The angular distance north or south of the earth's equator, measured in degrees along a meridian, as on a map or globe.
Leaf Scars - Where leaves were attached, can be found on older stems transformed to appear superficially like lenticels.
Lichen - A lichen is a symbiotic relationship between a fungus and an alga. The composite organism behaves as a single independent organism.
Metabolic Rate - The amount of energy expended in a give period.
Migrate - To change location periodically, especially by moving seasonally from one region to another.
Mosses - Any of various green, usually small, nonvascular plants of the class Musci of the division Bryophyta.
Nivean - within the snow.
Organsim - Any living thing.
Over browsing - To feed on leaves, young shoots, and other vegetation; graze to an extent that removes all the vegetation.
Over Winter - To pass or spend the winter in an area. To remain alive through the winter
Perennials - A perennial is a plant that lives more than one growing season.
Photoperiod - The amount of light received daily. Total length of time between sunrise and sunset.
Precipitation - Precipitation is the result of water vapor that has condensed and formed clouds. The water that falls from these clouds is snow, sleet, hail, or rain.
Predator - An animal or other organism (such as a carnivorous plant) that hunts and kills other organisms for food in an act called predation.
Prey- An animal hunted or caught for food.
Ptarmigan - Bird that turns white and remains above treeline throughout winter.
Radiation- The propagation of energy through space. The energy received by or emitted from a radiating object. The leading cause of heat loss - occurs when heat is released directly from the body's surface - can be prevented by adequately covering the body.
Resistance - Staying and enduring challenges of winter and resisting its stresses.
Roost- A place with perches for fowl or other birds or to rest or sleep on or as if on a perch or roost.
Rut- An annually recurring condition or period of sexual excitement and reproductive activity in male deer.
Season -One of the four natural divisions of the year, spring, summer, fall, and winter, in the North and

South Temperate zones. Each season, beginning astronomically at an equinox or solstice, is characterized by specific meteorological or climatic conditions.
Solar Insolation - The amount of sunlight striking the earth's surface.
Snow Metamorphism -
Snow Pack - The accumulated depth of snow.
Snow Water Equivalent (SWE) - The amount of water that would be obtained if the snowpack were melted, usually expressed in inches of water.
Subnivean - Under the snow.
Supranivean- On top of the snow.
Trailing - Following in tracks made by a strong lead animal.
Temperature - Temperature is a measure of the average heat or thermal energy of the particles in a substance.
Torpor- A short-term condition physiologically similar to hibernation in which metabolic rate and body temperature may be reduced to conserve energy.
Tree Cavities - Holes in trees that can be used by many organisms for shelter.
Tree Well - The area around the base of a tree.
Toleration - A disposition to tolerate or accept people or situations.
Under Coat - A covering of short hairs lying underneath the longer outer hairs of an animal's coat.
Watershed- An area of land that drains downslope to the lowest point. The water moves through a network of drainage pathways, both underground and on the surface.
Wind Chill- The temperature your body feels when the air temperature is combined with the wind speed.
Winter Coats- Thicker pelage or fur, provides further cold protection (the winter coat of the mink is highly prized and is much thicker and heavier than the summer coat), as does the winter white fur of weasels and snowshoe hare. White hairs, without the pigment melanin, have more air spaces within the hairs and thus has greater insulation.
Winter- Usually coldest season of the year, occurring between autumn and spring, extending in the Northern Hemisphere from the winter solstice to the vernal equinox, and popularly considered to be constituted by December, January, and February.
Winterkill- To kill by the cold, or exposure to the inclemency of winter; as, "the wheat was winterkilled."
Winter Solstice - The shortest day of the year and the day winter officially begins, Dec. 21.
Yard-up - Stay in one location.

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