OA Guide to Winter Camping

by Rick Curtis

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Exploring the wilderness in winter is a wonderful experience. You are far from the crowds, in a hushed tranquil world of white. At the same time you must realize that this environment can be extremely dangerous. If you aren't aware of the hazards and of the proper precautions, skills, and equipment to have you can be at great risk. The greatest dangers in the winter environment are hypothermia and frostbite. These are covered completely in the Hypothermia and Cold Weather Injuries lecture.

Hypothermia - results when the body looses heat too rapidly. At a certain point the body's heat producing ability cannot keep pace with the heat loss and the core temperature—the temperature of the internal organs begins to drop. Once core temperature begins to drop the body can no longer reverse this trend without aid—either food, warm clothing, fire etc. Generally it is impossible to self-diagnose hypothermia once it is past the beginning stages. Without recognition and proper treatment it leads to death.

Frostbite - is the freezing of body tissue. It begins at the skin surface and can move to deeper tissues. Proper rewarming and treatment must be given or tissue may be lost. In extreme cases limbs are lost.

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1. TRIP PLANNING

Planning a trip in the winter means spending a good deal of time researching areas and conditions to determine where, when, and how the trip will work. All of these factors will interact to determine what your daily pace and mileage can be.

- Goals for the trip
- Route - will you be on a trail of off trail, or a mix
- Snow level - shallow or deep
- Snow quality - powder, packed, breakable crust, or variable
- Trail - breaking trail or on a broken trail
- Mode of travel - will you be hiking, snowshoeing, or skiing
- Elevation changes - going up may be very slow while coming down may be very fast
- Strength and experience of group
- Group size

Keeping all these factors in mind, set up a Time Control Plan for your trip. Keep in mind that everything takes

"twice" as long in the winter (setting up camp, breaking camp, cooking, going to the bathroom, etc.). Look at your proposed route for potential campsites for each day. Also look to see where you could camp before your planned site if you can't make it. Know what your emergency and bail out options are if conditions deteriorate or you have problems. Talk to area rangers about permits and camping restrictions. Find out about snow levels, avalanche danger, safety of ice crossings, etc.

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2. PERSONAL EQUIPMENT

The essence of staying warm in the winter is having the proper clothing layers and knowing how to use them effectively.

Heat Loss

The body basically acts as a furnace, producing heat through chemical reactions and activity. This heat is lost through conduction, convection, evaporation, radiation, and respiration. As physical activity increases so does heat production and conversely as activity decreases so does heat production. The key to keeping warm is to add insulation to the body.

Insulation

The thermal insulation of clothing is proportional to the thickness of the dead air space enclosed. Dead air is defined as any enclosed unit of air that is small enough that natural convection currents would not arise in it. Such currents have been detected in units as small as 2 millimeters in diameter. The dead air next to the skin is heated up by the body and provides a layer of warmth around the body. The clothing is not what is keeping you warm it is the dead air. This is because the denser a material the faster it can transfer heat through conduction, the density of air is obviously minuscule compared to a piece of a fabric. The "clo" unit was developed to provide a measurement of insulating effectiveness. One clo is roughly equal to the insulating value of an ordinary wool business suit. Each inch of thickness of conventional insulating materials (wool, pile, down) provides a theoretical value of about 4.7 clo or a practical "in use" value of 4.0 clo.

The Layering Principle

The key to providing this dead air space is through having a number of layers of clothing. Each layer provides a certain clo value of dead air space. This allows you to add or shed layers to increase or decrease your accumulated dead air space as the temperature changes and/or as your activity level changes. Remember, your body is the heat source, the clothing layers only serve to trap the heat and slow down your heat loss to the cold environment. If you have too much clothing on, you will overheat and start to sweat. You need to find the proper heat balance between the number and types of layers and your activity level.

Example 1: You are snowshoeing up a steep incline with a 50 lb. pack. The air temperature is 10^{o} Fahrenheit and you are dressed in wool pants and a lightweight polypropylene shirt. As soon as you stop for a rest, your heat production slows. If you stop for more than a couple of minutes, you will begin to chill. So you need to have an outer layer handy to put on.

Example 2: You are skiing along the flat. The air temp is 25^{o} Fahrenheit and you are dressing in light polypropylene tops and bottoms, a down vest, and a windshell. You come to a long steep hill and have to push hard to get up and over. You start to sweat as your heat production increase with the increased muscle activity. To prevent overheating, you pull off the vest and stick it in your pack.

Why not just have lots of layers on and sweat? Heat loss from a wet surface can be up to 25 times greater than a dry surface (due to the higher density of water). If you sweat and get soaked, you will lose heat much more quickly through evaporation of the water. Also you are loosing an incredible amount of water through sweating since the air is so dry. Too much water loss leads to dehydration which significantly increases the risk of hypo-

thermia. So you want to control your layers so as to be warm at the activity level you are in but not sweating profusely.

Thus, traveling in the winter is a *constant* process of adjusting your layers to keep comfortable. This means having a number of layers you can add or subtract and allowing for versatility within layers. Convection may account for the greatest amount of heat loss under most conditions. In order to properly insulate, you need to have an outer layer that is windproof.

Example 3: You are standing on a windblown summit in a wool sweater, the wind will penetrate through the openings in the sweater and quickly carry away the warm layer of air next to the skin.

Another convective factor is the "bellows action" of clothing. As you move a bellows action occurs which tends to pump your accumulated warm air out through openings in your clothing and sucks the cooler air in. In some conditions this action can reduce your body's personal insulation by 50% or more. Thus, it is important that *all* layers have effective methods of being "sealed" (i.e. buttons, zippers etc.) Openings in layers allow you to ventilate, to open the "chimney damper" if you are beginning to overheat, without having to actually remove a layer. So opening and closing zippers on a jacket, or armpit zips will allow you to either ventilate if you are getting too hot or seal up if you are getting chilly, all without having to add or take off a layer. With clothes that are too loose, the bellows action pumps warm air out through the openings. You need to have clothes that fit properly but not tightly. Too tight, and the clothes compress and actually reduce dead air space in layers below as well as restricting body movement.

Another general rule is that the efficiency of clothing is proportional to the diameter of the body part it covers. Thus a given thickness of insulation added to your trunk will be more thermally efficient than the same thickness added to your arm or leg. It will also help maintain that body core temperature. This is why vests work well to maintain body heat. There is an optimal thickness of insulation for each body part. Beyond that the added bulk tends to be more of a hindrance in movement than the added insulation is worth.

Have you ever noticed that your hands feel colder after putting on a thin pair of gloves? This is because when insulation is wrapped around a curved surface, the cross-sectional area of the insulation through which the heat may flow is greater as is the surface area from which the heat may be lost. This means that the total insulation efficiency of a given thickness progressively decreases as curvature sharpens over a surface. In addition, small cylinders, such as fingers, show a paradoxical effect. The addition of a thin layer of insulation actually increases heat loss until a thickness of about 1/4 inch is reached. This heat resistance gains as additional thickness is added. However, added thickness beyond 1/4 inch increases warmth very little in proportion to its thickness. This is one reason that thin gloves don't keep your hands particularly warm.

Clothing Materials

Some of the different types of materials for winter clothing and insulation are discussed below.

1. Wool - derives its insulating quality from the elastic, three-dimensional wavy crimp in the fiber that traps air between fibers. Depending on the texture and thickness of the fabric, as much as 60-80% of wool cloth can be air. Wool can absorb a fair amount of moisture without imparting a damp feeling because the water "disappears" into the fiber spaces. Even with water in the fabric wool still retains dead air space and will still insulate you. The disadvantage to wool is that it can absorb so much water (maximum absorption can be as much as 1/3 third the garment weight) making wet wool clothing very heavy. Wool releases moisture slowly, with minimum chilling effect. Wool can be woven in very tight weaves that are quite wind resistant. An advantage to wool is that it is relatively inexpensive (if purchased at surplus stores). However, it can be itchy against the skin and some people are allergic to it.

2. Pile or Fleece fabrics - is a synthetic material often made of a plastic (polyester, polyolefin, polypropylene, etc.). This material has a similar insulative capacity as wool. Its advantages are that it holds less water (than wool) and dries more quickly. Pile is manufactured in a variety of different weights (thicknesses) offering different amounts of loft and insulation. This allows for numerous layering possibilities. The disadvantage of pile is that it has very poor wind resistance and hence a wind shell on top is almost always required. Versions of pile are available that have a middle windproof layer.

3. Polypropylene and other Hydrophobic fabrics - polypropylene is a synthetic, plastic fiber which offers dead air space and a fiber which cannot absorb water. The fiber is hydrophobic so it moves the water vapor away from the source (the body). Polypropylene layers are extremely effective worn directly against the skin as a way of keeping the skin from being wet and reducing evaporative heat loss. As the water moves away from the body it will evaporate, but each additional millimeter of distance between your skin and the point of evaporation decreases the amount of body heat lost in the evaporative process. Some fabrics rely on the chemical nature of the fiber to be hydrophobic. Others fabrics use a molecular coating the achieve the same end.

4. Vapor Barrier Systems - another way to stay warm in the winter is through vapor barriers. The body is always losing water through the skin even when we are not active. This loss is known as insensible perspiration and occurs unless the air humidity is 70%. This insensible perspiration goes on at the rate of nearly half a quart every 24 hours. Since it takes 580 calories per gram to turn liquid water into water vapor, heat is continually lost through insensible perspiration as well as through sweat from any activity. A vapor barrier is a clothing item which is impervious to water thereby serving as a barrier to the transportation of water vapor. When worn near the skin it keeps water vapor near the skin. Eventually the humidity level rises to the point where the body senses a high humidity level and shuts off insensible perspiration. This prevents evaporative heat loss and slows dehydration.

Vapor barriers should not be used directly against the skin because any evaporation of moisture directly at the skin surface leads to heat loss. Wearing polypropylene or some other hydrophobic layer between the skin and the vapor barrier allows the moisture to be transported away from direct skin contact. There is no doubt that vapor barrier systems are effective **for some people in some conditions.** The issues you must consider before using a vapor barrier are activity level, amount you naturally sweat, and "moisture comfort." If you are not active, such as when using a vapor barrier liner at night in a sleeping bag, the system will work well. A vapor barrier sleeping bag liner will typically permit you to sleep comfortably in temperatures 10 - 15 degrees colder than in the bag alone. However, some people find that they are not comfortable with the level of moisture in the bag and fell clammy. If this interferes with sleeping it may be a problem, better to have a better insulated sleeping bag. Vapor barrier liners for sleeping bags also help in another way. In cold conditions, the moisture from your body escapes upward through the bag, when reaching the cold outside of the bag it condenses into liquid or event frost. Over a number of days this moisture level in your bag increases. If you can't dry out the bag it will slowly get heavier and heavier as it holds more water. With a down bag, this moisture can actually soak the feathers and cause the bag to loose significant amounts of loft (dead air space), thereby reducing it's effectiveness.

When you are active, like snowshoeing, and you are wearing a vapor barrier such as a vapor barrier sock, you must carefully monitor how you sweat. If you are someone who sweats a lot with activity, your foot and polypropylene liner sock may be totally soaked before the body shuts down sweating. Having this liquid water next to the skin is going to lead to increased heat loss. If you don't sweat much, your body may shut down perspiration at the foot before it gets actually wet. This is when the vapor barrier system is working. The important point is that heat loss comes from water changing state from a liquid to a gas. Liquid water next to the skin leads to significant heat loss. Water vapor next to the skin does not. You must experiment to determine if vapor barrier systems will work for you.

5. Polarguard™, Hollofil™, Quallofil™ and others - these are synthetic fibers which are primarily used in sleeping bags and heavy outer garments like parkas. The fibers are fairly efficient at providing dead air space (though not nearly as efficient as down). Their advantages are that they do not absorb water and dry fairly quickly. Polarguard™ is made in large sheets. Hollofil™ is a fiber similar to Polarguard but hollow. This increases the dead air space and makes the fiber more thermally efficient. Quallofil™ took Hollofil™ one step further by creating four "holes" running through the fiber.

6. "Superthin" fibers - Primaloft™, Microloft™, Thinsulate™ and others - the principal behind these synthetic fibers is that by making the fiber thinner you can increase the amount of dead air space. For example, take an enclosed space 5 inches wide and place 2 dividers into that space, each 1 inch thick. You have an effective air layer of 3 inches. If you take the same 5 inch space and divide it with 4 dividers, each 1/4 inch thick you now have an effective air layer of 4 inches. You have gained one inch. Under laboratory conditions a given thickness of Thinsulate™ is almost twice as warm as the same thickness of down, however, the Thinsulate™ is 40% heavier. Thinsulate™ is made in sheets and therefore tends to be used primarily for outer layers, parkas and pants. New materials such as Primaloft™ and Microloft™ are superthin fibers that are close to the weight of down for an equivalent fiber volume. They are now being used in parkas and sleeping bags as an alternative to down. They stuff down to a small size and have similar warmth to weight ratios as down without the worries about getting wet.

7. Down - feathers are a very efficient insulator. They provide excellent dead air space for very little weight. The major problem with down (and it can be a major problem) in the winter is that down absorbs water. Once the feathers get wet they tend to clump, and lose dead air space. Using down items in the winter takes special care to prevent them from getting wet. For example, a vapor barrier sleeping bag liner in a down bag will help the bag stay dry. Down is useful in sleeping bags since it tends to conform to the shape of the occupant and prevents convection areas. Down is very compressible, which is an advantage when putting it into your pack but also realize that your body weight compresses the feathers beneath you and you need good insulation (foam pad, etc.) underneath you, more so than with a synthetic bag. Some people are allergic to down. The effectiveness of a down bag is directly related to the quality of the feathers used. Since down is made of individual feathers, sleeping bags are garments must have baffles sewn in to prevent the down from shifting in the bag which would create cold spots.

8. Radiant Barriers - some portion of body heat is lost through radiation. One method of retaining this heat is through use of a reflective barrier such as aluminum. This is the principal used in "Space Blankets" and is also used in some bivy sacks and sleeping bags.

Note: Cotton is basically useless in winter time. It wicks water, but unlike polypropylene, cotton absorbs this moisture and the water occupies the space previously occupied by dead air. This means a loss in dead air space, high evaporative cooling, and a garment that is almost impossible to dry out.

The Body and Clothing

1. Head - because the head has a very high surface to volume ratio and the head is heavily vascularized, you can lose a great deal of heat (up to 70%) from the head. Therefore, hats are essential in winter camping. The adage - if your toes are cold, put on a hat - is true. A balaclava is particularly effective and versatile. A facemask may be required if there are high wind conditions due to the susceptibility of the face to frostbite.

2. Hands - mittens are warmer that gloves because you don't contend with the curvature problem described above. Also the fingers tend to keep each other warm, rather than being isolated as in gloves. It is useful to have an inner mitten with an outer shell to give you layering capabilities. Also "idiot strings" are important to keep you from losing mittens in the snow. However, gloves are always essential as well in winter because of the

need for dexterity in various operations.

3. Feet - finding the right footgear depends a great deal on the activity you are involved in as well as temperature and environment. The two general modes of travel are skiing or snowshoeing (in areas with only a few inches of snow you can hike in just boots).

Cross-country skiing - you need a boot that has some ankle support due to the extra weight of a backpack. Also you may need a ski overboot to give you additional insulation over the ski boots.

Snowshoeing/Hiking - regular backpacking boots are *not* sufficient. They simply do not provide the necessary dead air space. The options for boots include:

- **Insulated Boots** - such as Sorels™ or "Mickey Mouse" boots. These are rubber or leather and rubber boots that use a layer of wool felt to provide dead air space. The Mouse boots can be Army surplus or modern copies (avoid the copies since they are often poorly made). With the true Army boots, the black boots are rated to -20 degrees and the white ones to -40 degrees. The one drawback with Sorels™ is that the wool felt liner is exposed. Breaking through a frozen stream may soak the liner which will be difficult to dry. They can be used with snowshoes, crampons and skis (with special bindings).
- **Plastic Mountaineering Boots** - plastic shell mountaineering boots use inner boots made with wool felt or a closed cell foam insulation. These can be very warm and easily used with ski bindings, crampons, and snowshoes. Depending on the inner boot, you may need insulated overboots to add enough insulation to keep your feet warm.
- **Mukluks** - one piece moccasins which reach to the knee. They are used with felt liners and wool socks. The Mukluk itself serves as a high gaiter. They are flexible and breathable. They work with snowshoe bindings and can be used on cross-country skis with special bindings (Berwin Bindings™) and with hinged crampons (not for technical ice). They are extremely comfortable, but since they are not waterproof they are best used in dry cold winter settings where water and rain are not a problem (e.g. stream crossings, possibility of rain, etc.)
- **Heavy leather mountaineering boots** with an insulated overboot - this can be effective but the system still is not very thermally efficient and may lead to frostbite of the feet *(not recommended).*

Socks - one of the best systems for keeping feet warm is using multiple layers. Start with a thin polypropylene liner sock next to the skin to wick moisture away followed by 1 - 2 pairs of wool or wool/nylon blend socks. Make sure the outer socks are big enough that they can fit comfortably over the inner layers. If they are too tight, they will constrict circulation and increase the chances of frostbite. Keeping your feet dry is essential to keeping your feet warm you may need to change your socks during the day. Foot powder with aluminum hydroxide can help. High altitude mountaineers will put antiperspirant on their feet for a week before the trip. The active ingredient, aluminum hydroxide will keep your feet from sweating for up to a month. (Some medical research has suggested a link between aluminum and Alzheimer's Disease but small exposure [as of the original writing of this article] does not appear to be a problem).

High Gaiters - are essential for winter activity. They keep snow from getting into your boots and keep your socks and pants legs free from snow.

Insulated Booties - these are booties insulated with a synthetic fill that typically have a foam sole to insulate you from the ground. They are very nice to have to wear in your sleeping bag at night.

Camp Overboots - are shells with an insulated bottom. These can be worn over insulated booties for traipsing around in camp. Also for those middle of the night visits to the woods.

4. Outer Layer - it is essential to have an outer layer that is windproof and at least water resistant. In some cases it may be best to have the garment waterproof. It also needs to be able to be ventilated. There is a big

trade off between waterproofness and ability to ventilate. A completely waterproof item will keep the water that is moving through your other layers trapped, adding to weight and causing some heat loss. However, in wet snow conditions, if the garment is not waterproof it can get wet and freeze. Gore-tex™ and other similar fabrics provide one solution. These fabrics have a thin polymer coating which has pores that are large enough to allow water vapor to pass through but too small to allow water droplets through. Nothing is perfect, however, and although Gore-tex™ does breathe, it doesn't breath as well as straight cotton/nylon blends. If you opt for a straight wind garment, 65/35 blends of cotton and nylon work well. The other approach is to have a waterproof garment with sufficient ventilation openings to allow water vapor to escape. This provides the ability to work in wet snow without worrying about getting the garment soaked. Part of the basis for making the decision is the area and you are traveling in. If you are in the dry snow of the Rockies you needn't worry so much about waterproofness. If you are in the northeastern mountains where freezing rain is a possibility or very wet snow, you need to be prepared to be wet.

5. Zippers - are wonderful accessories for winter clothing. Having underarm zippers on jackets can greatly increase your ability to ventilate. Having side zippers on pants can allow you to ventilate and to add or subtract a layer without taking off skis or snowshoes.

6. Miscellaneous - knickers with knicker socks can make a good combination. You have the option of ventilating by opening up the bottom of the knickers and/or rolling down your socks. Also bibs are helpful (both pile and outer waterproof layer) because they prevent cold spots at the junction between tops and bottoms. Underwear is also available in the traditional union suit design which accomplishes the same thing. Snaps on jackets etc. can be a problem because they fill with snow and ice and fail to work. Velcro™ works much better as a closure.

Clothing Techniques

1. When you first get up in the morning (and at the end of the day in camp), your activity level will be low as will be the temperature. You will need to have many, if not all, of your layers on at this point until breakfast is over and you have started to become active.
2. When you get ready to be active, you will need to take off layers since you will begin generating heat. A good rule of thumb is to strip down until you feel just cool, not chilled just before activity. Failure to do this will mean overheating, sweating, losing heat and you will have to stop in 10 minutes down the trail anyway to take layers off. Open or closing zippers, rolling sleeves up or down, taking a hat off or putting one on will all help with temperature regulation.
3. If you stop for more that a few minutes, you will need to put on another layer to keep from getting chilled. Keep a layer close at hand.
4. Whenever you get covered with snow, either from a fall or from dislodged snow from a tree, it is essential to brush yourself off to keep your clothing free of snow. Failure to do this often results in the snow melting into your clothing and refreezing as ice.
5. At the end of the day, as activity decreases and temperature drops, you will need to add layers. Once you start to cool down it takes a lot of the body's resources (calories) to heat up again so layer up ASAP before you get chilled. It may be good to put on more that you think you need; it will only get colder. If you are too warm, you can open up layers and ventilate to reach the proper temperature.

Packs

Internal versus. External Frame: Internal frames tend to be better for winter use. They have a lower center of gravity and hug your body better. When skiing or snowshoeing, the weight moves more with your body allowing for greater freedom of movement. This is especially important when you are on skis. External frame packs have a higher center of gravity and tend to swing a lot, sometimes throwing you off balance.
In order to carry all the winter gear for a multi-day trip (large sleeping bag, lots of clothing layers, tents, lots of food and fuel, etc.) you need a pack with a capacity of 5,000 cubic inches or greater.

Sleeping Bags

Sleeping bags for winter camping should be rated to temperatures below what you will likely experience if you want to be comfortable. If the nighttime temperature can drop to -15° Fahrenheit, then your bag should be rated to -30° Fahrenheit. There are a variety of different fills for sleeping bags: down, Primaloft™, Microloft™, Qualofill™, Polarguard™, etc. The bag itself should be a mummy style bag with a hood. It should also have a draft tube along the zipper and a draft collar at the neck. In sleeping bags, you want the bag to snugly conform to your body. If the bag is too big, you will have large spaces for convection currents and you will be cold. In a bag that has too much space, you may need to wear clothing layers to help fill up the space. You can opt for the expedition bag which is rated to -30° Fahrenheit or you can use a three season bag rate rated to 0° Fahrenheit and augment it with a vapor barrier liner (adds 5-10 degrees), a bivy sack (adds 5-10 degrees), and/or an overbag (a summer weight bag that fits over your mummy bag - adds 15 - 20 degrees —make sure it is big enough to fit over the mummy without compressing it). Keep in mind that each of these options has advantages and disadvantages in terms of price, weight, and volume taken up in your pack.

Foam Pads

You also need to insulate yourself from the underlying snow. Foam pads (Ensolite™) or inflatables (Thermarest™) work well. Your insulation should be a least 1/2 " thick (two 3/8 " summer pads work well, or use a Thermarest™ on top of a 3/8 " foam pad). It best to use full length pads so that all of your body is insulated.

Stoves versus. Fires

In most cases you will be taking stoves and fuel for cooking. Fires are possible in some locations, but in high use areas, it is best to rely on a stove as firewood can be difficult to find in the winter. Your stove should have good heat output. In order to insulate the stove from the snow (so it doesn't melt itself into a hole) place something underneath it like a pot lid, or a piece of fiberboard. Since the burner is usually significantly smaller than the pot bottom, placing a metal pot lid on top of the burner can also help spread the heat more efficiently to the pot. Wind shields are also helpful in the winter to concentrate the heat. Priming stoves in the winter can be difficult. It is best to use alcohol or lighter fluid rather than trying to prime the stove with white gas.

Fuel - plan on 1/4 quart per person per day if you need to melt snow for water. Plan on 1/8 quart per person per day if water will be available. *Make sure you have at least a day's surplus of fuel in case of bad weather, water being unavailable, etc.*

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3. FOOD

Planning food for winter activities must take into account the great demands the cold weather and physical activity placed on the body along with the difficulty of preparing foods in the winter (it takes time, stove fuel) and having a menu which appeals to the group). Appetite is generally reduced during winter activity even through the food needs of the body have increased. If the meal isn't appealing, it won't get eaten. In some situations you literally need to force yourself to eat.

Food types

All foods are made up of varying proportions of the three basic food types - carbohydrates, fats, proteins, and water, vitamins and minerals. Each of the three major types can be converted into simple sugars and burned by the body to produce energy but the time required for conversion increases as the complexity of the molecule increases, so carbohydrates are quicker to convert than proteins and proteins quicker than fats.

Dietary Percentage for Winter Camping	Food Type	Nickname	Description
50%	Simple Sugars	kindling	5 calories/gram (1,800 cal./lb.) - released quickly.
	Complex Carbohydrates	sticks	5 calories/gram (1,800 cal/lb.) - released quickly. They are easy to digest. Candy, cereal, bread, rice, macaroni, dried fruit, vegetables.
20%	Protiens	logs	5 calories/gram (1,800 cal/lb.) - generally released slowly. Proteins are primarily used for maintenance and building of body tissue. Meat, fish, cheese, milk, eggs, nuts, grains.
30%	Fats	logs	9 calories/gram (4,100 cal/lb.) - released very slowly but are useful because they release heat over a long period. However, it takes more energy and more water to break down fats into glucose. Margarine, nuts, cheese, eggs, and fats from pepperoni, salami.

Vitamins and Minerals - are generally found in most foods we eat and for a trip less than 7-10 days no special resources are needed. For longer trips and expeditions vitamin and mineral supplements are necessary. See a physician to get specific recommendations for expeditions.

Caloric Requirements

General caloric requirements increase in the winter due to the energy expended in keeping the body warm. Caloric requirements for different activity levels are summarized below.

Activity	Caloric Requirement (kilogram-calorie/day)
Basal metabolism	1,500 calories
Sedentary occupation	2,500 - 3,000 calories
Three season backpacking	3,500 - 4,000 calories
Winter backpacking	4,500 - 5,000 calories

Keep in mind that there are definite individual variances on these figures based on age, body metabolism, health, etc.

Meals

Avoid taking fresh food in the winter (fresh fruit, vegetables, eggs). These all contain water and weigh a lot (and you have enough to carry). The exception to this is cheese, butter, or meats (needed for their high fat content). Take mostly dry foods (cereal, pasta, rice, wheat, oatmeal,) baked goods (brownies, cookies), or freeze dried foods (expensive but very lightweight and quick to cook which can save on stove fuel).

1. Breakfast - should not be a complicated meal but should be a complete one since it supplies the foundation for a full day's work. Time is also a factor since you probably want to get up and moving. Just standing around in camp in the early morning (cold) hours only leads to cold feet and bodies. Since the easiest thing to cook is water it is best to go for items which can be made in each individual's cup. Suggestions include: instant oatmeal with hot milk & margarine, hot Tang™, Granola with hot milk, hot Jello™, hot chocolate with extra milk & margarine.

It is best to supplement some of these items with extra powdered milk to add additional protein and margarine for fats. This is the meal to be careful *not* to dump too much sugar into the bloodstream at once, but rather to eat a good mix of all three major food types. The sugars will get you started and the proteins and fats will keep you going through the morning.

2. Lunch - There are two approaches to lunch on a winter trip. One is to stop for a traditional lunch and take a long break. This means cessation of activity which can lead to people getting cold. Additional layers would need to be put on and taken off. All of this adds up to a lot of time. But this also allows time for exploring an area and taking it easy. You can break out the stove and cook up a hot meal if you like. The other approach is carrying a personal lunch which can be eaten throughout the day, at scenic points, water stops, clothing breaks, etc. The second approach minimizes the amount of time people would be standing around, but also doesn't provide a major rest stop. In both cases you should include all the food groups by having some of the following items: meats, cheeses, nuts, dried fruit, raisins, cookies, candy, granola bars.

In the case of an “eat through the day lunch” a general formula is to take the following per person per day:

- 1/2 - 3/4 lb. GORP - raisins, peanuts, M&M’s, sourballs coconut, chocolate morsels etc.
- 1/4 - 1/2 lb. Lunch Meat and/or Cheese - cut into bite size chunks so you don’t break your teeth
- Other items include cookies, brownies, peanut butter, bagels, etc.

3. Dinner - It is often good to start dinner with an instant soup or a hot drink that can be made in each persons’ cup. This gives some internal warmth while waiting for the main course. In the winter, the main dish is usually some form of one pot glop/stew. This is to save time and stove fuel. A glop starts with a soup or gravy base, and includes a starch (rice, noodles), some vegetables (frozen vegetables keep well on winter trips), whatever protein you are carrying (lunch meat, cheese, canned chicken, tuna). This should be spiced to make it tasty. Remember, at the end of the day you will be more tired than hungry and having an interesting meal is essential to get you to eat.

The other approach to dinner is freeze-dried foods. These have the advantage of simply adding the dish to boiling water so less fuel is needed and they weigh very little. There are a number of companies offering these items. They are generally more expensive than what you would pay for basic staples like rice & noodles. Be aware of portion size. Some companies give an unrealistically high estimate on how many their meal pack will feed.

The meal is concluded with hot drinks (tang, tea, hot chocolate, jello etc.) and possibly dessert. At the end of the meal water should be melted/heated up for personal water bottles at night. *(See water section below).* Dehydrated foods (which are different than freeze dried *are not* recommended because they require large quantities of water to rehydrate them.

4. Food for sleeping - you need to take some of your lunch for the next day to bed with you. This allows fresh items like the meat and cheese to thaw. If you wake in the middle of the night and are cold (or just before you go off to sleep) it is best to eat proteins. The protein will be broken down more slowly so the heat will be released over a longer period of time. If you eat a sugar, you will get a quick “heat high” and then your body temperature will drop back down, sometimes falling below its previous level.

5. Utensils - all the personal utensils you will need is a large plastic cup (insulated if possible) and a plastic spoon. *(Do not bring metal utensils in winter).* It is also recommended that you tie an idiot string between the cup and the spoon. Cleaning these utensils is generally only scraping out the remainder with snow. Anything left will be part of your next meal.

6. Food Packing - You will need to repack you food to minimize the amount of trash you bring in with you. It

is best to combine food items by meal or type into separate stuff sacks (breakfast bag, lunch bag, dinner bag, hot drink & dessert bag). Label them or color code them so you can easily distinguish them.

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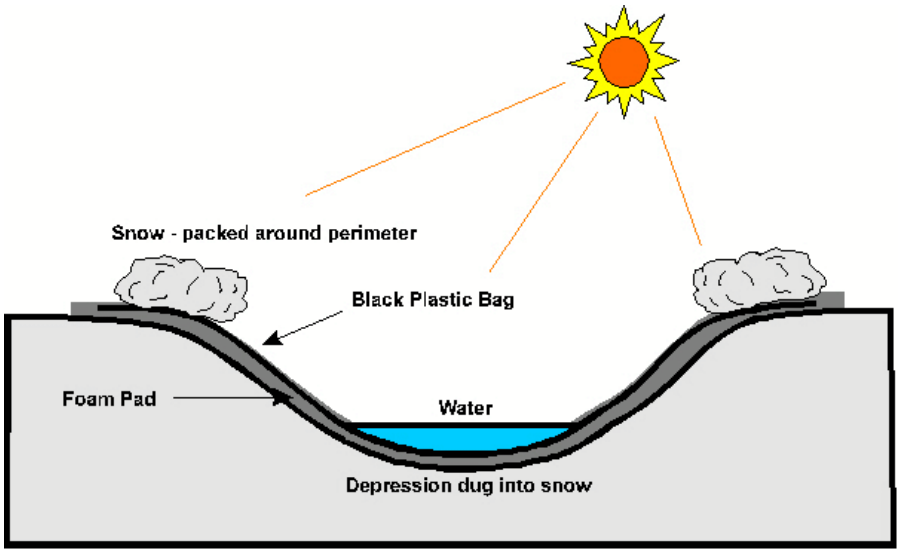
4. WINTER WATER

1) ***Do not eat snow!*** It takes an incredible amount of energy to transfer water from one state to another (solid to liquid). You are burning up too many calories to do this which can quickly lead to hypothermia.

2) Water may be obtained by digging a hole in frozen lakes or streams where there is running water beneath the ice. *Be careful about falling in.* Remember, in most cases water will need to be purified from giardia and other bacteriological contaminants (see below).

3) Snow can be melted on a fire or stove to make water. It should be clean snow, *no yellow* (urine) *or pink* (bacterial growth). Because it takes so much energy to convert from one state to another you should have some water in the bottom of your container. Heat this water up and add snow to it slowly so it turns to slush and then water. This is much more efficient. If you dump in straight snow, you will only burn the bottom of your container and not make any water. By volume it takes about 10 quarts of snow to make 1 quart of water. Snow does not need purification.

4) Winter Solar Water Collector - In a spot that will remain sunny for several hours, dig out a depression in the snow about 2 feet across and 1 foot deep. If possible, line this depression with a foam pad or other insulation (not essential but it speeds the process). Then spread a dark plastic bag (trashbag) over the depression forming a shallow dish pan. All over the raised margins pack ***clean*** snow. Drawn by the dark plastic the sun's energy will melt the snow and water will collect in the depression.



5) Water in a pot can be stored overnight by placing the pot lid on and burying the pot under a foot of snow. Snow is such a good insulator that it will keep the water from completely freezing even in sub-zero temperatures.

6) Personal Water - You should have a water bottle with a wide mouth, otherwise the opening will easily freeze up. During the day you should carry at least one bottle next to your body (usually with a shoulder strap arrangement). Your body heat will keep it from freezing and the bottle is handy to rehydrate yourself throughout the day. Insulated water bottle holders are available for this. Other bottles can be kept upside down in an insulated

container (sock etc.) preferably in an outside pocket on your pack. Being upside down will keep the mouth of the bottle from freezing. *Keep in mind that the lid must be on tightly or water will leak all over the place.* A cold water bottle may have ice crystals in the threads. As the bottle heats up from body temperature the ice may melt causing the cap to loosen also the lid may expand with heat causing leakage. At night keep your water bottles in your sleeping bag to prevent them from freezing.

7) Getting Water - sometimes filling pots and water bottles from a stream or lake is a major expedition in itself. Make sure that the area you plan to get water from is secure. Avoid steep banks that might lead to a plunge and make sure any ice is sufficiently stable to hold your weight. Also make sure you don't get your mittens soaked with icy water. A loop of string tied tightly around the water bottle neck will allow you to lower a bottle in by hand or with a ski pole or ice axe. Don't trust pot grips on a large pot, with mittens you can lose your grip and your pot. Fill the pot up part way and then use a water bottle to top it off. Mark the area so you can find it next time.

8) Water purification - keep in mind that water gotten from streams in the winter time may have bacteriological or other contaminants. You should check with local rangers about any water problems before going in. If the water does need to be purified, the best methods during the winter are either:

a) **Boiling** - for at least 3-5 minutes (add 1 minute for every 1,000 feet above sea level so that at 10,000 feet you are boiling for 15 minutes). ***This is the best method in winter situations.***

Less Effective Methods:

b) **Filtration** - using a filtration pump system such as the PUR™, First Need™, or the Katadyn™ is not recommended in subfreezing temperatures. Keep in mind that the water in filters can freeze preventing them from working. Also, as the water freezes, it expands and may crack the filter, rendering it inoperable or even worse transmitting harmful microorganisms into your system. For these reasons, filters should be used with great caution in the winter. Be careful of inferior filters which do not strain out many organisms.

c) **Chemical treatments** (iodination or chlorination) are ***not recommended*** because they become ineffective at low temperatures. Only use these methods if the water has been preheated to about 60° Fahrenheit.

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5. WINTER SHELTERS

Tents

In many cases you will be traveling to areas without shelters, so you need to bring your own. There are a range of tents available. The key factors are:

- Strength - to withstand both wind and snow. In general it is recommended that you use a tent specifically rated to be a 4-season tent. Four season tents typically have stronger poles (to hold snow loads).
- Ability to shed snow - the tent must have a roof line that allows snow to fall off. Otherwise the tent will load up and the weight will cause it to collapse. (Four season tents are designed this way).
- Room - you need *lots* of internal space on a winter trip for all the bulky gear you are carrying. Also you may get snowed in and need to stay in the tent for an extended period of time. Being snowbound in a cramped tent with several other people can be unpleasant.
- Rainfly - the tent must have a rainfly. Having a breathable inner tent wall with a waterproof fly outside helps reduce condensation in the tent (see below). It also helps provide better insulation by increasing (relatively) unmoving air space layers. Typically a tent will be 10-20 degrees warmer than the outside air (once your body is inside heating it up).
- Free standing tents (dome type) are recommended because they shed snow fairly well and they provide

efficient interior space. *Make sure* that the manufacturer recommends the tent for winter use. Many dome tents are designed for three season use only and the stitching and the poles are not designed to take the weight of snow.

- Other shelter options include the Black Diamond Megamid™. This a single, center pole, pyramid tent with no floor. They require some staking but are quit roomy. By adding a space blanket as a floor, and covering the edges with snow, you can seal off the tent quite well.
- Another issue with tents is condensation. During the night your breathing pumps a great deal of humid air into the tent. This air rises and hits the inner tent wall where the moisture condenses into ice. These fine particles can get all over you and your gear. It is best to brush the ice particles off the tent in the morning and sweep them outside. A frost liner, hung inside the tent, allows the moisture to pass through and provides a layer between you and the ice.

Tips for Tents

- Make sure you bring extra poles with you and pole splints in case a pole breaks.
- A ground sheet (like a space blanket or tarp) can help protect your tent floor (the ground underneath usually turns to ice from your weight and body heat. Sharp ice can tear the floor)
- Always stake you tent down if you are going to be in windy areas or leaving your tents during day excursions. Bring stakes or know how to stake using “dead men.”
- Wisk Broom - is an important addition to *every* tent. You should brush all the snow off your clothes and boots before getting into the tent at night. This helps reduce condensation and water buildup in the tent keeping you and your belongings dryer. Also when snow gets into the tent at night it often melts from your body temperature, then freezes during the day when you are not in the tent.
- Cooking - *Do not* cook in a tent. It is possible to asphyxiate yourself from accumulated carbon monoxide and the water vapor leads to extensive condensation.

Winter Campsite

Keep the following factors in mind when choosing a winter camp.

- Camping regulations
- Other campers
- Wind - avoid ridge tops and open areas where wind can blow down tents or create drifts.
- Be aware of “widow makers”, dead branches hanging in trees.
- Avoid low lying areas where the coldest air will settle.
- Avalanche danger - select sites that do not pose any risk from avalanches.
- Exposure - south facing areas will give longer days and more direct sunlight.
- Water availability from lakes or streams will prevent you having to melt snow for all your water.
- Level ground

Setting up Camp

When you first get into camp, leave your snowshoes or skis on and begin to tramp down areas for tents and your kitchen. If possible, let the snow set up for 30 minutes or so, this will minimize postholing once you take snowshoes or skis off. Set up your tents with the doors at 90 degrees to the prevailing winds. Stake the tents out. On a cold night you can build snow walls on the windward side of the tent. Mound the sides of the tent with snow (have someone inside pushing out on the tent to keep it from collapsing. When the snow sets up you will have a hybrid tent-snow shelter which will have better insulation than the tent alone. Dig out a pit in front of your tent for a porch. This makes taking your boots off much easier. Put your foam pads in the tent and unstuff your sleeping bag and place it in the tent so it can “expand” from it’s stuffed size.

If the snow is deep, you may want to dig out a pit for your kitchen. Dig a pit at least 6 feet in diameter (for 4-6 people). You can mark out the circle using a ski or a rope. Dig down about 2-3 feet and pile the excavated snow around the perimeter. Pack the snow at the perimeter of the hole with your shovel. This will give you a 4-5 foot

deep area, protected from the wind. You can carve out seats and benches, put your skis or snow shoes behind the pile as backrests, carve places for stoves, etc.

General night sequence - after dinner, getting warm water for water bottles, and putting gear away, it's time for bed. This is a general sequence:

1. Get warm before you get into your bag. Do some jumping jacks, etc. so your heat is built up for when you get in your bag.
2. Get any clothing/gear you will need out of your pack as well as full water bottles and tomorrow's lunch.
3. At the tent door, brush off any snow with the wisk broom. Sit down inside the tent entrance and, keeping your boots outside, either have a friend brush them off, or remove them and brush them yourself.
4. Climb into the tent and close the door.
5. Strip off your layers of clothing to what will be appropriate in your sleeping bag. The more layers you wear the better insulated and the warmer you will be (contrary to the myth that says sleep in your underwear). However, too much clothing can compress dead air space in the bag and reduce its effectiveness.
6. Remove any wet/damp layers and replace them with dry ones, particularly socks.
7. Pre-warm your bag with your body (get it nice and toasty).
8. Place damp items in the sleeping bag with you near your trunk. This will help dry them overnight.
9. Place your boots in your sleeping bag stuff sack (turned inside out) and place the stuff sack between your legs. This will keep them from freezing during the night and the stuff sack keeps your legs from getting wet.
10. Put water bottles and food with you in the bag.
11. A hat and polarguard booties are recommended to help keep you warm.
12. Try to sleep with your face out of the bag. This reduces moisture build-up inside the bag (which could be catastrophic for a down bag). A scarf on your neck may be better than using the sleeping bag neck drawcord (which makes some people feel a little claustrophobic and creates a difficult nights sleep).
13. You will probably wake up a number of times during the night. This is normal in cold weather. Your body needs to change position to allow for circulation to compressed tissues and to move around a bit so that muscle movement generates more heat. If you are still cold, eat some protein to "stoke up your furnace" If that doesn't work, wake a tent-mate for some extra warmth.
14. With 10 or more hours in the tent, you are likely to need to urinate in the middle of the night. Go for it! Otherwise you won't get back to sleep, and your body is wasting energy keep all that extra fluid warm. You will be surprised how quickly you can get out and back in and your body really won't chill that much.
15. It is useful to have a thermos of hot drink in each tent.

Snow Shelters

The following snow shelters are also useful in winter. Keep in mind that there is great potential for getting your clothing wet while constructing these shelters. You should be dressed accordingly.

Snow Mound Shelter (Quin-zhee) - If the party does not have the experience or the snow conditions aren't good for an igloo, a snow mound shelter can be made. In a selected spot, place an upright marker (ski pole, ice axe, etc.) to mark the center. Tie a cord to the marker and scribe a circle in the snow to indicate the pile size. The rule of thumb for size: if the snow in place is not to be dug out, the radius should be the interior size plus about 2 feet; if the snow in place is to be dug out, about 1 foot can be subtracted from the radius for each foot of in-place snow. Piling the snow for a two person shelter will take two people about an hour. Pile loose snow within the marked circle with shovels, tarp etc. Don't compact the snow. When the mound is the right size and shape, do not disturb it; allow it to compact naturally - minimum time one hour. Chances of collapse are greatly reduced if you let it settle for two hours. Thirty-five degrees is the natural angle at which loose snow rests. Be

sure to allow the snow to settle at this angle. Otherwise you will have thin spots or a buckling roof when you excavate the interior. After compaction you are ready for digging. The entrance direction should be away from the prevailing incoming weather. From the entrance point start digging toward the marker. Pass the snow out to helpers. As soon as you reach the marker, do no not disturb it. This is your guide for excavating the interior. Clear out the inside to the intended radius. To check on wall and roof thickness, measure with a stick poked through. When the dimensions check, remove the marker and trim the interior. Then install a vent in the roof. Get rid of waste snow promptly before it hardens. The process is a wet one so make sure you have waterproof gear on and good shovels for making the mound and digging out.

Snow Cave - A snow cave can be dug into a hillside. Dig the entrance up so that the door is below the sitting level. Also there are natural snow caves formed by the overhanging branches of trees covered with snow. By digging down you can get into the cave beneath the branches. In both cases you should poke a ventilation hole and keep it clear.

Igloo - can be constructed if there is snow of the proper consistency to pack into hard blocks. Keep in mind that building such a shelter takes a great deal of energy and time. Two skilled persons can build a two person igloo in 2-3 hours with proper equipment and good snow. Obviously several such structures would need to be built to hold a larger group. Building an igloo is a process that requires a certain amount of artistry, but is less of an energy expenditure than a snow mound shelter. In general, rectangular blocks roughly 24" by 18" by 6" are cut and stacked in an ascending spiral. The rectangular blocks are placed vertically and the bottom shaped so that only the two bottom corners are supporting the block. Then the block is tilted inward and the vertical edge contacting the adjacent block is cut away until the weight of the block rests only on the upper corner. The weight of the block is supported by the diagonally opposite corners, while the third corner prevents rotation. Once the first row is laid you shave off the tops of several blocks ($^1/_4$ - $^1/_3$ of the circumference) to create a ramp and build upward in a spiral. Once the structure is complete, snow is packed into all the open joints. (See the *Off Belay* reprint *Igloo.*)

Snow Pit - This structure can be created by digging a trench in the snow down to ground level (if possible). The structure should be a little longer than your body and 3 - 4 feet wide. Line the bottom with insulative material to insulate you from the cold ground (in an emergency you can use 5-6 inches of evergreen boughs). A roof can be made of skis and poles or overlapping boughs and sticks then covered with a tarp and then loose snow or blocks of hard pack snow. The doorway will be a tunnel in from the side. This can be plugged with a door of hard pack snow. ***A ventilation hole must be poked into the roof for air flow.*** Keeping a stick in this hole and shaking it every so often will keep the hole open. If possible, the entrance should be lower than the level of the trench, this keeps the coldest air in the entrance rather than in the trench.

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6. MINIMAL IMPACT CAMPING IN WINTER

Winter generally provides a blanket of snow which protects underlying soil and vegetation, the major concerns for minimizing impact. However, when thin snow cover is compressed and compacted in early or late season, snowmelt can be delayed, shortening the growing season. Also, early and late winter trips can run into melting conditions, where top layers of soil melted by the sun lie overtop frozen ground. Erosion, and destruction of plant life is extremely likely at these times, and winter travel is best avoided. Otherwise travel in small groups and visit either remote places where your disturbances won't be compounded by others following you (allowing for recovery) or high impact areas that have already been disturbed. Special considerations exist for high altitude and glacier conditions (see Soft Paths).

Backcountry travel and camping

- Winter clothing and equipment, even when “natural” colored will show up well against the snow.

Brighter colors can be a safety measure, as people and equipment can easily be lost in a winter storm. Since there are less people out in the winter, the visual impact is less.

- Winter is an exceptionally quiet season in the backcountry. Travel quietly and avoid excess commotion at your campsite.
- One of the greatest impacts can be on wildlife. Animals in the winter have limited food supplies and are often stressed to their limits to survive. Being disturbed by backcountry travelers can drive them away from food sources, require them to use more energy, and can lead to death. Animals may seem more "approachable" in the winter. This is because they are trying to conserve energy. Do *not* approach wildlife too closely.
- Camping
    - Tent, igloo and snow cave sites should be selected away from trails and open bodies of water if possible.
    - All campsites and cooking areas should be disguised when you leave so that accidental stains are covered, and so that camping areas will be undetectable after 2 - 3 inches of snow has fallen.
    - Large snow structures such as igloos and snow caves can be left intact, as long as the rest of the camping area is well camouflaged. Occasionally these snow structures can be used again by other grateful winter travelers.
    - Camp away from animal feeding, watering, and bedding areas.
- **Fires** - Under winter conditions, it can be difficult to build a disguisable fireplace or to gather wood by acceptable means. Since any downed wood is under the snow and possibly wet, wood is both difficult to find and may not be usable for a fire. Gathering wood from lives trees can have significant impacts on an area especially at high use sites. Therefore, one should carefully examine the location, the ecosystem, and the ability to clean up the site after the fire before deciding to build one. Obviously, in a real emergency, a fire might need to be built in spite of the impact it might have on the environment
- **Sanitation** - Lack of sunlight and cold temperatures retard the decomposition of fecal material. Maximizing sunlight will help but will leave a visual impact if others are in the area. The best solution is to dig a cathole in just below the surface of the snow. Keep in mind that after the thaw, the feces will be resting on the ground. So pick a cathole site far from any water, summer trails, or summer camping areas. Locate a site with as much ground cover (grass or forest downfall), and as little slope as possible to minimize washing into surface water, and ***maximize feces-soil contact.***
    - For maximum fecal dispersion, persons should make personal holes as needed. There is no reason for a group's waste to be deposited in one place. Head away from camp. Snow should be kicked over urine stains to prevent the "yellow snow" effect. Toilet paper can be a problem in the winter. Burning it once it has hit the snow is very difficult. You can burn it in a tin can or pack it out. A better idea may be to use snow or ice (although powder snow is difficult to use).
    - You almost never need to wash pans in the winter. A simple scouring with snow will freeze all particles. They can be packed out with garbage (or left for the next meal). Ending dinner with hot drinks usually takes care of any food particles. Water left over from pasta is full of carbohydrates and makes good drink water. If you do have leftover cooking water, solid food waste should be strained out of the water and packed out. The water should be concentrated in sump holes far from water sources to prevent massive unsightly stains on the snow. The sump holes should be covered when breaking camp. Leftover grease will cool to a solid and can be carried out. Minimize all solid food since animals will often dig up sump holes.
    - Litter is especially difficult to check in the winter when dropped items can be lost so easily in the snow. Special attention should be given to plastic bags, white toilet paper (use colored or better unbleached, or use snow or ice), candy wrappers and candle wax. Candy wrappers should be removed from all candy before leaving town to prevent accidental litter. Candle wax should be caught in a cup and packed out.

7. WINTER TRAVEL

Travel in the winter depends a lot on what form of locomotion (feet, snowshoes, skis). There are some general travel techniques that are applicable to all forms of winter travel.

Travel Tips

- When breaking trail, rotate the leader. Have the leader step off the trail and the rest of the group passes. This person drops into the last position (like a goose) for a rest while the second in line takes over. You can also have a lighter pack that is carried by the person in front and switched off.
- Map and compass is often critical in winter travel since you may be off trail or trails may be hidden by the snow. Feel for difference in the snow between a packed trail and unpacked. Look for opening line above in the trees which could indicate the trail
- When bushwacking, wear goggles to protect your eyes.
- When bushwacking or traveling through dense brush and forest, take your hands out of your ski pole straps. If the basket catches on something and you fall, being in the straps can lead to a dislocated thumb.
- Watch out for "spruce traps," evergreens with the lower branches covered with snow. Beneath there is an air pocket ready to swallow you up (this can be used for an emergency shelter - see above).
- Whiteouts can be extremely dangerous. Even skilled mountaineers have become disoriented and walked off cliffs. Decide 1) if it is safe to continue 2) if it is really necessary for you to continue. Otherwise, set up camp where you are if possible, or hunker down (in a group) with lots of layers on and wait until conditions improve. If you decide to continue, know where you are going and what possible dangers lie ahead. Stay close together and in constant voice contact with the people in front of you and behind you. If one person has to stop, the whole group has to stop. If you are following cairns, have the group stop at the last cairn, send one person out tied into a rope (with a compass and on the right bearing) to find the next cairn. People can then follow the rope.

Ice Crossings

Coming up to a frozen or snow covered lake in the middle of winter raises sudden safety questions for winter travelers whether you are on foot, snowshoes, or skis. Will the ice hold? What happens if I break through? Here is a collection of information to help with both of these questions.

Ice Formation (temperatures based on fresh water)

As surface water on a stream or lake is chilled by the low atmospheric temperature, the water contracts and sinks to the bottom where it is chilled to the point of the greatest density of water, where molecules are packed as closely as it is possible for them to be. This critical temperature is 39° Fahrenheit (4°C). The dense, cold water sinking to the bottom displaces water at a higher temperature which rises to the top. Thus vertical convection currents are produced. This process continues until the entire body of water reaches 39° Fahrenheit. Then the water can no longer sink. Instead it is progressively cooled at the surface. As the water chills below 39° Fahrenheit it starts to expand, until at 32° Fahrenheit (0° C) it changes state and becomes a solid by expanding into a lattice structure that is lighter than the liquid state. From the description of this process, it is clear that flowing water will require a greater length of time to freeze than still water and that shallower depths near the shore of any body of water will reach a uniform 39° Fahrenheit sooner. Thus, ice on a small pond that can support a person's weight cannot be used to gauge the safety of ice midstream or in the middle of a lake.

Generally the first type of ice to form on a lake is called *black ice.* This is a misnomer because the ice itself is clear—it is the water seen through the ice that looks black. If a prolonged spell of clear, cold weather occurs after the lake first freezes, this black ice initially grows quite rapidly. However, as is thickens it insulates the water underneath from the atmospheric temperature, and ice growth slows.

As snow accumulates on the lake, the stage is set for a major change in the characteristic of lake ice.

The snow cover, when it's deep enough, begins to exert downward pressure on the black ice, and pushes it beneath the hydrostatic water level of the lake. If a period of cold weather follows, thermal contraction of the black ice produces cracks, which allow the lake water to rise up and flood the surface. This is called a slushing event.

Since the lake is under pressure it spills out, and as it freezes, turns the snow cover to ice. The new ice layer contains many air bubbles between the snow crystals and therefore appears white. This *white ice* forms on top of black ice, and with further snowfalls and cold periods, the process may be repeated throughout the winter. When struck white ice gives a solid sounding "thump."

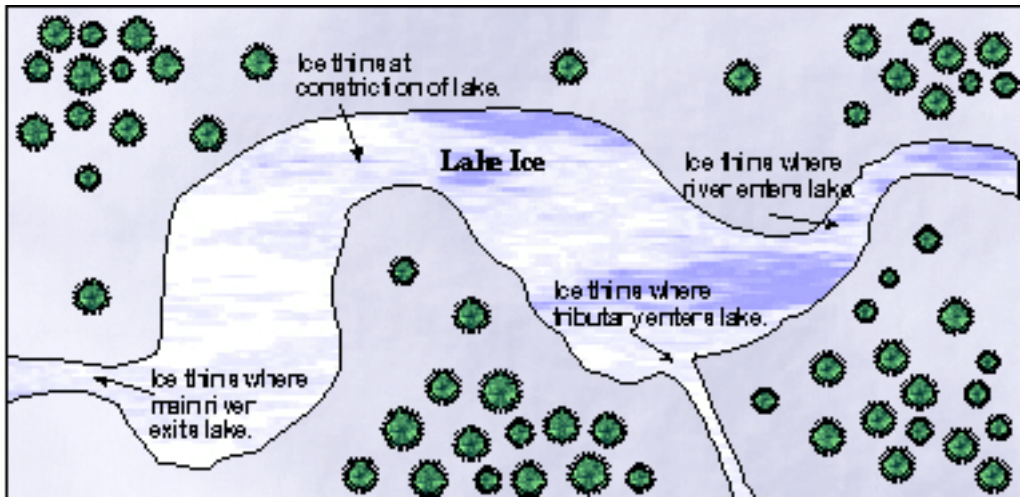
Because of the close link between snow accumulation and white ice production, it's not surprising to find a predictable pattern of ice types on a lake. Snow in the center of a lake may be redistributed onto the downwind sides of the lake and along the shoreline. Thus, it's not surprising to discover that these area also have the greatest thickness of white ice. A lake's snow cover is frequently much thinner than the surrounding shore's due to removal by wind and conversion of snow to white ice during slushing events, and may be a preferred route for snowshoers or skiers.

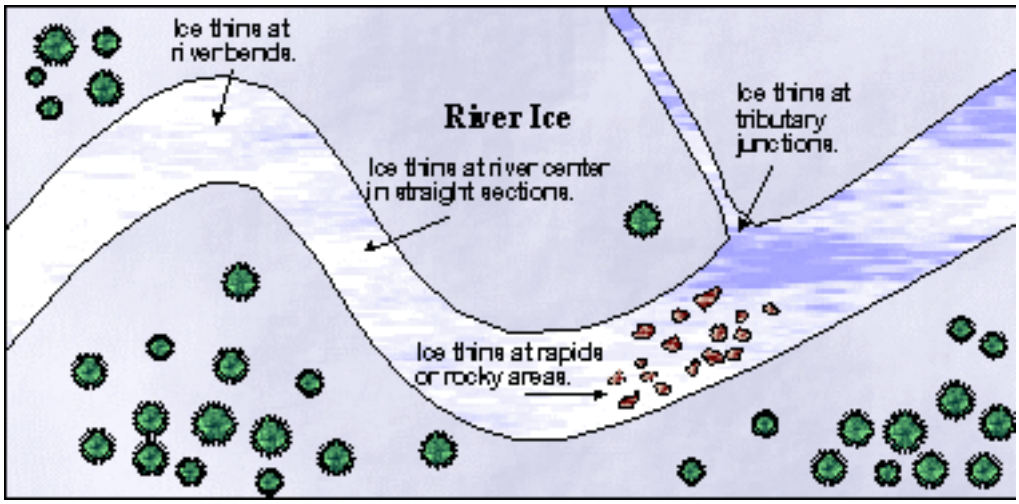
Selecting Routes

The following are guidelines which will help you determine which routes to follow across a frozen body of water.

- Lakes - watch for constrictions where rivers or streams enter or exit. These are likely to be thin.
- Rivers - care should be taken when crossing on the outside of bends or at the center of the river in straight sections. Also sections of rapids, where tributaries join, or where the river is constricted should be avoided. All of these areas have the greatest current flow which means less stable ice.
- Since thinning of ice by under-ice water currents is often difficult to ascertain especially when it's snow-covered, test the ice periodically by using your ski poles to tap out the ice in front of you. Vibrations will tell you about the ice thickness, structure and strength. If the ice is suspect, move around the area or move back to a safe location and chip a small hole to check the thickness and type of ice.
- Spring-fed bodies of water may have flow percolating up in different sites causing less stable ice.
- The continuity of ice and hence its structural strength is greatly diminished when freezing occurs in swamps with alder or cattail.
- Logs, stumps, rocks, earth hummocks, basically anything sticking up out of the ice picks up heat from the sun during the day; some of this heat melts the ice surrounding the object. These obstructions often have weak "moats" of ice surrounding them and are prone to breakthroughs.
- Ice formed during a snowstorm amounts to frozen slush that will appear grey to white and have a pebbly, opaque surface, the result of microscopic trapped air bubbles that resist cohesion, weakening tensile strength by as much as half.
- Water on top of ice is dangerous, especially during warm spells and in the spring. Water is heavier than ice, and as a result it leaks down through it, creating fractures known as *honeycombs*. No matter how thick it may be, honeycombed ice can give way.
- Beware of dark patches in ice. They may be a sign that the water underneath has melted and thinned the ice from below, a common situation around underground springs and current lanes. Moving water of any kind eats away at the ice above it.
- The surrounding landforms or lake geography also suggest some things about ice. The deeper the lake and the longer it takes to freeze tight, the harder and safer the ice will be. Ice will be thickest along the north shore of a lake and thinnest along the south shore (due to greater sun exposure on the south shore).
- Straight open cracks may be safe to cross even if there is open water. If two or more cracks meet at open water, crossing is dangerous.
- Discolored snow over ice may indicate water or a slushing event. If the snow looks dark or slushy, avoid the area.
- A depression of slump in a normally even snow surface may indicate soft ice underneath.

- Ice jams with smashed blocks of ice piled on one another are often found downstream of rapids. This means the area upstream may not be safe to cross because of fast moving water.
- Overflow caused by water seeping up through cracks in the ice or over the edges near banks can saturate the snow cover and create deep wet slush. A new layer of ice can form on top. If this layer is covered with snow it may be indistinguishable from the snow surface (although a pole tap will give a very different sound).
- Remember that ice will support your weight best if you're on snowshoes or skis (greater surface for weight distribution), so don't stop to remove skis or snowshoes in the middle of a lake or river, especially if you think the ice could be thin. If your skis are icing up, wait until you reach land before scraping and rewaxing. It's not only safer, but you'll avoid getting your boots wet.





Ice Safety and Rescue

- Keep in mind that, like avalanches, ice can give way on the first person or the last or not at all. You can cross any area safely during the morning and then have it give way on your way back in the afternoon. Therefore, you *always* need to be cautious.
- Spread the group out so as not to concentrate weight on the ice.
- The lead person should be probing ahead with a ski pole or similar object. Poke the ice fairly hard. If the probe goes through, turn back and find another route. You can also hear a different sound with solid ice (sound - tick) versus thin ice over an air pocket (sound - tock).
- Avoid the danger areas outlined above, why not try a trail around the lake if you are not sure about the ice?

- If you have serious concerns about the ice, make sure your pack hipbelt and chest compression strap are off. This will allow you to quickly jettison your pack if you fall through. If you go through, immediately shed your pack and kick to the surface.
- **Self-rescue** - Attempt self-rescue by extending your arms forward over the ice , kicking the legs up so that the body is in a level position in the water, and working forward onto the ice by kicking and carefully pulling with the arms. A pocketknife or other sharp object can be used in the hand to increase traction. This maneuver can be successful even if the ice continues to break ahead of the victim; it should be continued until firm ice is reached. After pulling the entire body onto firm ice, the victim should carefully roll or edge toward shore, distributing body weight as widely as possible.
- **Group rescue**

1. Check on everyone and make sure the rest of the group is one safe ice. If not have people crawl (not walk) to safety (crawling spreads on the weight).
2. Toss a throw rope to the person to stabilize them (an essential piece of equipment). This will also help minimize panic and give you something to help pull them out.
3. Stay a safe distance from the hole. If necessary, lie down on the ice and extend objects towards the hole (skis, ski poles, etc.). If necessary, a human chain can be formed by laying down on the ice and grabbing the ankles of the person in front of you. The person closest to shore is "on belay" for the group. *Don't* try to reach the person with your body, in their panic and struggle (like a drowning person) there is a good chance they will pull you in.
4. Span the edge of the hole with skis or saplings extended to the person. Since the ice is likely to keep breaking as they try to climb out, this gives them something to climb onto and distributes the weight. Use the rope to help pull the person out. They will need to kick their feet to the surface to be as horizontal as possible.
5. Once the person is out of the water. ***Begin immediate assessment and treatment for hypothermia.*** Rolling them in the sow can blot up some of the water in their clothing.

Ice Thickness

As a general guideline, 1 inch of black or white ice will probably hold you up. Two inches is safe, and six inches will hold up a moose. Thickness of suspect ice can usually be determined quite quickly by using an ice axe or auger to drill through. However, for advanced trip planning, you can use the following formula to estimate the thickness:

Z = ice thickness in inches
S = degree days accumulated below 32° Fahrenheit
A = a coefficient which varies as follows:
(.8) - windy lake with no snow
(.5 to .7) - average lake with snow cover
(.5 to .7) - average river with snow cover
(.2 to .4) - sheltered small river with rapid flow

S is calculated as follows: Suppose ice is formed December 15 and the mean temperature for December 16 was 5° F. To find degree days, subtract 5° F from 32° F for a value of 27. If on December 17 the temperature is 4° F, subtract 4° F from 32° F for a value of 28. S would then have a value of 55 by December 17 (27° F + 28° F = 55). Next take the square root of 55 (7.4). To determine ice thickness, multiple 7.4 by the appropriate coefficient A (say .8 for a windy lake with no snow), and your answer is 5.9 inches of ice.

If you don't know the date of ice formation, you can estimate by the following technique:

1. For lakes 3 - 10 feet deep, freezing occurs very close to the date when the 3-day running mean temperature is 32° F and where temperatures remained mostly below that for the rest of the winter.

2. For lakes 20 - 50 feet deep, the date of freeze-over occurs when the 40-day running mean temperature reaches 32° F.

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Avalanche Basics

Types of Avalanches

Loose Snow Avalanches - These start from a single point incorporating more and more unconsolidated snow as they fan out. They are caused when the weight of new fallen snow succumbs to the forces of gravity. This occurs most often after periods of heavy snow (10-12 inches accumulation, or snowfall or 1 inch or more per hour) especially when piled on top of a smooth snow surface (from thawing, freezing, or rain) The smooth snow surface provides a slick ramp for the heavy new snow to run down.

Slab Avalanches - Are caused when well compacted and cohesive layers of snow aren't anchored to the slope. If there is a weak layer of snow underneath the compacted layer, the slope is primed to avalanche. Various forces, sun, wind, or a person can trigger the slab at the release zone.

Avalanche Sites - Open slopes between 25 and 45 degrees. Especially lee slopes (the direction toward which the wind is blowing) which get greater snow loads.

Avalanche Safety

- Most victims trigger their own avalanche.
- Be aware of your surroundings. Watch for evidence of sliding, snow sluffs - small slides indicating avalanche danger, avalanche chutes or slides where trees have been torn away, or snow debris at the bottom of a slope indicating previous avalanches.
- Keep track of the weather. The first 24 hours after a heavy snow, high wind, rain, or thaw is the most dangerous period. Check local avalanche forecasts and be prepared to postpone your trip if the danger is high. Delaying for 24-48 hours can significantly reduce the danger.
- Recognize danger zones and be conservative about planning your route or crossing a slope.
- Travel on ridge tops or heavily wooded areas as much as possible.
- Avoid the midslopes or the release zone near the top of the slope.
- Detour completely around a suspect slope.
- If you must cross and avalanche slope, gather as much information as you can about the snowpack. Probe the snow to see if there is even resistance (if so the danger may be reduced). If there is uneven resistance to the probe (breaks through a crust, punches into layers of loose or unconsolidated snow) then the avalanche danger may be high. Even better, find a safe location on an adjacent slope with similar exposure, snow level and steepness and dig a test pit. Look at the different layers. If you see layers characterized by course, grainy, crystals, the slope is probably not safe. If layers are firm and bonded it *might* be safe.

Crossing Avalanche Zones

- Remove ski pole straps and undo all pack buckles.
- Put on additional warm clothing in case of entrapment.
- Zip on and fasten all clothing securely to keep snow from entering (cuffs, collars, etc.)
- Use avalanche cords or an avalanche beacon.
- Look at the crossing. Are there any islands of safety along the way, a rock outcropping, a stretch of trees? If so, head to the island of safety ASAP if a slide is triggered.
- Cross one at a time with all other group members watching.

Self-Rescue

1. Yell to alert the group.
2. Jettison your pack and head to an island of safety if possible. Otherwise, try to stay on top of the snow using a swimming motion.

3. Before the snow stops, try to make an air pocket in front of your face by punching out the snow with your hands. Take a deep breath to expand your chest before the snow settles. The snow will quickly set like concrete. If your chest is not expanded, you may not be able to breathe.
4. Try to reach your hand to the surface to provide a clue for rescuers (if you can tell where the surface is).
5. If possible, try to dig yourself out.

Group Rescue

1. Watch the victim in the slide. Where was the person when they were first hit by the slide (point A) and where were they when you last saw them (point B)?
2. Wait until the slope has settled and there is no indication of further avalanche. You don't want to complicate the scenario with another victim(s).
3. Mark point A and B on the slope with visible objects
4. Visualize the line between point A and B. This is the path the victim was swept down. Look for any clues on the surface (clothing, skis, etc.) that might give more indication of the person's position. Mark these spots.
5. Turn your avalanche beacons to receive and begin search procedures.
6. Probe the snow below point B. Stand shoulder to shoulder and advance downslope in a line.
7. If you locate the victim, dig them out quickly.
8. Treat for hypothermia and shock.
9. There is a good chance of head and spinal injuries in an avalanche as well as fractures. Be careful moving the person.

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Snowshoeing

Types

There are a number of general types of snowshoes. The major design features are the following:

- Width - a wider snowshoe means better flotation. This means the shoe can be shorter and still provide sufficient flotation. A shorter, wide shoe is more maneuverable, especially good in brush and wooded areas. It does force a wider stance.
- Length - a longer snowshoe also means better flotation. This means the snowshoe can be narrower and still provide good flotation. A longer snowshoe is easier to move quickly like a ski, especially good for open country.
- Weave - the finer the weave, the greater the flotation. Modern metal snowshoes utilize a decking that provides excellent flotation in a small snowshoe.
- Tip - tips may be flat or upturned. An upturned tip rises clear of the depression the snowshoe makes without catching. It is useful on steep uphills. But an upturned toe is more difficult to kick steps into the snow with than a flat toe.
- Tail - long tails help snowshoes track in a straight line which is good when travelling fast. The tail also provides a counterweight to keep the tip up.

The particular size of the snowshoe depends on the weight of the person (including pack), the terrain, and the snow conditions. Cold, deep powder requires more flotation than hard pack. Open country allows for longer, faster snowshoes; deep forest or steep areas may require shorter, more maneuverable snowshoes. Keep in mind that smaller people will need narrower shoes otherwise they have to straddle too much. This can lead to an injury known as *mal raquette* which is inflammation of the front hip tendons.

Heavy Woods and Frequent Turning - Bearpaw or Green Mountain Bearpaw
Deep Snow - Maine or Alaskan

Construction

Current snowshoes are either wood with neoprene lacing or aluminum frame with a plastic decking. The aluminum models are very strong and lighter weight than wood models. The decking also provides superior flotation over an equal area of laces. Remember that 1 pound on the feet is like 5 pounds on the back. So go with the lightest model that fits the conditions.

Bindings

The two major bindings are the H Binding which wraps over the toe and the Super A Binding. The Super A binding is easier to put on and much sturdier. The H Binding allows too much foot play. The toe of your boot should fit through the toe hole of the snowshoe without catching (going out or coming back). In cases where you are going on hard pack snow or ice, you should have some form of snowshoe crampon attached to the snowshoe under the ball of your foot for traction. Aluminum snowshoes often have such a traction device built in.

Snowshoe Travel

- Using snowshoes is mostly strapping them on and walking.
- When traversing a slop, edge your snowshoes into the hill like a ski.
- Traversing a hill often requires repetitive high steps with the uphill leg which can tire faster.
- On step sections you can kick the snowshoe tip into the snow to create a platform to stand on. You can also kick your toe into the slope through the toe hole.

Rising on the ball of your foot while going uphill tires the calf muscles. But letting the heal sag down flat on the snowshoe stretches the muscle. Either produces some leg fatigue. Alternating between the two may reduce repetitive stress syndrome. Stretching before travel, especially the hamstrings, will help reduce the chances of injury.

Repair

Wooden snowshoes can be splinted like a bone fracture using wood and lacing. Broken lacing can also be repaired.

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OUTDOOR ACTION
WINTER CAMPING PERSONAL EQUIPMENT LIST

**** Available from Outdoor Action***

Head:
_____ ***** Wool/Pile Balaclava
_____ Silk Balaclava (optional - for sleeping)
_____ ***** Leather Face Mask
_____***** Ski Goggles or Glacier Goggles with side screens

Upper Body:
_____ 2 Long Undershirts - polypropylene
_____ Vapor Barrier Shirt (optional)
_____ ***** Wool/Polypropylene/Pile Shirt - medium weight
_____ ***** Wool/Pile Sweater or Jacket - heavy
_____ Wind Jacket with Hood - 60/40, nylon, Goretex-will double as rain jacket
_____ *****Winter Parka with Hood - synthetic fill, nylon or Gore-tex outer

Hands:
_____ Glove Liners - synthetic, polypropylene
_____ Wool Gloves
_____ ***** Wool/Synthetic/Pile Mittens
_____ ***** Mitten Shells (not needed if above mittens are shelled)

Lower Body:

_____ Underwear
_____ Long Underwear - polypropylene - light to medium
_____ Vapor Barrier Pants (optional)
_____ * Wool/Pile Pants/bibs or Knickers - heavy
_____ * Wind Pants - nylon (Goretex-doubles as rain pants)
_____ Overpants - insulated, synthetic fill ski pants (optional)

Feet:
_____ Liner Socks (thin) - polypropylene - 2+ pairs
_____ ***** Vapor Barrier Socks
_____ Wool/Pile Socks (heavy) - 4+ pairs (knicker socks if knickers)
_____ ***** Mickey Mouse Boots or Mountaineering double boots + overboot
_____ ***** Gaiters - coated nylon, large to fit over Mouse boots
_____ ***** Polarguard/Down Booties
_____ ***** Camp Overboots
_____ ***** Cross-Country Ski Boots (if skiing)
_____ ***** Ski Overboots (if skiing)

Raingear:
_____ Rain Jacket - nylon, Goretex - must fit over stacked layers
_____ Rain Pants - nylon, Goretex - must fit over stacked layers

Pack & Packing:
_____ ***** Large External Frame Pack - with frame extension or Large Internal Frame Pack (4500+ cubic inches)
_____ ***** Stuff Sacks of all sizes - all equipment in stuff sacks
_____ Pack Raincover

Travel Equipment:
_____ ***** Snowshoes with binding & snowshoe crampons
_____ ***** Ski poles - 1 pair
_____ ***** Ice Axe
_____ ***** Crampons with binding and point protectors
_____ ***** Skis and boots (if skiing)

Sleeping Gear:
_____ ***** Synthetic/Down Sleeping Bag - rated to -15 or to 0 with overbag and/or vapor barrier liner, if down should have Gore-tex shell,
_____ ***** Ensolite Foam Pad - 1/2" or Thermarest Pad

Eating Utensils:
_____ Plastic Cup - double walled recommended
_____ Plastic Spoon - should be tied to cup
_____ * 2 1 Quart Water Bottles - plastic, wide mouth, cap retainer should be outfitted in small stuff sack with webbing loops

Food (individual):
_____ 1/4 - 1/2 pound meat & cheese per day
_____ 1/2 - 3/4 pound gorp per day

Miscellaneous:
_____ Day Pack - for carrying extra clothing, water, lunch, camera, doubles as stuff sack
_____ ***** Flashlight - headlamp best, with lithium (best) alkaline (ok) batteries (workbetter in cold)
_____ Knife
_____ Whistle
_____ Belt or suspenders
_____ Bandanas - the ultimate useful item
_____ Extra Glasses, Sunglasses, Glasses Strap, Antifog
_____ Sunscreen
_____ Chapstick
_____ Toilet Articles
_____ Any Medications needed during trip
_____ Camera, film, books, games, paper & pen, etc. (optional)
_____ Cough drops or sour balls

Notes:
Contact lenses can be a problem!
All clothing must be clean.
Nonfreezing laces on all boots.
Develop method for hanging water bottles on body.
Figure out how you carry snowshoes or skis on your pack if the need arises.
Zipper pulls on all clothing and pack zippers.
Idiot strings on all mitts/shells.
Defog all glasses and goggles.
Adjust and mark boots, snowshoes and skis before leaving.
Figure out clothing arrangements: How will you organize glasses & face mask & balaclava ?

Will your shell go over pile, over polypro, over water bottles, over body?
Can you get wind/rainpants on with boots on, snowshoes?
Can you get gaiters on with boots on?
Plan your pack beautifully, so that it takes as little time as possible to get anything out.
All extra clothing should be quickly accessible.

OUTDOOR ACTION
WINTER CAMPING TRIP GROUP EQUIPMENT LIST

Additions to standard trip Group Equipment List

SHELTER:
_____ Winter tent with fly
_____ Snowstakes for each tent (may need regular stakes e.g. Chouinard depending on conditions)
_____ Wisk broom - one per tent, one for Quinzee
_____ Thermos (metal) - one per tent
_____ Spare tent poles

COOKING:
_____ Stoves - Optimus 111 MF or MSR X-GK - 2/group of 8
_____ Fiberboard with ensolite stove platform - 1/stove
_____ Large nesting pots with lids - 1/stove
_____ Small nesting pots withlids - 1/stove
_____ Pot grippers - 2
_____ Fuel bottles with Fuel - figure 1/2 pint/person/day - ADD 1 EXTRA BOTTLE FOR EMERGENCY
_____ Funnel - 1/stove
_____ Plastic cooking spoons, other utensils
_____ Dip Cup
_____ Waterproof matches - strike anywhere - large supply
_____ Scrubbies
_____ Garbage Bags

REPAIR:
_____ Pliers
_____ Visegrips
_____ Screwdrivers - regular, phillips, posidrive (if ski)
_____ Ripstop & Duct tape - lots
_____ Sewing awl and heavy thread
_____ Regular needles and thread
_____ Hose clamps - 4
_____ Parachute cord - many yards
_____ File
_____ 1/4" waterproof rope - 100 ft.
_____ Extra snowshoe binding
_____ Neoprene straps
_____ Wire
_____ Epoxy glue - something good down to low temperatures
_____ Pack repair parts
_____ Stove repair parts
_____ Pole patch kits - 2 (ski or tent)

_____ Spare bails for XC bindings (if skiing)

FIRST AID KIT: (ADDED TO STANDARD FIRST AID KIT LIST)

_____ Throat lozenges
_____ Antacid tablets
_____ Heavy space blankets - 1
_____ Heat packs
_____ Hypothermia thermometer

MISCELLANEOUS:

_____ Snow shovels - 2 - packable
_____ Ice hammer (1-2)
_____ Goretex bivy sack
_____ Spare ski pole
_____ Lots of parachute cord
_____ Thermometer
_____ Altimeter/barometer
_____ Signal mirror
_____ Extra sleeping bag straps
_____ Oil lantern - 1/tent, oil
_____ Candles
_____ Extra batteries/bulbs for headlamps
_____ Toilet paper & lots of ziplocks
_____ Alarm clock
_____ Extra spoon
_____ Extra garbage bags
_____ Guide book(s) & Maps
_____ Snowsaw - inside snow shovel (2 if igloo planned)
_____ 2 Throw bags with 1/4" polypropylene rope - 1 (for ice rescue, snow belays)

EXTRAGEAR:

_____ Food - group gorp and extra days rations
_____ Clothing - balaclava, pile/wool pants, pile/wool mittens, goggles, face mask

DAY TRIP/SUMMIT EQUIPMENT:

Day packs - each person with appropriate ***extra clothing, food, water technical gear (ice axe, crampons etc.), face mask, goggles, headlight*** - figure out how to get snowshoes, ice axe, crampons on day packs if necessary - have enough straps. Extra Gear to be carried by group members:

_____Sleeping bag
_____75 feet 1/4" rope
_____Small ensolite pad
_____Extra Balaclava
_____Bivy sack
_____Altimeter for peak climbs
_____Heat Packs
_____Extra mittens
_____First aid kit
_____Thermos
_____Stove with fuel
_____Pot with lid
_____Matches
_____Compass
_____Map
_____Shovel
_____Candle
_____Knife
_____Whistle (each person)

VAN CHECK PRE-TRIP:

_____ battery
_____ snowtires
_____ oil
_____ antifreeze
_____ brake and transmission fluids
_____ lights

BRING ALONG:

_____ chains
_____ flare kit
_____ extra antifreeze
_____ jumper cables
_____ scraper
_____ shovel, and sand

ON ARRIVAL:

_____ have gas tank full
_____ disconnect battery

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