Rescue Dynamics®

5109 - 17A Avenue NW, Edmonton, AB T6L 1K5
780 - 461 - 5040 fax / voice
Internet - www.compusmart.ab.ca/resqdyn/ or email: resqdyn@compusmart.ab.ca

Subject: **Winter Hazards During Travel On Ice**

Instructional Support

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This article provides general guidelines for persons who may have to travel on frozen rivers, lakes and ponds. It applies equally well to all winter travelers such as snowmobilers, hikers, skiers, snowshoers and mountaineers.

FORMATION OF ICE

The initial clear layer of ice formed on a lake is called "black Ice" or "blue ice". In cold weather it can increase in thickness rapidly. This freezing usually results in a sheet of columnar crystals, also called "candles", which are vertically oriented. Once covered by snow, the ice growth rate slows due to the insulation of the snow. If snow accumulation becomes significant, there may be so much weight that the ice is pushed below the hydrostatic water level of the black ice. During a period of cold weather, the underlying black ice may contract and crack followed by water welling up and flooding the ice surface until equilibrium is again reached. This is called a ***slushing event.*** A new layer of ice, called "white ice," is formed from this slurry of snow and water and is more porous than the underlying black ice. This process can happen often over the period of one winter. White ice thickness tends to be greatest in areas of lakes with the greatest snow accumulations. In areas where wind keeps snow from accumulating, there may only be black ice present.

FACTORS AFFECTING ICE STRENGTH ON RIVERS AND LAKES

The strength of the ice overlying a body of water is influenced by many variable factors. Some factors that will be briefly discussed in this article include:

- Thickness of ice
- Type of ice (black vs. white)
- River vs. lake ice
- Temperature variations
- Size, depth & age of lake
- Amount of decomposing material
- Lake's water chemistry
- Proximity to shore or dark objects
- Water movement

ICE THICKNESS

Ice thickness is extremely variable even on the same lake, pond or stream. Within a span of several feet, thickness can vary drastically. Generally, lake ice can bear more weight than river ice. Similarly, clear black ice can bear twice the weight that the same thickness of porous white ice can hold. To calculate the effective thickness of an ice surface, you must allow for the lesser strength of white ice by using the following formula:

Thickness of clear ice + 1/2 Thickness of white ice = Effective Ice Thickness

For example, 10 cm of clear ice and 10 cm of white ice would have the equivalent or effective strength of 15 cm of clear ice. ***When water lies between the ice layers, you must use only the depth of the top layer of ice in the strength calculations.***

Vehicles or other loads should not be left stationary on ice for prolonged periods, as this may cause deflection and weakening of the ice. If a load is stationary for more than two hours, twice the thickness of ice is required to ensure safety.

Temperature variations can alter the ice strength. The temperature must be somewhat stable for several days for the ice to retain its' strength. Drops in temperature can cause stress and cracking in the ice. If the temperature drops 5° - 10° in a period of less than three days, you should double the effective thickness of ice required for safe travel. During a thaw, the ice thickness should be increased by 20% for safety.

Ignoring other external influences that will be discussed later, Table 1 can provide general guidance:

Effective Ice Thickness			**Permitted Load**
Lake	**River**		
cm.	**cm.**	**in.**	
5.0	6.0	2.5	one person on foot
9.0	10.0	4.0	two skiers - single file
10.0	12.0	5.0	ice fishing station
12.5	15.0	6.0	snowmobiles / ATV's
18.0	21.0	8.5	passenger car - 2,000kg
20.0	23.0	9.0	light truck - 2,500kg
26.0	30.0	12.0	medium truck - 3,500kg
35.0	41.0	16.0	heavy truck - 7,000kg
38.0	44.0	17.5	heavy truck - 10,000kg
63.0	73.0	29.0	heavy truck - 25,000kg

TABLE 1 - Ice Thickness for Continuous Travel (clear, black ice)

The nature of a lake in terms of size, depth, age, chemical composition, biological activity and the presence of decomposing material can have a tremendous effect on the safety of its overlying ice. Small, shallow lakes tend to fluctuate in temperature more dramatically and thus thaw earlier. These small lakes are also generally more biologically active. Large amounts of decomposing material can create heat, cause melting and create gases that may weaken the crystalline structure of the ice. Decomposing material occurs in shallower water (smaller lakes), near beaver dams and where refuse is dumped into rivers and lakes. Many lakes become shallower and more biologically active as they age. The water chemistry, such as the degree of salinity and amount of dissolved minerals can affect the freezing point and strength of ice.

During warm weather or periods of sunshine, the ice near shore or close to dark or protruding objects is generally weaker due to local heating. Columnar black "candle" ice near shore can apparently "rot" or dramatically lose strength in ice that is up to a meter thick. This may be due to the vertical growth of ice crystals into the water during which minerals are excluded from the freezing process. This results in thin vertical veins of concentrated salts running alongside each crystal. As thawing progresses in the spring, these veins thaw at an accelerated rate and leave vertical columns of poorly connected crystals that can fail catastrophically under a person's weight. This condition may occur most often in shallow waters and is not easily detected. If you locate this type of ice, avoid it completely.

Water movement beneath the ice is another important consideration when assessing ice safety. In addition, one source claims that river ice holds approximately 15% less weight than lake ice. There are many locations at which ice is generally thinner due to water motion:

- at lake inlets and outlets
- on the outside of river bends where water is fast, turbulent
- in narrows
- where two streams join, due to turbulence
- close to animal and fish runs
- where rapids and rocks cause local currents and eddies
- where springs or gas eruptions occur

There are several man-made influencing factors on ice strength. Dams can cause fluctuations in water levels and subsequent cracking and shifting of ice. Power plants and pipe lines may cause a local or general heating of surrounding water.

HAZARDS

Falling through thin ice is obviously one significant hazard. Be sure thickness is adequate for the load and distribute the load appropriately across the ice surface.

During a slushing event the immediate hazard may not be falling through the ice, although this also may be a possibility depending upon conditions. Instead, frozen skis, boots or clothing may lead to frostbite or hypothermia. The paradox of this situation is that slushing events occur during or after periods of cold weather, when we think free water should not be present. Avoid situations where free water is present below the snow.

For the adventurous who venture into canyons in the winter, there is an additional hazard. Falling water levels can create unsupported shelves of ice that can hang suspended many feet above the water surface. The unwary traveler may receive a nasty surprise should the shelf collapse and drop you into the water below. The prospect of rescue or extrication from such a situation is likely bleak without specialized equipment and technique. Be doubly cautious in such places and enter only if you are prepared for the consequences.

A related hazard that occurs in spring and early summer is weak snow cover over streams. Flowing water undermines and erodes the snow cover and often leaves little evidence of the tenuous nature of the bridge of snow remaining. Unsuspecting travelers have dropped through such bridges to meet disaster in a rushing torrent of cold water.

Driving on ice requires special precautions. Vehicle speeds should be less than 30 kph over water less than 15 metres deep. When approaching shore or driving parallel to shore, reduce speeds to less than 15 kph. When several vehicles are traveling in convoy, they should be spaced at least 800 metres apart.

IF YOU FALL IN

As with most hazardous activities, **PREVENTION** is the best defense. Make an adequate assessment of the hazard and avoid dangerous conditions. Ensure adequate space between members of your party while on any ice of a dubious nature and undo your pack straps. Test the ice ahead of you with ski poles or an ice axe. Skis and snowshoes may distribute the load better than boots. If you are at all unsure of conditions, stopping to scrape or wax skis is best done on solid ground rather than in the middle of the lake.

PREPARATION is the second defense. Many sources suggest carrying ice grips and a weighted line with a pre-tied loop in it. (Ice grips can be constructed by driving a nail into a short section of dowel or broom handle. Two such grips are carried attached with a cord.) Mountaineers should consider having an ice axe or ice hammer as well as the rope at the ready. Having a long pole or any type of reaching assist ready may prove valuable. Decide what course of action you will take if you or any member of your party falls through the ice.

REACTION is your last defense. If you fall in, use slow deliberate motions and try not to panic. Avoid getting more people in trouble and use reaching assists whenever available. Rescue teams have now started using a section of fire hose inflated with air to perform water or ice rescues, so many other ideas may be useful lifesavers. Remove all wet clothing and replace with dry clothing when possible after getting out of the water. Stabilize the heat loss as soon as possible. Treat for hypothermia and administer appropriate first aid or CPR, if indicated, according to your level of training. Remember that persons in near drowning situations may be protected by a physiological response known as the Mammalian Dive reflex coupled with the seemingly paradoxical protection afforded by hypothermia, so do not give up hope if the situation seems grave. This reflex can prolong the time a cold person can survive without oxygen underwater.

If you can't get out, don't remove your clothing as it most often helps keep you afloat and slows your rate of cooling. Call for assistance. Minimize your motions to decrease the rate of cooling.

ASSESSING THE HAZARD

In assessing whether to venture onto a given section of ice, ask yourself the following questions.

1. Have the preceding weather conditions been conducive to the formation of good solid ice? How thick is the ice?
2. What do I know about this body of water?
3. Are there any local reasons for this section of ice to be unsafe?
4. Are there any local signs that the ice may be unsafe?
5. Is this section of ice near moving water?
6. What are the consequences if this section of ice fails or collapses?
7. Am I prepared to get myself out of trouble if the ice fails?
8. Can I get a member of my party out of trouble if the ice fails?
9. Is there a better way to get where I am going?
10. If conditions are bad, do I really have to cross this ice or is it wiser for me to turn back?

If you cannot answer these questions to your satisfaction, perhaps you should stay on solid ground and seek a safer route. Above all, use common sense.

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This article is based on a lecture given to the Alberta Snowmobile Association by Cyril Shokoples in 1985. I has been revised and is reprinted courtesy of Cyril Shokoples. Cyril is an internationally certified Mountain Guide and has been a member of the Alpine Club and Edmonton Section since 1975. He became a Senior member in 1979 and received the Silver Rope Award in 1988. He currently resides in Edmonton and is the proprietor of the firm Rescue Dynamics, which is involved in climbing, rescue and safety instruction, as well as mountain guiding. Further information on courses as well as additional copies of this and other technical notes in this series can be obtained directly from Rescue Dynamics. On the Internet, visit the Rescue Dynamics World Wide Web Site at - http://www.compusmart.ab.ca/resqdyn/