CAVE TERRAIN GUIDELINES: A TOOL FOR CAVE RESCUE AND PARK VISITOR MANAGEMENT

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Abstract

Cave rescue callouts are very rare in Canada and even rarer in National Parks of Canada. None the less, Parks Canada public safety rescue leaders in western National Parks need a tool to help them deploy the appropriate resources for the incident.

When a call comes for a cave rescue, Parks Canada depends upon the assistance of volunteer cave rescue groups like British Columbia Cave Rescue and Alberta Cave Rescue Organization. Members of these groups may have response times of one to eight or more hours. Parks Canada can, in certain situations, be able to make an initial response with Park Wardens to assess the incident and stabilize a patient before external resources arrive.

In order for rescue managers to have sufficient knowledge about the specific cave hazards and skills required, a matrix of cave-terrain guidelines has been developed. Each known park cave will be evaluated to provide enough information for the rescue leader to comfortably deploy local (Park Wardens) and remotely located personnel. Some of the factors considered include, map availability, cave length, navigation difficulties, hazards, travel skills and equipment required. The matrix format was adopted from the Parks Canada Avalanche Terrain Exposure Scale (ATES). Although a much different environment, ATES had much to offer from its presentation structure.

There may be application of these guidelines to help park visitors determine if their abilities and experience are compatible with the cave they may wish to visit.

Key words: cave rescue, caving safety, British Columbia, Alberta, Parks Canada

Introduction

The national parks of the western Canadian cordillera (Rocky and Columbia Mountains) have approximately 100 known caves. The potential for more caves to be discovered is considerable. A draft, three-tier classification system (Horne 2005) is proposed to manage the level of public access. Although this classification system addresses general safety concerns, it does not record enough detail to be useful for an actual cave rescue response.

Parks Canada, the agency responsible for the management of Canada's national parks, does not have a formal cave rescue capability. This is because of the extremely rare occasion to carry out this type of rescue. The agency does have extensive technical rescue preparedness in the areas of high angle rock or ice, crevasse, avalanche, swiftwater and helicopter sling rescue. All these technical specialities require dedicated training and equipment. Adding technical cave rescue to the list is not a realistic option.

Parks Canada relies on the volunteer groups British Columbia Cave Rescue and Alberta Cave Rescue Organization to perform major cave rescues. Park Wardens have been sent to their training courses. The purpose of park staff attending the courses is to build contacts, learn skills and understand the volunteer incident command structure. Any cave rescue in a national park will involve logistical support by Parks Canada. The better the understanding and cooperation between volunteers and the land manager, the more likely it will be a safe and successful rescue mission.

Location and Its Complications

Most of the western Canadian national parks developing this strategy (Jasper, Banff, Kootenay, Yoho, Waterton Lakes, Glacier and Mount Revelstoke) are situated away from large urban centers. The cave rescue volunteers, for the most part, live several hours to a full day's drive from a national park. The time to get volunteers to a cave entrance can delay an expedient response. With cave temperatures of the region averaging 2-3° C, hypothermia will always be an urgent concern, even for the most minor injury.

First Response

Is it possible for Park Wardens to perform some basic reconnaissance, patient assessment and stabilization before out-of-park rescue resources arrive? It will depend upon the cave location, its access considerations, difficulty of the cave, equipment available and skills of the wardens. For the rescue leader, especially one not familiar or interested in caves, a summarized description of the terrain difficulties of the cave where a rescue or search is required becomes extremely important.

After listing the factors or conditions in a cave that a rescuer or rescue leader would want to consider, it became clear Parks Canada already had an assessment format that could be adapted to the cave environment. In February 2003, a school group of 17 students and teachers who were backcountry skiing was caught by an avalanche in Glacier National Park, British Columbia. Ten people were saved by another ski party of two who just happened to witness the slide. The ensuing shock waves this incident caused through the avalanche forecasting community, public land managers and backcountry users was significant. One of the positive results of this tragic accident was the Avalanche Terrain Exposure Scale (ATES), a new development from Parks Canada, which offers an avalanche classification system based on the landscape—not the snow (Statham et al. 2006)

ATES is a clearly presented classification or rating system of avalanche terrain for both the land manager and the backcountry user. These ratings are intended to supplement pre-trip planning material.

Table 1. Avalanche Terrain Exposure Scale (ATES) v.1/04, the public communication model developed by Parks Canada.

Description	Class	Terrain Criteria
Simple	1	Exposure to low-angle or primarily forested terrain. Some forest openings may involve the runout zones of infrequent avalanches. Many options to reduce or eliminate exposure. No glacier travel.
Challenging	2	Exposure to well-defined avalanche paths, starting zones or terrain traps; options exist to reduce or eliminate exposure with careful route-finding. Glacier travel is straightforward but crevasse hazards may exist.
Complex	3	Exposure to multiple, overlapping avalanche paths or large expanses of steep, open terrain; multiple, avalanche-starting zones and terrain traps below; minimal options to reduce exposure. Complicated glacier travel with extensive crevasse bands or icefalls.

This means reading guidebook descriptions, studying maps and photos, talking to friends, checking weather and avalanche conditions, and referring to the ATES ratings while planning the trip. Two models of the ATES are available, a public communication model (Table 1) (http://www.pc.gc.ca/pn-np/ab/banff/visit/visit7a1_E.asp, Parks Canada 2005) is designed for communicating general concepts to the public, who is largely unable to comprehend the technical details, and a technical model (Table 2) (http://www.pc.gc.ca/pn-np/ab/banff/visit/visit7a7_E.asp#tech, Parks Canada 2005) designed for users trained and skilled in the subtle nuances of avalanche terrain.

The Cave-terrain Guidelines uses the technical model format of ATES. Public safety Park Wardens are already very familiar and comfortable with ATES. Therefore, to adopt a similar format for the cave environment would mean a higher degree of acceptance and use.

Cave-terrain Factors To Consider

These factors will influence the seriousness of a rescue and/or the complications users may encounter leading to the need for assistance. This list should be considered "a work in progress" with additions or subtractions as the guideline matrix is implemented in the field.

Table 2. *Avalanche Terrain Exposure Scale (ATES) v.1/04, the technical model developed by Parks Canada. Using this scale: Any given piece of mountain terrain may have elements that will fit into multiple classes. Applying a terrain exposure rating involves considering all of the variables described above, with some default priorities. Terrain that qualifies under an italicized descriptor automatically defaults into that or a higher terrain class. Nonitalicized descriptors carry less weight and will not trigger a default, but must be considered in combination with the other factors.*

	1 - Simple	2 - Challenging	3 - Complex
Slope angle	Angles generally < 30º	***Mostly low angle, isolated slopes >35º***	***Variable with large %, >35º***
Slope shape	Uniform	Some convexities	Convoluted
Forest density	Primarily treed with some forest openings	Mixed trees and open terrain	Large expanses of open terrain. Isolated tree bands
Terrain traps	Minimal, some creek slopes or cutbanks	Some depressions, gullies and/or overhead avalanche terrain	***Many depressions, gullies, cliffs, hidden slopes above gullies, cornices***
Avalanche frequency (events:years)	1:30 ≥ size 2	1:1 for < size 2 ***1:3 for ≥ size 2***	1:1 < size 3 ***1:1 ≥ size 3***
Start zone density	Limited open terrain	Some open terrain. Isolated avalanche paths leading to valley bottom	Large expanses of open terrain. Multiple avalanche paths leading to valley bottom
Runout zone characteristics	Solitary, well defined areas, smooth transitions, spread deposits	Abrupt transitions or depressions with deep deposits	Multiple converging runout zones, confined deposition area, steep tracks overhead
Interaction with avalanche paths	Runout zones only	Single path or paths with separation	***Numerous and overlapping paths***
Route options	Numerous, terrain allows multiple choices	A selection of choices of varying exposure, options to avoid avalanche paths	***Limited chances to reduce exposure, avoidance not possible***
Exposure time	None, or limited exposure crossing runouts only	***Isolated exposure to start zones and tracks***	***Frequent exposure to start zones and tracks***
Glaciation	None	***Generally smooth with isolated bands of crevasses***	***Broken or steep sections of crevasses, icefalls or serac exposure***

- **Natural Light.** Many of the national park caves are short, in fact short enough that daylight might extend into a significant part of the cave. Obviously, this factor when present, will assist a rescue.
- **Resource Protection.** The more delicate and situated cave resources are in regards to a rescue, the more effort and expertise will be required to minimize impact and carry out protective measures.
- **Air Quality.** Although there are no known national park caves with a deadly air quality environment, it is worthwhile to cover this topic and raise awareness of its importance. Dust concerns due to mineral and/or organic materials are a reasonable hazard to consider in some caves.
- **Map.** A well-drafted cave map will indicate rappel and climb heights or drops. This information can be used to build a tackle list when needed. A complex cave may make a map a necessity for a team unfamiliar with it.
- **Maximum Distance From Entrance.** Greater distances from the nearest accessible entrance will escalate the difficulty of a rescue, human waste management and travel times.
- **Passage complexity.** This factor considers the possibility of navigation errors leading to wasted time, becoming lost or overdue. Additionally, complex caves will require much more time or personnel to adequately search for overdue cavers.
- **Rock Fall—Natural or User-caused.** This factor can be the cause for a rescue or seriously threaten the rescue mission. In a cave with a known high hazard, extra precautions are worth making.
- **Flooding.** The possibility and predictability of flooding may be relevant in regards to overdue parties and/or affect safety of rescuers.
- **Water Travel.** In Canada cave water temperatures are typically cold. Hypothermia is a concern. The inability to keep dry will influence both user and rescuer. Swimming ability and personal floatation may need consideration. The required clothing for safe and comfort travel is covered under a separate terrain factor.
- **Rope Use—In Cave or to Access.** This factor will determine the technical training, experience and equipment required to access the entrance and/or move through the cave. Although ropes may be rigged by the party needing search or rescue assistance, an ability to evaluate their integrity is still needed.
- **Climbing—Unroped in Cave or Access.** This factor will determine the experience and judgement required to access the entrance and/or move through the cave safely. Surface conditions that are less than ideal, altered by rain or snow, may change an easy approach to an entrance into an on-rope event.
- **Stem/Bridge.** Caves can present stemming or bridging terrain with a degree of difficulty, exposure and length that tax users or rescuers both mentally and physically. In a rescue situation, this terrain very likely will result in rope use where it normally was not needed. It may present terrain requiring huge amounts of time, personnel and equipment to safely move an immobile patient.
- **Crawl.** The length and roughness of the cave floor will determine the significance this terrain factor has on travel time. Cave formations, where present, are subject to more accidental damage by this activity.
- **Squeeze.** Squeezes can be a serious barrier to move immobile patients, rescuers not comfortable in the cave environment and size of the rescuer.
- **Technical Equipment.** The more technical equipment required to travel safely, the greater the barrier to hasty searches and reconnaissance situation checks. Level of training and experience become important as the amount and type of gear increases.
- **Clothing.** Easy, simple caves can be visited with little or no special clothing. Or a complex cave may require personally fitted wetsuits and/or other cold/aquatic items. The type of clothing needed, its storage location and availability will influence response times and personnel selection.

Cave-terrain Categories

Each of the previously described cave-terrain factors is described in three categories: Simple, Challenging, and Complex (Table 3). The text descriptors chosen convey the general sense of seriousness, severity or importance of the factor. Minimal speleo-vocabulary was used on purpose

to facilitate broad user understanding.

- **Simple Cave.** These caves are friendly, have few surprises and few consequences from poor trip planning or technique. They will typically be short in length, not need special clothing, at the most require only easy handlines and no map. This category of cave would be a reasonable location for Park Wardens trained in mountain rescue to conduct a reconnaissance check with regards to overdue or injured cavers. Potentially, the wardens would be able to complete a rescue without assistance from volunteer rescue organizations.
- **Challenging Cave.** One needs to know what one is doing to safely travel in a challenging cave. There may be the requirement for single-rope technique (SRT), suitable protective clothing for the cave may be needed, multiple factors may have serious injury or deadly consequences and injuries could lead to hypothermia. Park Wardens with extensive mountain-rescue and caving experience may be able to reach a patient to assess and stabilize, but possibly the terrain may be beyond local in-park capabilities. Out-of-park rescue assistance is a high probability unless the situation were very straightforward.
- **Complex Cave.** The seriousness of the terrain factors prevailing in a challenging cave only get more pronounced in a complex cave. Out-of-park rescue assistance, particularly for patient movement, is a near certainty. Screening of public users for this category of cave is crucial for accident prevention.

Cave-terrain Defaults

Cave terrain that qualifies under a **bolded** descriptor in Table 3 automatically defaults into that or a higher terrain category matrix. Non-bolded descriptors carry less weight and will not trigger a default, but must be considered in combination with the other factors. The same principal is used with ATES (Table 2). These defaults are particularly important when most descriptors are rated as Simple terrain, and it would appear the cave's overall evaluation would be a Simple category as well. However, one or more critical descriptors are Challenging or Complex enough that their importance shifts the overall rating to a higher category. Table 4 illustrates as an example how Lost Light Cave primarily scored Challenging factors, yet there is one factor rating complex, stem/bridge. This Complex factor puts the cave's overall rating as Complex. The underlying factor of these bolded descriptors is the potential for significant bodily harm or death if conditions and/or actions go bad. The bolded descriptors are all situations where rescue personnel or public users must know what they are doing—trained and experienced in other words.

Cave Evaluation to Determine Category

The objective is to complete the cave evaluation before it is needed (Table 4 example). Ideally, the evaluator has personal knowledge of the cave. The larger the territory, the more unrealistic this scope of expertise will be. Other first-person knowledge is preferred. One can ask assistance from local cavers and/or by contacting regional speleological groups. Detailed written trip reports, other literature, drawn surveys and second-hand sources can be used if nothing better exists. It is useful to record the source of cave knowledge for each evaluation.

Integration of the cave-terrain evaluation with other information about a specific cave would be an ideal scenario. Then, one-stop shopping could take place when there is an incident. Where the cave is located, how to access it, resources at risk, maps, local knowledge and the cave-terrain category etc. could all be found in one database. However, information security for various reasons may force separation of information. If this is the case, a one-page text summary covering the critical information required by a rescue leader or land manager needs to be attached with a completed evaluation matrix.

Use of the Cave-terrain Guidelines for Pre-Trip Visitor Planning

Although originally developed as an in-house tool to assist staff with cave search and rescue, the cave-terrain guidelines have possible application in public, pre-trip planning. If used to its full potential, the guidelines may prevent a public safety incident from occurring.

Regardless of sport, there is a portion of park users who know the activity they wish to partici-

Table 3. Cave-terrain Guidelines generic matrix (version 5.0, Nov/2007). If any factor scores in the bold cave-terrain categories, then the minimum default rating for the cave will be the same.

Category / Factor	Simple	Challenging	Complex
natural light	present for significant portion of cave	present for small portion of cave	present for very small portion of cave
resource protection	there are few or no known resources at risk	some resource protection concerns should be addressed during travel	there significant resource protection measures to be taken during travel
air quality	good	good but may have sections with dust concerns	**significant health concerns—dust, dead air or high CO_2**
map	not required	very useful	necessary
maximum distance from entrance	<100m	100–500m	>500m
navigation	none or few junctions or loops	several junctions or loops	many junctions or loops
rockfall - natural or user caused	low potential	some potential	probable unless very careful
flooding	none	predictable and or low consequences	**unpredictable and or serious consequences**
water travel	none or shallow wading	**deep wading, easy swim, and or climbing/rappel in waterfalls**	**lots of wading and or swiftwater, climbing/rappel in waterfalls and or diving**
rope use, in cave or to access	none or easy to rig handlines	**simple rappels <50m, anchors secure**	**rappels >50m, awkward lips, rebelays, deviations, anchors questionable**
climbing, unroped in cave or access	none or less than 3 m	**some, consequences of fall serious**	**some to lots, consequences of fall fatal**
stem/bridge	none or few moves	**longer easy sections or short with moderate fall consequences**	**short to long sections with fall consequences serious to fatal**
crawl	none or short and easy	considerable distances of low and or uncomfortable	very long sections of low and or uncomfortable
squeeze	none or very easy	some moderately tight or awkward places	**many and or some very tight, awkward or unstable**
technical equipment	none	basic SRT equipment,	SRT, aid gear, dive gear
clothing	none special or coveralls	heavy duty coveralls, wet suits, rubber boots/neoprene socks	heavy duty coveralls, dry suits

Table 4. *Cave-terrain Guidelines for Lost Light Cave in Jasper National Park (grayed cells). The overall rating of the cave is complex because the stem/bridge factor is a default complex descriptor. If any factor scores in the bold cave-terrain categories, then the minimum default rating for the cave will be the same.*

Category / Factor	**Simple**	**Challenging**	**Complex**
natural light	present for significant portion of cave	present for small portion of cave	present for very small portion of cave
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pate in, but do not really know where they want to go. Another group of users has unrealistic trip goals based on their skills, seasonal conditions and experience. Both of these types of users could benefit from the detail provided by the cave-terrain guidelines evaluation. Also, park staff that are tasked with providing pre-trip planning advice to the public have a very useful tool. This especially is the case for staff who have little or no knowledge of caves.

The ATES builds lists sorted by the three-level categories. Similar style lists of caves held by park staff could quickly help them narrow their recommendations when consulting the public.

How much information, and by which media, that a land manger will provide to the public about caves in their jurisdiction could be a discussion paper in itself.

Conclusion

The cave-terrain guidelines were developed, in part, as a result of a caver fatality on the approach scramble to a national park cave. These guidelines were formatted using the Avalanche Terrain Exposure Scale, also developed as the result of fatalities while travelling in the backcountry. Tragedy can lead to improved safety awareness and accident prevention.

Cave rescue leaders, land managers and speleological groups can use these guidelines to assist with information summary and safety awareness. Homework, consisting of the evaluation of known caves, must be completed and accessible before the rescue call or information request is received.

Acknowledgments

The interest shown and suggestions made by the following people contributed to the success of these guidelines: Mike Grande, Bill Hunt, J.P. Kors, Brad Romaniuk, Jordy Shepherd, Grant Statham, Rupert Wedgwood, Phil Whitfield and Percy Woods. Their help is much appreciated, thank you.

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