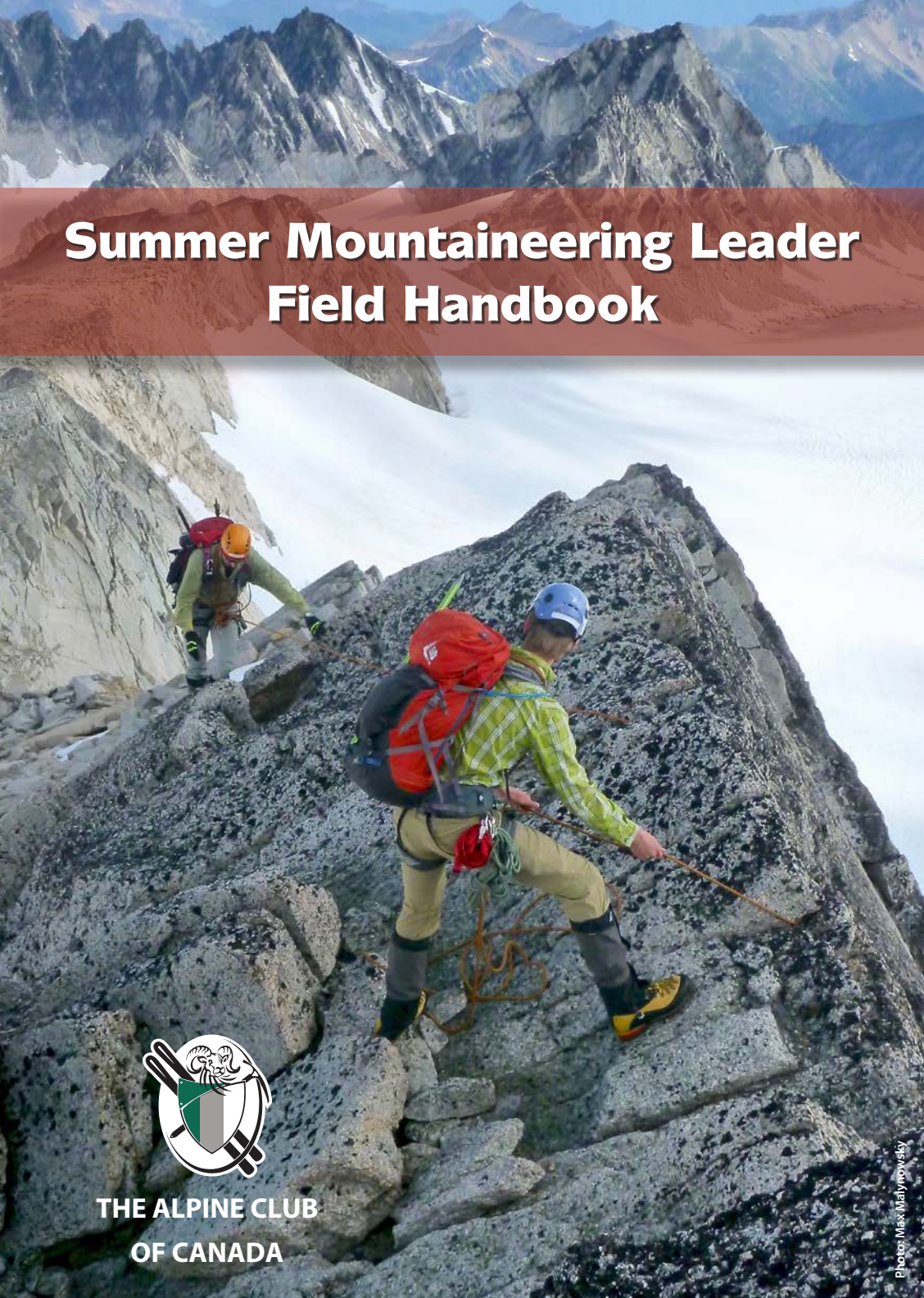
Summer Mountaineering Leader Field Handbook



THE ALPINE CLUB OF CANADA

Photo: Max Malynowsky

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Foreword

The Alpine Club of Canada's (ACC) passionate volunteer leaders have expressed a desire for a nationally-supported training program that recognizes the diversity of ACC trip leaders and their roles in the various types of trips they lead in sections across Canada. The ACC's Section representatives and Board of Directors have expressed concern at lack of a standardized national training curriculum. Over the last four decades previous attempts to provide standardized leader training materials (developed by national panels, mountain professionals or external consultants) were not well-received.

The approach taken in developing this field manual (and associated materials) recognizes that past attempts to develop curricula and training materials failed, largely because they were developed using a top-down approach whereby the sections and their volunteer leaders were merely the recipients of materials at the end of a process. In 2012 the Leadership Development Committee (LDC) co-chairs proposed the opposite, whereby the sections and their leaders would be involved right from the beginning in identifying volunteer leader types, associated competencies and appropriate levels of proficiency, to be considered 'really excellent leaders'.

The process proposed by the Leadership Development Committee (LDC), and endorsed by Section Council and the Board of Directors, was driven by ACC volunteer leader input and participation. The LDC merely acted as facilitators, coordinating the process and ensuring results met ACC members' expectations. All ACC sections were invited to appoint a volunteer leader to participate in an ACC Competency Profile working group (ACP). ACP reps were active volunteer leaders who were familiar with their section's own leadership needs and current training practices. After establishing an initial list of leader types found nationally, ACP representatives and LDC members met to finalize the list and draft a competency profile for each leader type. Resulting 'DACUM' charts list competencies and related learning objectives.

Draft profiles were sent to ACP reps for their review and then shared with other volunteer leaders, for further input. A final set of 15 competency profiles was endorsed by the ACP reps, and by Section Council and Board of Directors.

With section input, ACP reps then prioritized the development of training materials for their top three leader types: Top Rope Rock Climbing Leader, Winter Backcountry Leader (avalanche), and Summer Mountaineering Leader. In addition, the ACP reps ranked

a list of course goals addressing the competency profiles for each leader type based on their section's view of the highest-priority learning objectives for each competency. Section Council then directed the LDC to begin developing a training module for the Top Rope Rock Climbing Leader (completed 2016) followed by the Winter Backcountry Leader (avalanche) (completed 2017) and this module, the Summer Mountaineering Leader.

Both the ACP and LDC recognize there are numerous skilled and competent volunteer leaders currently active in ACC Sections, and not all of them will have high proficiency in every competency identified in the applicable profile. It is not the intent of the LDC or the ACP reps to define the minimum levels of proficiency in each competency for a given leader type necessary to lead section trips. The relative importance or necessity for proficiency in each competency varies across the country according to the context in which each section operates. It is therefore up to individual sections to decide which competencies are absolutely necessary for the various leader types in their context, and what appropriate minimum levels of proficiency are in each competency relative to their section's needs.

Aspiring volunteer leaders can consider the Competency Profile to represent the ACC's definition of what skills an exceptional volunteer leader would have or aspire to develop. It is possible that volunteer leaders already leading section trips may not have the highest levels of proficiency in all competencies. This should NOT be taken to mean they are no longer qualified to continue leading section trips; rather, the competency profile can be used by these individuals as a road map for continued personal leadership development.

This handbook follows competencies in the Summer Mountaineering Leader Competency Profile. Together with an accompanying Instructor Agenda, Lesson Plans, Participant Evaluation Form and Competency Vetting Form, it forms a complete module intended to facilitate training of volunteer Summer Mountaineering Leaders by qualified ACC volunteers, professional outdoor educators, or guides. Individual ACC Sections may choose to simply refer to the module to augment existing section training materials, or use it as the basis for their own local volunteer training programs. They may choose to use volunteers from within their own or other sections, or professional instructors, in the delivery of all or some of the materials presented.

Table of Contents

Introduction

The purpose of this field handbook is to support The Alpine Club of Canada's Summer Mountaineering Leader training program, as well as to act as an ongoing resource for Summer Mountaineering Leaders. It is designed to highlight techniques and applications commonly used by Summer Mountaineering Leaders to assist in the delivery of a successful summer mountaineering outing.

TARGET AUDIENCE

The directed audience for this field handbook includes experienced recreational mountaineers, with some prior basic group management experience, who are confident mountaineers and lead climbers on rock and ice, and who also possess current wilderness first aid training. Additionally, it designed for aspiring leaders who are in the process of increasing their recreational summer mountaineering knowledge and abilities, and as a reference resource for Summer Mountaineering Leaders who have successfully completed higher level training (e.g. Assistant Guide) or have been recognized via the Prior Learning and Assessment Recognition process.

LIMITATIONS

This field handbook strives to provide information specific to common, or routine, summer mountaineering travel and group management scenarios. However, it is not all-encompassing and cannot account for all potential situations or circumstances. It is therefore expected that in addition to this manual, Summer Mountaineering Leaders are capable of exercising good judgement and situational awareness.

DISCLAIMER

The information contained in this field handbook has been obtained from equipment manufacturers, industry best practices, applications promoted by the Association of Canadian Mountain Guides, and the policies of The Alpine Club of Canada. Every care has been taken to ensure that the information contained herein is accurate and current. However, the content of this field handbook is subject to change as equipment, techniques and best practices evolve. Therefore, the field handbook should be used as a resource guide only.

The author, publisher, The Alpine Club of Canada, its board, directors and officers, and employees are not responsible for the results of any actions taken by users of the information contained in this book. Summer mountaineering outings are an inherently dangerous activity that you pursue at your own risk.

Designing a Summer Mountaineering Outing

A successful summer mountaineering outing starts well before stepping out on the trail. Careful planning and diligent preparation significantly increases the probability that the summer mountaineering outing will be a success. In this chapter, we will explore the key aspects specific to the process of designing a summer mountaineering day or multi-day trip.

Pre-trip planning

The first step in organizing a summer mountaineering outing involves basic pretrip planning. This planning will enable the leader to determine the suitability of the trip for varying participant abilities, and ensure that the terrain and objectives are appropriate.

ESTABLISHING TRIP OBJECTIVES

Establishing clear trip objectives early in the planning process will enable the Summer Mountaineering Leader to choose the most suitable route for the outing. The objectives will determine necessary participant prerequisites, equipment requirements, participant to leader ratios, and overall feasibility.

Common summer mountaineering outing objectives may include:

- Climbing a particular mountain feature (summit, ridge, face).
- Traversing multiple peaks.
- Introducing first time summer mountaineers to single day ascents or multi-day ascents.
- Multi-day section or national ACC mountaineering camps.
- Teaching basic movement skills on rock, ice and/or snow.
- Teaching introductory crevasse rescue skills.
- Continued development for intermediate summer climbers.
- Team work and trust building.

TRIP DURATION AND LOGISTICAL COMPLEXITY

The preparation for a multi-day trip will typically be considerably more complex than that for a day trip. However, the technical gear, weather protective gear and emergency response gear (first aid kit) carried on a car-to-car day climb will not vary significantly from that carried on a day climb originating from a base camp setting such as the ACC's General Mountaineering Camp (GMC). Multi-day trips will incur a multitude of additional considerations with regards to camping, cooking and food.

Trips can be categorized according to their duration and logistics.

Day trips – Everything needed for the day must be carried. Having a current, detailed weather forecast is crucial. Emergency bivouac equipment should be carried (guide's tarp, lighter and extra food).

Multi-day trips (hut-based) – Get detailed information on the current contents of the hut (stove type and availability of fuel, cooking equipment, sleeping accommodation, etc.). Once at the hut, climbs can be treated as day climbs, or if multiple huts are to be linked it becomes more of an alpine-style trip. Huts must be booked in advance and paid for. Communicate with the hut operator as early as possible to confirm space. Some huts can only be booked through a lottery process. It is unacceptable to just show up at a hut and expect to find space.

Multi-day trips (base camping) – Be clear on who is supplying the base camp contents. Communicate the amenities provided. Once at a base camp, climbs are treated in the same way as day trips. However, accurate daily weather forecasts may be harder to source.

Multi-day trips (alpine style) – It is essential to keep the pack as light and small as possible, while still carrying everything needed for the ascent. Big, bulky packs make the climbing harder.

Multi-day trips (expedition style) – An extension of the base camp model, satellite camps are used to penetrate further into the terrain. A series of camps may be used, progressively higher on the mountain.

ACCESS

- Parking – Consider how to keep your vehicle and its contents secure while you are climbing. At popular trailheads, the primary concern may be theft, while at more remote backcountry locations the primary concern may be animal damage. Porcupines are known to have an affection for brake lines and radiator hoses. Chicken wire around the vehicle can reduce the likelihood of returning to a disabled vehicle.
- Helicopter support:
  - Fly-in trips require detailed trip planning as helicopter time is expensive. At about $0.50 per second, that extra flight to go back and pick up the boots that you left in your vehicle, makes for an expensive trip.
  - Helicopters have limited weight and volume capacities. Careful research on the capacity of the machine to be used will impact the planning process. Everything gets weighed before the flight.
  - Hiking – If you are hiking into your camp location, consider the carrying capacity of each member of your group.

Ridge

Mountain terrain

As there is a wide range of mountain terrain options, consideration must be given to selecting an option that fits well with the group's needs and abilities. A desirable objective may need to be modified in light of the group's abilities.

CHOICE OF TERRAIN TYPE AND FEATURE

Mountain rock routes typically follow natural lines such as ridges, corners and crack systems. The easiest lines of ascent are most often ridgelines. Harder lines may wander up faces, connecting discontinuous features.

Corner

Snow and ice routes can be found on faces, ridges and couloirs. They can vary tremendously as the season progresses. Classic north face routes such as Athabasca can be predominantly a snow climb in the early season, whereas by September it is dense, hard ice from bottom to top with a short rock step just below the summit.

Routes that follow ridges, buttresses, or ribs are somewhat less prone to rockfall hazard, as natural or climber initiated rockfall will track away from the ridge and out onto the face. Conversely, couloirs, gullies and chimneys are natural funnels for rockfall. Consideration must be given to the likelihood, timing and magnitude of potential rockfall.

Technical difficulty

Rock routes have technical grades that remain relatively consistent. Key holds may break off or become polished over time, but for the most part the grade does not change from day to day.

Snow, ice and mixed routes have technical grades that are highly subjective. The difficulty can change quickly. Firm, frozen snow becomes slush within hours of receiving direct intense sunshine.

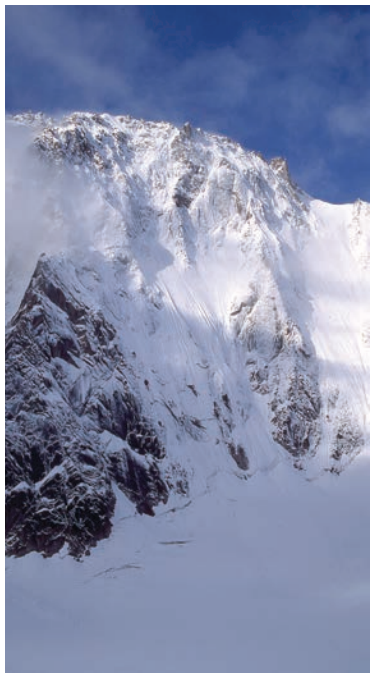
Length of route must be considered in relation to the group's ability to move through terrain. For example, the Northwest ridge of Mount Sir Donald is rated 5.4, but the route gains 750 metres of elevation. A successful one-day ascent is unlikely if the entire route is pitched out and belayed. Much of the route is third and fourth class, so the team must be able to move through this terrain efficiently.

Crack

Rock Face

Snow and ice ridge

Colouirs/gullies



Ice face

Bugaboo East Face

SELECTING A MOUNTAIN ROUTE

Based on the established objectives for the summer mountaineering outing, the leader can then select the most ideal route of ascent and descent for the trip. The Summer Mountaineering Leader would consider the following criteria in their trip selection:

- The route difficulty and commitment.
- The descent options.
- The weather forecast.
- Popularity of the trip (may determine group size).
- Whether or not avalanche hazard may be encountered.
  - Identify a Plan B in the event avalanche and or weather conditions suggest that Plan A may be unsafe.

Route grading system

Route grading is at its best somewhat subjective. When applied to mountain routes, the grades become even more subjective with the potential to change over time. For example, a 5.7 rock section that is covered in verglass becomes an M7, a 40 degree snow gully becomes a rubble filled, loose, unprotectable 5.9 chimney.

North American route grading is based on technical difficulty and commitment (or seriousness). The route's technical grade is based on the hardest move and can include: rock, ice and or mixed grades. The French Alpine Rating system is based on overall difficulty.

Rock terrain is classified from 1 to 6

Classification & Description	
Class 1	Walking.
Class 2	Scrambling, minimal exposure.
Class 3	Scrambling, using hands and feet, some exposure.
Class 4	Using hands and feet, exposed, rope used for beginners.
Class 5	Technical rock climbing. Subdivided from 5.0 to 5.15.
Class 6	Aid climbing.

Snow and ice terrain is graded from 1 to 7

Classification & Description	
Grade 1	Low angle, 20-40º.
Grade 2	Up to 60º, some bulges.
Grade 3	Consistent 70º, with some steeper bulges.
Grade 4	Long sections of 80º with some sections of 90º.
Grade 5	Continuous vertical ice, may be hard to protect.
Grade 6	50 metres of vertical ice, very technical and hard to protect.
Grade 7	A full pitch of vertical and overhanging ice.

Mixed climbing terrain is graded from 1 to 15

Classification & Description	
M1-3	Easy.
M4	Feels like 5.8 rock.
M5	Some vertical sections, Feels like 5.9 rock.
M6	Some overhanging sections, Feels like 5.10 rock.
M7	Overhanging with powerful moves, Feels like 5.11 rock.
M8	Powerful, boulder, Feels like 5.12 rock.
M9 to M14+	Harder and harder climbs.

Alpine Grades

Grade	*Difficulty*	*Characteristics*
F	Easy	Scrambling – rock or snow, easy glacier travel.
PD	Not very hard	Some technical climbing, belays, rappels, more complicated glaciers.
AD	Somewhat hard	Steep technical rock, or snow/ice steeper than 50º.
D	Hard	Sustained technical climbing.
TD	Very Hard	Long sections of hard climbing.
ED	Extremely Hard	Continuous, poorly protected, highly technical.
ABO	Abominable	High level of difficulty and danger

Commitment

The length of time that a competent party will take to complete the route is only one factor in the route's commitment level. The vertical and horizontal distances, objective hazards, and complexity of travel (particularly retreat) are also factors to be considered.

Grade	*Route*	*Descent*	*Hazards*	*Retreat*
I	Short Route, not remote	Easy	Low	Easy
II	Longer or more technical.	Requires caution in places	Low	Easy
III	Long route	Tricky	Limited	Somewhat tricky
IV	Large scale, requiring significant mountain expertise.	Long approach or complicated descent	Notable	Tricky
V	Long route on a big wall.	Long or difficult	Substantial	Difficult
VI	Every pitch is hard. Conditions rarely good. Complicated route finding, complex belays.	Long and difficult	High	Uncertain
VII	Like Grade VI, but harder.	Long and difficult	Very high	Very uncertain

PERMIT REQUIREMENTS

Many Provincial and National parks require user permits, and in some instances activity permits may also be required. National parks also require backcountry overnight permits and fees. Prior to offering a summer mountaineering outing the leader must determine what, if any, permits are required. They must also determine what, if any, stipulations the permit presents, and who will be responsible for obtaining the permit or permits prior to the outing.

SEASONAL/UNUSUAL CLOSURES, AND ACCESS ISSUES

Many popular backcountry areas are subject to seasonal or periodic closures for a variety of reasons. Often the closures may be related to ecological sensitivities or habitat areas (i.e. grizzly bears). It is important that the Summer Mountaineering Leader research the proposed trip and ensure that no closures are in place.

Occasionally the climbing route itself may not be closed, but the roads, approach trails, or descent route used for access and egress may be under a closure. In these instances, it is imperative that the Summer Mountaineering Leader research whether alternative access points to the route exist. If no alternate access to the venue exists, the leader must select a different trip option.

Determining participant prerequisite requirements

Once the route objectives have been determined the Summer Mountaineering Leader should then determine the skill set that the participants will need. Criteria such as age, experience, and ability should be considered when determining participant requisite requirements. Some trips may not be suitable for specific participant demographics. Trips that involve long approaches through rough terrain may not be appropriate for participants with lower levels of fitness. If considering an overnight trip, the Summer Mountaineering Leader would consider the length and difficulty of the trip and the targeted experience level. Participants new to overnight summer mountaineering travel, for example, may be more suited to a shorter trip in simpler terrain where successful skill development can take place without the urgency of a long day to complete the outing in the prescribed time.

Depending on the objectives of the outing and the technical rating of the route, prerequisite experience may be required. Technical summer mountaineering requires a certain level of fitness, movement skills on rock, ice and or snow, previous crevasse rescue training, or previous summer overnight experience.

DEFINING LEADER TO PARTICIPANT RATIOS

The appropriate ratio between Summer Mountaineering Leaders and participants will vary depending on the objectives of the outing, the technical rating of the terrain, the technical skills of the members, the fitness of the members, the leader's competence and expertise, and the leader's familiarity with the area.

Recommended ratios

Ideal ratios will depend on the participants' skill sets in relation to the technical nature of the terrain. Each rope team will need a competent leader.

Small delays due to stuck gear, equipment problems such as crampons falling off or blisters to the feet can be more easily managed with a co-leader that can readily communicate the information to the leader who can then take appropriate group management measures.

Whenever possible, Summer Mountaineering Leaders should avoid taking participants on trips they are not personally familiar with. In situations where the Summer Mountaineering Leader is facilitating an outing that is unfamiliar, they should increase their margins of safety with strategies such as earlier turnaround times.

Familiarity with a trip allows for the Summer Mountaineering Leader to anticipate breaks and transitions, cruxes, and potential challenging areas for participants. Inexperienced participants may appreciate this knowledge. Familiarity also aids in time management of the outing determining if the trip can be completed as planned or the selection of a turnaround point to ensure the group returns to the trailhead safely.

Developing pre-trip communications

Initial communication between the trip leader and participants will begin to build rapport with participants and set the tone for the summer mountaineering outing. Participants need to be acutely aware of the trip objectives, the type of terrain (rock, ice, and/or snow), the technical rating of the terrain, the access, driving directions, what is expected of them, and what the leader will be responsible for. Early communication with participants also allows the Summer Mountaineering Leader to gain information specific to the participants, and modify the objectives slightly to best meet the participants' needs.

EQUIPMENT AND CLOTHING LIST

Participants will typically be responsible for ensuring that their personal gear such as clothing, climbing equipment (i.e. mountain boots, crampons, harness, helmet, etc.), pack, food and water, etc., are appropriate. Additional equipment will be dependent upon whether the outing is a day trip, multi-day trip, hut-based or camping. A sample list that could be provided to participants prior to their participation in a summer mountaineering outing is:

PERSONAL EQUIPMENT

(Depends on the nature of the route)

- Pack (big enough to fit everything inside for the objective)
- Helmet
- Harness (adjustable leg loops and fits over boots & crampons)
- Belay device
- 3 x locking carabiners
- Two x 5 m and one x 1.5 m x 7 mm accessory cords
- Mountaineering boots
- Crampons (fitted to boots prior to trip)
- Ice axe (50 - 80 cm depending on height)
- Rock shoes and chalk bag
- Glacier glasses and goggles
- Small personal 1st aid kit (moleskin tape etc.)
- Headlamp
- Water bottle
- Knife
- Altimeter
- GPS
- Thermometer (recommended)
- Field book
- Compass
- Lighter (or alternative fire-starting device)
- Sunscreen
- Lip balm
- Personal medications
- Personal hygiene kit - wet wipes, toilet paper, toothbrush/ toothpaste, hand sanitizer
- Collapsible ski pole (2 or 3 section, adjustable)
- Avalanche transceiver (digital)
- Shovel
- Probe

CLOTHING

- Rain/wind shell - jacket & pants (waterproof breathable)
- Gaiters
- Softshell jacket & pants
- Base layer top and bottom
- Insulated jacket
- Shelled & insulated gloves
- Warm hat & sun hat
- Neck tube (i.e. buff)
- Socks & spares
- Spare mitts or gloves
- Spare base layers
- Approach shoes and/or hut booties

GROUP EQUIPMENT

- Group first aid kit
- Tarp or emergency shelter(s) able to accommodate all group members
- Emergency communication device
- Crampon repair kit
- Improvised rescue equipment
- Backpacking stove and pot (optional)
- Emergency fire starting kit
- Map (in addition to the leader's map)

TECHNICAL EQUIPMENT

(Depends on the nature of the route)

- Rope
- Rack
  - Rock protection
  - Ice protection
  - Snow pickets or deadman anchors
  - Anchor kits (120 cm or 240 cm sling + carabiners)
  - V-thread hook

CAMPING EQUIPMENT

- Stove and pots
- Spare batteries for headlamp
- Eating utensils
- Cup and bowl
- Candle
- Lighters(s) or alternate fire-starting method (i.e. strike anywhere matches)
- Sleeping pad
- Sleeping bag (rating depends on time of year and trip)
- Toiletry kit
- Camp booties
- 3 or 4 season tent
- Large pack (60 to 70 liters)

Layering

Appropriate layering ensures the comfort of the leader, and of the participants throughout the day in a multitude of conditions. Appropriate layering will enable participants to stay warm when it is cool, and avoid overheating when it is warm. Layers are commonly separated into three categories; a base layer that sits next to the skin, a mid-layer that traps in heat, and an outer layer that protects from the elements such as wind, rain, and snow.

CHARACTERISTICS OF BASE LAYERS

Base layers should

- Wick moisture away from the skin,
- Be lightweight,
- Be close fitting,
- Have flat seams to avoid chaffing, and
- Be constructed of a material that dries quickly and is breathable.

Common base layer fabrics include synthetics such as polyester or natural materials such as wool.

Cotton articles should be avoided in climates that are cool and/or damp. This includes cotton base, mid, and outer layers. That said, on an overnight hut based trip, a cotton or cotton blend shirt or pants can make one's hut stay more comfortable.

CHARACTERISTICS OF MID LAYERS

Mid layers should be
- Light-weight,
- Air permeable,
- Compressible and packable,
- Provide insulation and warmth, and
- Fit comfortably over a base layer, but still fit close to the body.

Common mid layer materials include synthetics like fleece, lofts, and down.

CHARACTERISTICS OF OUTER LAYERS

Outer layers should
- Block the wind,
- Block precipitation,
- Be breathable,
- Fit comfortably over base and insulating layers, and
- Should allow freedom of movement.

Common outer layer materials include breathable hard-shell nylon materials, and soft-shell nylon materials.

Risk management

EMERGENCY RESPONSE PLAN

Summer mountaineering leaders need to prepare an emergency response plan for their trip. This will facilitate the leader's response to an emergency and accelerate the response rate from outside agencies. The leader carries a copy and a copy is left with the appropriate club contact person.

An Emergency Response Plan (ERP) should include:

- Emergency Contact Information (name and phone number)
  - Club contact person
  - Local RCMP
  - Local rescue team
  - Provincial emergency management personnel
  - Nearest hospital / medical clinic
  - Local helicopter company
- Communication Protocols
  - Document the inter/intra group communication process.
    - Call-in times and methods.
  - Research and document mobile phone coverage.
  - Research and document VHF radio channels and coverage.
    - Ensure that hand held radios have the appropriate frequencies.
  - Confirm access to satellite communication (phone, SPOT, Garmin, Delorme).
    - Record the satellite phone number.

- Emergency Incident Levels
  - Level 1 – minor injury, basic first aid
  - Level 2 – broken bones, TBI, possible evacuation
  - Level 3 – evacuation and extended medical treatment needed
- Evacuation Protocols
  - Methods
    - Helicopter
    - Ground
- Evacuation routes and trailheads
  - Reasons
    - Motivational evacuation
    - Non-life threatening medical evacuation
    - Emergency evacuation
  - Costs – payment method
- Backcountry location information
  - Trailhead
  - Route plan
  - Horizontal distance to be travelled
    - Elevation – gain and loss
    - Campsite locations
- Time plan
  - Departure
  - Turn around
  - Return
- Hazard analysis and risk assessment
  - Hazard analysis
    - Methods of prevention, control and mitigation
- Objective hazards
  - Transportation
  - Environmental
  - Terrain
  - Activity
- Subjective hazards
  - Participants
  - Leaders
- Maps – evacuation routes

WAIVER DOCUMENTS

Waivers are commonly used to transfer responsibility and highlight risks associated with summer mountaineering activities that will travel in or through complex mountain terrain. It is recommended best practice to provide participants with waivers in advance of the summer mountaineering outing so they can familiarize themselves with the risks specific to their participation, and ensure they are comfortable and accepting of them.

Participant waivers should be signed in blue or black ink, in person, at the commencement of the summer mountaineering outing. Providing the waivers as part of the participant pre-trip communication allows participants to review the waiver, and choose not to participate in the activities without any element of duress. Copies of these and any other forms in this book can be found at www.alpineclubofcanada.ca/forms.

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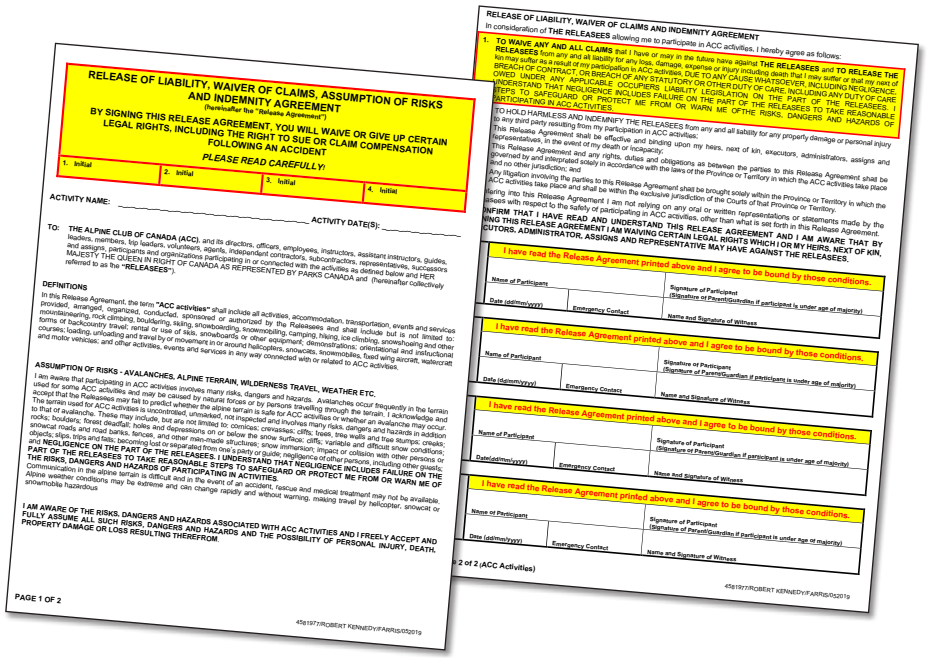
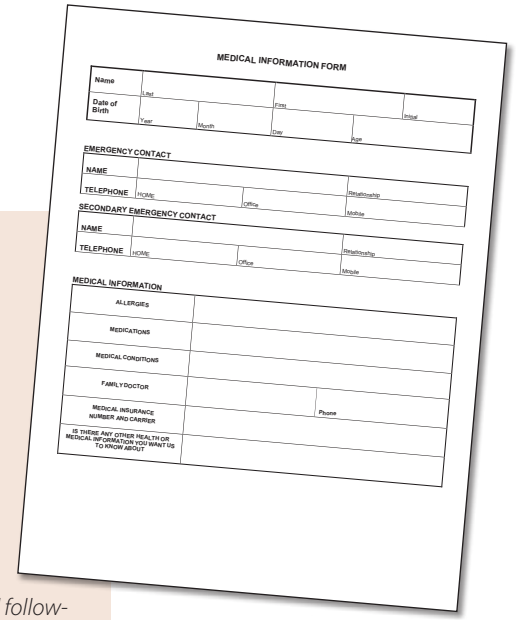

RELEASE OF LIABILITY, WAIVER OF CLAIMS, ASSUMPTION OF RISKS AND INDEMNITY AGREEMENT

RELEASE OF LIABILITY, WAIVER OF CLAIMS AND INDEMNITY AGREEMENT

MEDICAL FORMS

Medical forms enable the Summer Mountaineering Leader to familiarize themselves with pre-existing injuries, medical conditions, allergies, and any medications participants may have or require. It is recommended that this information be collected from the participants prior to the outing and reviewed by the leader to ensure the outing is suitable for all members of the group. If medications are required by participants for allergies or pre-existing medical conditions, this provides the Summer Mountaineering Leader with the opportunity to remind participants to bring their medications on the trip. Occasionally a participant may innocently omit disclosing pertinent medical information. For this reason, it is recommended that the Summer Mountaineering Leader check in with participants at the trail head prior to departure as a means to double check if any medical information has not been disclosed.


MEDICAL INFORMATION FORM

Name — Last, First, Initial

Date of Birth — Year, Month, Day, Age

EMERGENCY CONTACT

NAME

TELEPHONE — HOME, Office, Relationship, Mobile

SECONDARY EMERGENCY CONTACT

NAME

TELEPHONE — HOME, Office, Relationship, Mobile

MEDICAL INFORMATION

ALLERGIES

MEDICATIONS

MEDICAL CONDITIONS

FAMILY DOCTOR — Phone

MEDICAL INSURANCE NUMBER AND CARRIER

IS THERE ANY OTHER HEALTH OR MEDICAL INFORMATION YOU WANT US TO KNOW ABOUT

Participant medical information should be sourced prior to the trip; however, the forms should be accessible throughout the outing for reference by the leader should a medical incident occur. Personal medical information is subject to Freedom of Information and Privacy laws and must be kept strictly confidential and destroyed following an outing. Copies of these and any other forms in this book can be found at www.alpineclubofcanada.ca/forms

CONTINGENCY PLANS

Participants should also be informed of any potential contingency plans. The Summer Mountaineering Leader should ensure they have contact information for all participants, in the event last minute communication with participants is needed the morning of the trip. Participants should also be provided with a phone number, or other means of contacting the trip leader on the day of the outing.

TRIPS WITH MINORS
(participants under the age of majority)

It is possible an outing may be designed for, include, or attract the participation of youth (participants under the age of majority). Travelling with minors requires certain and specific procedures. Some of these are policy within The Alpine Club of Canada (ACC), while other policies have been implemented by external land managers – i.e. national parks.

The Summer Mountaineering Leader should be familiar with the ACC Policy for persons under the age of majority. A PDF copy can be found on this web page: www.alpineclubofcanada.ca/forms

This policy describes the process of waiver (assumption of risk administration), information and trip requirements as well as terrain limitations. These may include strategies beyond the typical planning process such as the following examples from the ACC policy for persons under the age of majority:

- Detailed trip plan forwarded to the parent(s) or guardian.
- Permission forms together with the required waiver forms.
- Encourage parental participation if practical/possible.
- Emergency plans and communications.

References and further reading

Dougherty, S., (1997) *Selected Alpine Climbs in the Canadian Rockies,* Rocky Mountain Books, Calgary, AB

Houston, M., & Cosley, K., (2004) *Alpine Climbing: Techniques to Take You Higher,* The Mountaineers Books, Seattle, WA

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Priest, S., & Gass, M. (2005). *Effective leadership in adventure programming* (Second ed.). Champaign, IL: Human Kinetics.

Prouty, D., Panicucci, J., & Collinson, R. (Eds.). (2007). *Adventure education theory and application*. Champaign, IL: Human Kineitcs.

Stremba, B., & Bissoon, C. A. (Eds.). (2009). *Teaching adventure education theory.* Windsor, ON: Human Kinetics.

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Preparing Participants for a Summer Mountaineering Outing

Following completion of the pretrip planning phase, it is important to then communicate with participants and prepare for the mountaineering route/objective. Participants who possess a clear understanding of the trip's logistics, activities, and expectations will be far better equipped to achieve the outing objectives. In this chapter, we will explore the key information that needs to be conveyed to participants, the requisite weather-related information that the Summer Mountaineering Leader should research, and the required decision-making process as to whether or not to proceed with the outing based on that research.

Coordinating and communicating with participants

Early in the preparation stage it is important to coordinate and communicate with participants. Bigger objectives may require substantially more lead time. This provides them with sufficient time to ensure the trip is suitable for their skill level, they meet any prerequisite requirements, and they are capable of appropriately equipping themselves for the trip and arranging transportation to the climbing objective. There are many ways to communicate to participants, however, email is one of the simplest methods to ensure all participants receive consistent and accurate information. Information that must be communicated to participants includes:

- Meeting time
- Meeting location
  - Parking lot for well-established venues, carpool locations, or restaurant/coffee shop, etc.
- Summer Mountaineering Leader contact information
  - Cell phone number and email.
- Level of risk specific to the activity
  - Route and weather considerations, difficulty of the climbing, and access concerns.
- Prerequisite requirements
  - Previous summer mountain experience, ability to climb a specific grade, minimum age.
- Training trips may be needed to build technical skills, fitness and acclimatization.
- Fitness level
  - Participants must be fit enough to maintain the pace needed to achieve the objective in a timely manner.
  - Participants may need help in developing and implementing a training plan as they prepare for the trip.
- Altitude acclimatization
  - Participants must be sufficiently acclimatized. Someone who lives at sea level will likely feel the negative effects of altitude by the time they reach the summit of a 3500 metre peak. Sea level dwellers should spend a few days acclimatizing before attempting any major summits.
- Clothing requirements for the trip
  - Send a clothing list to the participants.
  - Follow up to ensure that clothing and footwear is appropriate for the trip.
- Equipment requirements for the trip
  - Send an equipment list to the participants.
  - Follow up to ensure that packs are of appropriate size and well fitted and technical equipment is appropriate.
- For example – someone who has technical waterfall ice climbing equipment may want to use it on a general mountaineering trip rather than purchasing or renting mountaineering crampons and axe.
- Contingency plans for the trip (nearby alternate route selections, trip cancellation).

Gathering weather information

One of the greatest factors in determining the success of a summer mountain outing, and the level of risk the outing will present, is the weather. Warm, dry, and calm conditions are more conducive to the completion of a successful objective than cool, wet, and windy conditions. Access to a high-quality weather forecast for the duration of the trip will aid the Summer Mountaineering Leader. Being able to anticipate weather occurrences and changes enables the leader to adapt the objectives, location, or timing of the outing to increase participant enjoyment and success while also decreasing the level of risk.

RESOURCES FOR GATHERING WEATHER INFORMATION

Current, short-range, and long-range weather forecasts can be quickly accessed online through a variety of sources. During periods of stable and predictable weather, these forecasts tend to be quite accurate and highly reliable. However, during periods of instability or changing weather, the forecasts and the modelling upon which they are based, become less reliable and the Summer Mountaineering Leader may need to complete further research to obtain an accurate depiction of the weather systems that will affect the outing. The reliability of weather forecasts decreases as the forecast is predicted further into the future. A forecast for the next 24 hours will be more reliable than a seven-day forecast.

Resources for obtaining a basic weather forecast:

- Environment Canada www.weather.gc.ca/ (radar, satellite, and jet stream mapping)
- The Weather Network www.theweathernetwork.com/ca
- Accuweather www.accuweather.com
- Televised weather stations
- Weather Radio Canada: frequency (MHz) 162.40

Resources for obtaining a more detailed understanding of the weather systems:

- Environment Canada www.weather.gc.ca/radar
- Spot Weather www.spotwx.com

UNDERSTANDING BASIC WEATHER

Weather is influenced by global circulation which includes a combination of warm air rising, cool air descending, the spin of the earth, atmospheric pressure, atmospheric humidity, air temperature, elevation, and wind. These variables combine to create localized weather systems, widespread weather patterns, and changes in weather conditions. In the context of preparing for a summer mountain outing, it is crucial that the Summer Mountaineering Leader explores the weather forecast and completes further research to obtain a solid understanding of the anticipated weather for the day. Widespread weather systems are typically easy to predict, however localized weather can at times be more challenging. Understanding if the weather will be poor for an entire day, or just for brief periods during the day, will enable the Summer Mountaineering Leader to determine if she should proceed with the trip, reschedule, or implement contingency plans.

Atmospheric pressure

At a basic level, atmospheric pressure is the measurement of air density and is commonly measured in either hectopascals, kilopascals, or millibars. Variation in atmospheric pressure gives an overall sense of the widespread weather systems throughout a region, and is commonly viewed on a large-scale pressure map that enables the viewer to identify areas of both high and low pressure.

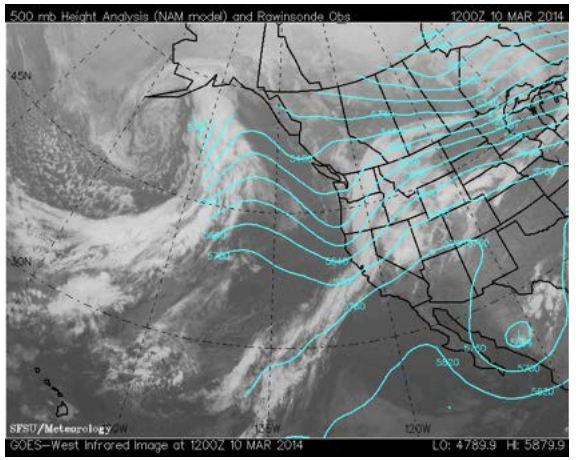
Jet streams are narrow bands of strong wind high in the atmosphere that steer weather systems and transfer heat and moisture around the globe.

The jet stream is an upper air westerly flow, generally travelling from west-to-east.

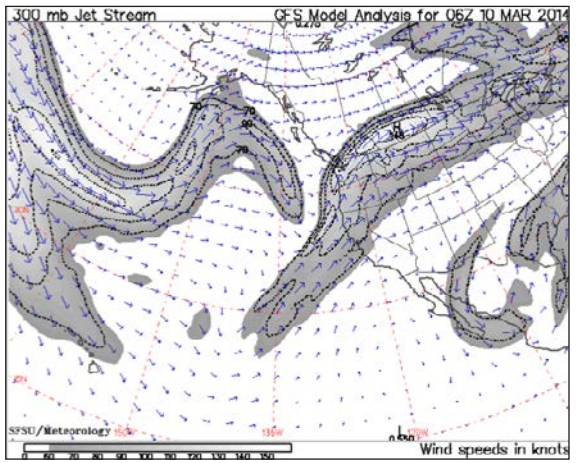
The jet stream constantly moves and changes. Typically, it is found at 9-14 km above sea level, with wind speeds as high as 400 kph.

The local weather that we experience is related to high and low-pressure systems and fronts, however, jet streams high in the atmosphere impact their movement and impact their trajectory and speed.

As air warms, it rises and expands, creating lower pressure at the earth's surface. The continual upward movement of the air mass can create strong winds and overall instability of the pressure centre. Warm air can retain more moisture and as it rises and cools, precipitation often develops. The primary means of cooling an air mass is to lift it. There are two major means of lift: orographic lift and frontal lift.

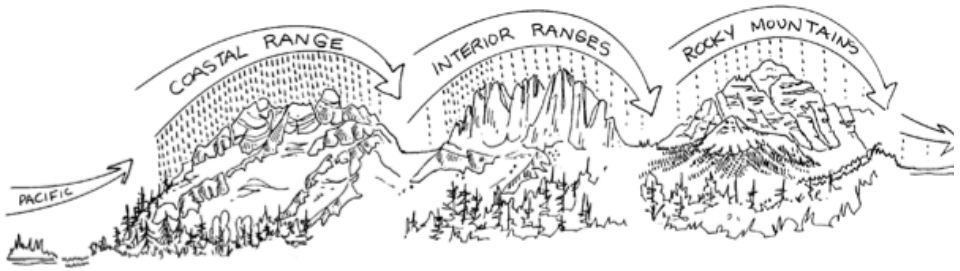


Atmospheric Pressure



Jetstream

Orographic Lifting is caused when an air mass is lifted flowing up and over mountains. The primary weather pattern in western Canada brings moisture laden air off the Pacific and up and over the Coast Ranges, Interior Ranges and Rocky Mountain Ranges. The orographic lifting and resultant precipitation of the westerly flow of the air masses produces the most amount of precipitation over the coast range and progressively less over the interior ranges and finally the Rockies.



Orographic lifting

During the summer months, this precipitation comes in the form of rain and thunderstorms, and in the winter months, it comes in the form of snow.

A low-pressure system will show increasing pressure outward when viewed on a large-scale pressure map.

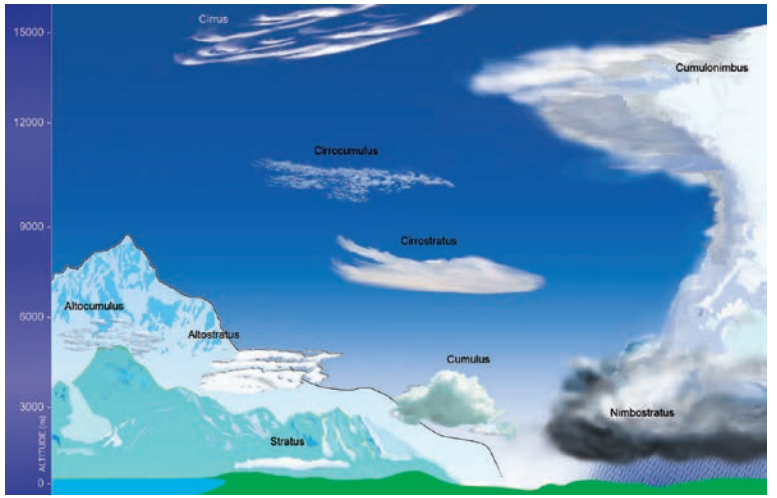
As air cools, it contracts creating higher pressure at the earth's surface. A high-pressure system draws air downwards often creating calm wind conditions and overall stability of the air mass.

Cool air tends to be dry and lack humidity; therefore, a high-pressure system is typically not characterized by notable precipitation. A high-pressure system in the summer usually offers calm, comfortable climbing conditions, whereas in the winter a high-pressure system may bring with it extreme cold and clear conditions. A high-pressure system will show decreasing pressure outward when viewed on a large-scale pressure map.

Decreasing pressure often signifies worsening weather conditions, whereas rising atmospheric pressure tends to indicate improving conditions. A rapid change in the pressure often signifies a shorter but more intense shift in the weather, whereas a slow and steady change in the pressure typically indicates a change that will last for an extended period of time. Changes in the atmospheric pressure are typically characterized by both ground and high-level winds.

The location where two air masses converge is referred to as a front. Fronts are often depicted on weather maps with modelling that illustrates the anticipated trajectory and speed of the front.

Cold fronts are typically shown in blue to delineate where a cold air mass is replacing a warm air mass, whereas warm fronts are typically shown in red to define warm air replacing cold air. Frontal lifting occurs when a warm front overtakes a colder air mass. The warm front rises over the colder air. As the warm, moist air rises it cools. If the relative humidity reaches 100%, precipitation will commence. If a cold front overtakes a warm air mass, it will drive under the warm air at a steep angle and cause rapid lifting and precipitation.



Interpreting clouds

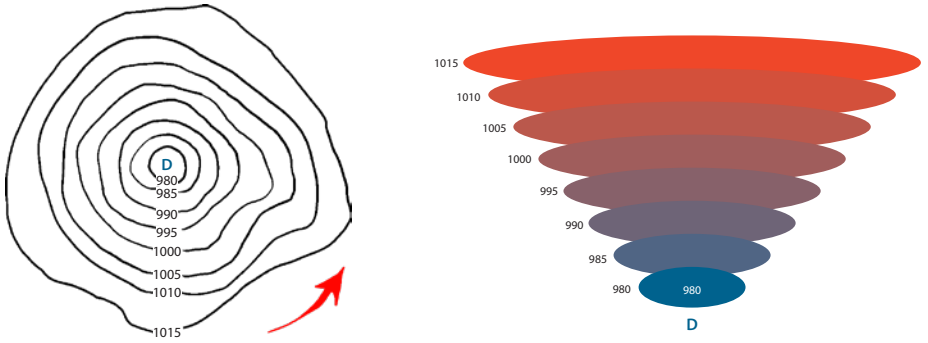
The ability to identify and understand cloud formations will assist the Summer Mountaineering Leader in identifying changes in the weather prior to their mountain outing, as well as throughout the day. Clouds are commonly categorized as either cumulus which indicate a vertical development, or stratus, which are clouds that form horizontally. Clouds between 2000-6000 metres, are commonly given the prefix 'alto' whereas clouds above 6000 metres are coined 'cirrus'.

Different cloud formations indicate the arrival of different weather systems. High cirrus clouds will be visible prior to the arrival of a low-pressure system or warm front. Cirrus clouds will commonly be visible before the weather changes are felt at a ground level. Initial cirrus cloud formation will precede the ground level weather changes because the warm air mass moving in is less dense and will overlay the cooler air mass. The initial high cirrus clouds are commonly followed by cirrostratus clouds, altostratus clouds, and eventually stratus, and nimbostratus clouds, which commonly bring rain or snow events.

Conversely, the arrival of a high-pressure system or cold front is often characterized by a decrease in visibility and the development of alto stratus and cumulus clouds in a chain-like configuration.

Weather changes at ground level are often felt quite quickly as the cold air mass pushes the warm air mass on top of it. This causes rapid cooling of the warm air as it gains elevation and nearly immediate precipitation.

One of the more significant weather-related risks to a summer



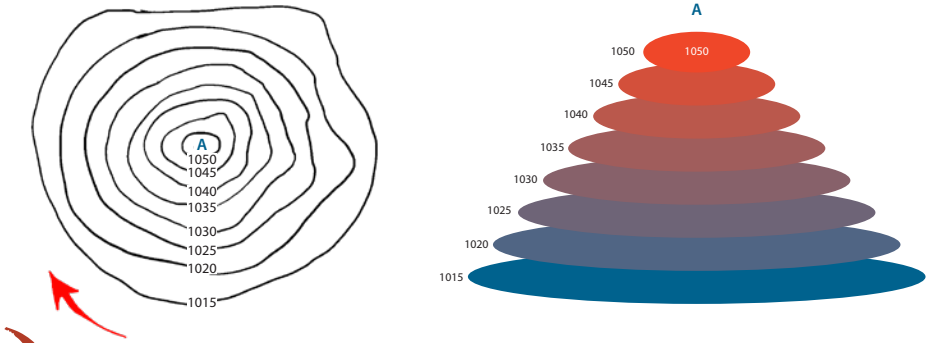
Low Pressure System

mountaineering outing is a thunderstorm. Thunderstorms are easily visible forming in the sky. The formation of small cumulus clouds that gradually rise and develop into cumulonimbus clouds are a marked sign of the development of isolated thunderstorms. Large cumulonimbus clouds with dark bases indicate an imminent thunderstorm and a need for the leader to manage the group accordingly. In the field, it is important to differentiate between cumulonimbus and cumulus clouds, as the formation of cumulus clouds that lack vertical development is often insignificant and non-indicative of the formation of a thunderstorm.

In the event that a mountaineering team is caught in an electrical storm, the following precautions should be taken:

- Avoid being the highest point in the surrounding landscape.
- Avoid hiding in small caves that may create a spark gap across the opening.
- Stay away from objects that conduct electricity such as ice axes and climbing hardware.
- Traverse out of gully/corner systems that are running with water.
- Seek shelter in low-lying areas.
- Insulate yourself from the ground by sitting on your pack.

High Pressure System



LOCAL TERRAIN AND MICRO-CLIMATE

Local terrain can create micro-climates that vary tremendously within a relatively small region. For example, glaciers will cool the air, resulting in down flowing winds later in the day. Mountain passes will funnel winds creating a venturi effect with much higher wind speeds flowing through the smaller opening. Rivers, lakes, inlets or ocean may produce fog as a result of cold air flow.

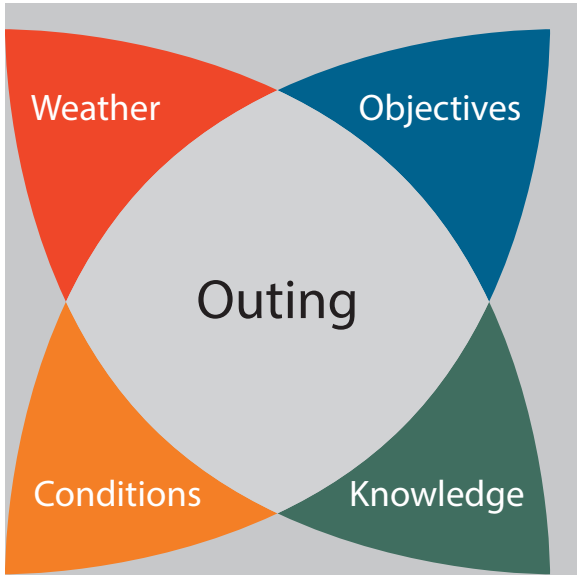
Pre-trip risk assessment

Prior to proceeding with a mountain outing it is important to complete a pretrip risk assessment to determine the viability of the outing. The pretrip risk assessment involves the determination of a course of action through an examination of: the objectives of the outing, the weather forecast, the current weather conditions, the current route conditions, the knowledge and experience of the Summer Mountaineering Leader, and the abilities of the group members. Periods of predictable and desirable weather matched with optimal route conditions, realistic objectives, and appropriate leader and group knowledge would demonstrate a likelihood to proceed with the trip as planned. Whereas periods of weather instability, poor route conditions, unrealistic objectives, or a lack of knowledge on the part of the Summer Mountaineering Leader or the group might necessitate a re-examination of the anticipated outing and adjustment to the itinerary.

WEATHER AND POTENTIAL IMPACT/RISKS ON A TRIP

Regardless of the forecast, the weather will have an impact and effect on a mountain outing. Rock routes are better suited to days that are sunny and dry, while ice routes may be in better condition when the weather is cooler. Crevasse bridges will begin to sag and eventually collapse during extended periods of warm weather. An overnight freeze will greatly improve snow travel, while significant afternoon warming will make for difficult snow travel. Stable and dry conditions, while ideal for climbing, may lead to crowding of popular routes. Conversely, cool and damp conditions present cold-related risks, slippery rock and

access trails, and increased rockfall. Windy conditions present a risk in the form of windchill, increased rockfall, communication challenges, and stuck rappel ropes. A Summer Mountaineering Leader needs to be acutely aware of the risks the weather presents and the impact they may have on the outing to ensure risks are appropriately mitigated.



A Summer Mountaineering Leader is responsible for ensuring that risks are well managed and appropriate for the participants throughout the trip. When completing the pretrip risk assessment and calculating the risks, it is important for the Summer Mountaineering Leader to determine their course of action based on their participants' abilities and risk tolerance. While the leader themselves may personally be comfortable proceeding with a mountain outing during periods of weather instability, proceeding with the outing in less than optimal conditions may be beyond the comfort level of the participants.

WEATHER MONITORING DURING A SUMMER MOUNTAIN OUTING

Even during periods of weather stability, Summer Mountaineering Leaders must monitor the weather for changing conditions throughout the day. Afternoon build-up and localized thunderstorms are common in summer mountain environments. Key elements to monitor throughout the day would include: notable changes in the wind strength and direction, significant changes in temperature, significant cloud formation, presence of thunder and/or lightning, and rapid changes in the atmospheric pressure (> 0.2 kPa change per hour).

References and further reading

Association of Canadian Mountain Guides, 1998, *Technical Handbook for Professional Mountain Guides*, Canmore, AB

Houston, M., & Cosley, K., (2004) *Alpine Climbing: Techniques to Take You Higher,* The Mountaineers Books, Seattle, WA

UIAA (2013), *Alpine Skills Summer: Basic knowledge – Alpine hiking – Climbing – Alpinism,* The Petzl Foundation

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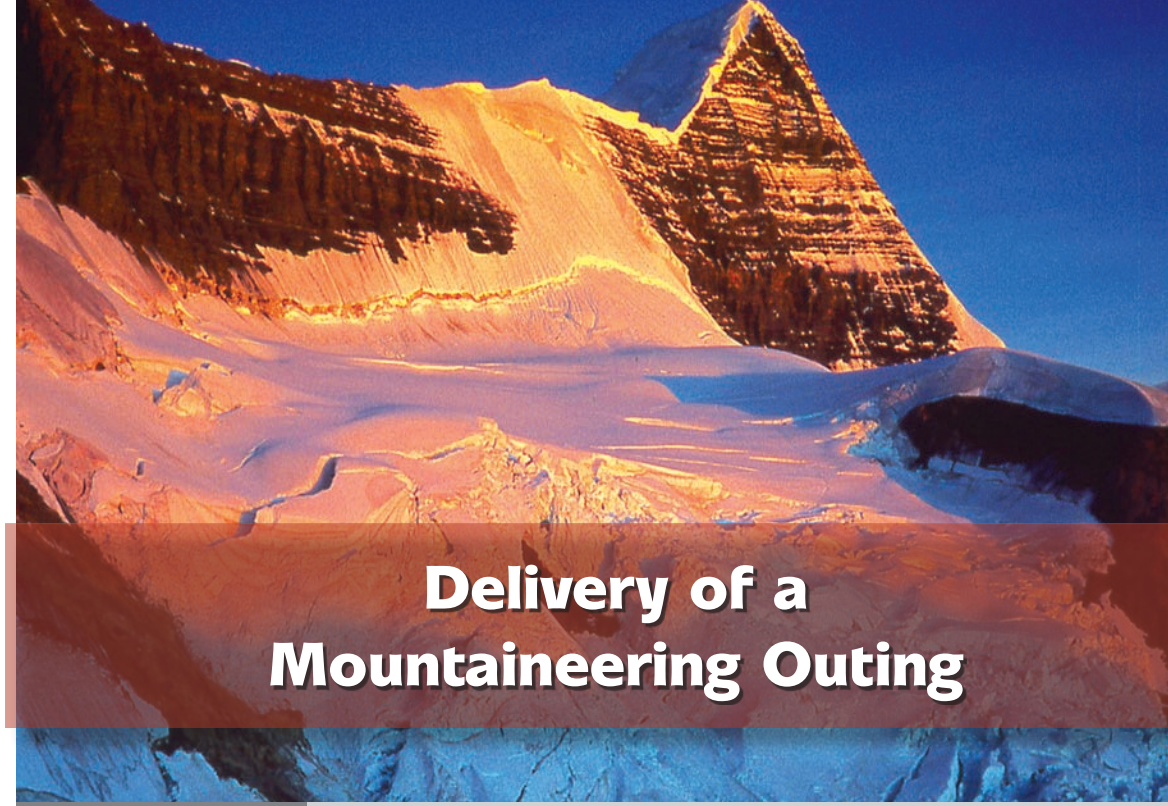


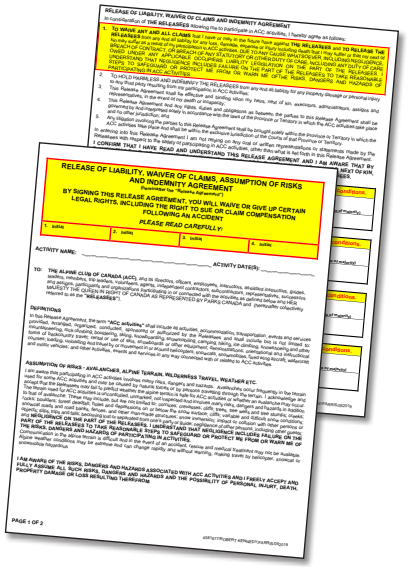
Delivery of a Mountaineering Outing

A successful mountaineering outing requires thoughtful management of the group, diligent management of potential risks, and administration of crucial documents such as waivers and acknowledgement of risk forms. In this chapter, we will explore the ACC waiver administration process, the basic principles of group management, and the cornerstones of risk management in a mountaineering context.

Waiver administration

In accordance with ACC policies, all participants must complete a waiver prior to participating in an outing. The importance of this document to The Alpine Club of Canada cannot be overemphasized. The conduct of the Summer Mountaineering Leader when administering the waiver to the participants is of paramount importance, as the administration of the waiver by the leader can affect its legal standing.

The role of the waiver is to protect The Alpine Club of Canada and outing participants against lawsuits in the event that a participant is injured or killed. It also protects The Alpine Club of Canada if a participant has any of their property or personal belongings damaged or lost. The document further protects The Alpine Club of Canada from liability for natural hazards as well as the possible negligence of any of the other Alpine Club of Canada member participants.


RELEASE OF LIABILITY, WAIVER OF CLAIMS, ASSUMPTION OF RISKS AND INDEMNITY AGREEMENT

BY SIGNING THIS RELEASE AGREEMENT, YOU WILL WAIVE OR GIVE UP CERTAIN LEGAL RIGHTS, INCLUDING THE RIGHT TO SUE OR CLAIM COMPENSATION FOLLOWING AN ACCIDENT

Copies of these and any other forms in this book can be found at www.alpineclubofcanada.ca/forms

Preferred waiver delivery practices include

- Sending waivers ahead of time to allow time for review.
- Ensuring clear communication when delivering the waiver.
- Allowing participants adequate time to read the waiver and provide them with the opportunity to ask questions.
- Ensuring that participants are aware of the specific and general risks associated with the activity prior to administering the waiver.
- Having participants acknowledge verbally that they have read and understood the waiver.
- Ensuring waivers are completed in full and are unaltered.
- Ensuring waivers are administered and witnessed by the Summer Mountaineering Leader.
- Ensuring waivers are presented in a standardized format.
- Ensuring waivers are ideally completed and signed in blue or black ink.

Other waiver delivery considerations

- Waivers do not guarantee protection from lawsuits.
- Waivers do not absolve leaders from acting appropriately.
- Waivers are often delivered annually to reiterate risks and ensure participants are accepting of them.
- Waivers are legal documents and cannot be altered in any way.
- Waivers do not expire.
- If the activity or risks change, a new waiver should be administered.

Completed waivers

Signed waivers must be retained by the ACC section for a period of seven years, after which time they can be destroyed. All signed waivers must be forwarded to the appropriate section member who is responsible for storing the documents, as soon as possible following the summer mountaineering outing.

Principles of group management

A well-managed group will be more likely to achieve the trip objectives, will foster a more cohesive group dynamic capable of resolving interpersonal conflicts, and will be better equipped to address and mitigate any risks associated with the outing. Participants in an effectively managed group will be aware of their responsibilities, will operate under the coordination and guidance of the leader, and will be educated and equipped for the day's activities.

Successful leaders diligently and deliberately set the tone for the outing early in the trip. This is often achieved through an initial face to face group briefing at the start of the day where the leader introduces themselves, explains the goals for the day, outlines their expectations of participants, and facilitates the opportunity for participants to introduce themselves to one another and the group.

COMMUNICATION

The decision-making process is typically negotiated and communicated between the Summer Mountaineering Leader and the group. A situational leadership approach is a dynamic process that needs clarity of communication. By including the group in the leader's thinking process, the potential for conflict can be reduced. For example, if weather and route conditions are deteriorating the leader should give the group a 'heads up' that the decision to pull the pin and head back is imminent.

EXPECTATIONS

Providing participants with clear expectations both before and during the mountaineering outing, will enable them to better manage their personal safety and achieve trip objectives. Common expectations may include:

- Group travel expectations
  - Pace and spacing
  - Scheduled breaks for water/clothing changes, etc.
  - Staying on trails
- Route expectations
  - Low hazard zones (helmets, proximity to edges or other natural hazards)
  - Personal pack contents
  - Litter and human waste (pack out what you pack in)
- Activity expectations
  - Participant positioning
  - Belay stances
  - Climber responsibilities
  - Equipment use expectations
  - Leader involvement expectations

LEADERSHIP

High quality leadership and timely motivation by the leader helps ensure that participants act according to the expectations that have been set. Further, supervision enables the leader to identify risks and address them before accidents occur, and to closely monitor the group's well-being throughout the outing. Depending on the outing objectives and participant experience, preferred supervision practices may include:

- Keeping the group's proximity close to allow for continued visual supervision and verbal communication.
- Checking participant technical systems such as the tie-in knot and set-up of the belay or rappel devices before the system is used.
- Continual monitoring of participant nutritional/caloric intake and hydration.
- Monitoring the group for signs of fatigue or distress.
- Monitoring the group dynamics to ensure continued participant motivation and enjoyment.

SELF-LEADERSHIP

The notion of self-leadership is not just an inventory of one's technical competence in a specific activity, but also includes communication skills, group management skills, judgment and decision-making skills, tolerance for uncertainty, emergency response skills, and self-awareness. These skills develop over time and typically progress from simple (low consequence) experiences to more technical (higher consequence) experiences. Self-leadership maintains a clear perspective of where one is at with respect to the inventory of leadership traits. When leading groups, the leader will select outings within their overall ability as a means of directing more of their energy towards the group versus themselves. As more experiences are gained, the leader may select more challenging outings in which to lead others as their overall leadership inventory now has more refined tools with which to manage the outing and the variety of unknowns that may be encountered.

EDUCATION

A significant component of group management involves ensuring that participants are educated and empowered to complete the day's activities under the guidance of the leader. In order for this to occur, leaders are often required to provide guidance and instructional inputs throughout the day. Typical instructional inputs may include topics specific to ethics, ecology, risk management, technical systems, local history, personal experience and insight, etc.

GUIDANCE

In addition to educating participants, the success of a summer mountaineering outing also requires diligent guidance on the part of the Summer Mountaineering Leader. Guidance differs from educating participants in the sense that it motivates and enables participants to develop independent competency with specific skills.

Well-guided participants will feel empowered to make their own decisions and manage their personal safety with the understanding that the Summer Mountaineering Leader is available to provide support and assistance where required. Qualities of a strong leader capable of providing sound guidance include:

- Situationally aware of risks and safety concerns.
- Enthusiastic, supportive, and motivational.
- Knowledgeable and capable of articulately sharing their knowledge.
- Technically proficient in their systems applications.
- Physically fit and able to complete the day's activities and climbs.
- Sympathetic to the needs of the group.
- Capable of resolving conflict and providing direct leadership if required.

CONFLICT RESOLUTION

Effective leaders recognize conflict building, and tactfully and firmly address it before it escalates.

Inevitably occasional conflicts will arise within a group or between participants and leaders. Therefore, Summer Mountaineering Leaders need to be prepared and adept at resolving minor conflicts. Basic strategies for resolving conflicts include:

- Being open and recognizing the conflict.
- Addressing the conflict privately if possible rather than in front of the group.
- Remaining calm and dedicated to resolving the conflict rather than winning an argument.
- Acknowledging the feelings of all parties involved in the conflict and seeking further clarification specific to the issues at hand if required.
- Determining potential resolutions to the conflict.
- Selecting an appropriate resolution and seeking support from those involved in the conflict.
- Proceeding with the resolution.

Effective leaders recognize conflict building, and tactfully and firmly address it before it escalates.

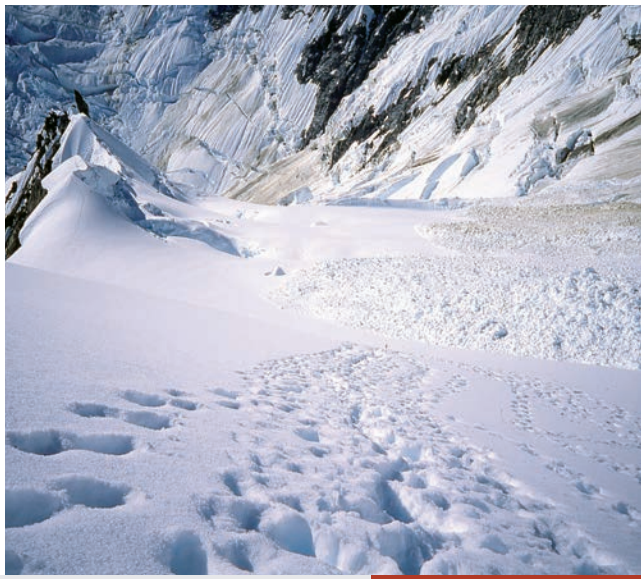
Risk management

A summer mountaineering outing may present a variety of risks throughout the day. It is the responsibility of a Summer Mountaineering Leader to recognize the risks, quantify them, and appropriately mitigate them to decrease the likelihood of an accident or injury occurring. In this chapter, we will explore several crucial risk management components including situational awareness, hazard recognition and mitigation, as well as the concept of participant demonstrated competency.

RISK ANALYSIS

Risk analysis is generated through an assessment of the likelihood or the probability of an occurrence and the consequence of that occurrence. The consequence is influenced through exposure and vulnerability. How long are people exposed to the hazard? What will happen if the people are struck by the hazard?

The starting point for a mountaineering risk management decision is based on the acceptance of some level of risk. This target level of acceptable risk is the level of risk chosen by a participant to attain optimal benefit from the activity. The acceptable level of risk is influenced by many factors including maturation (age) and prevailing conditions. A close call or an accident may trigger a reset in a person's acceptable level of risk. However, the absence of negative events such as close calls and accidents, may lull the decision maker into a false sense of security. The absence of negative outcomes is not a good measure of decision competency. When nothing bad happens, it is easy to attribute the success to good decision making. This can lead to complacency. It is essential to recognize that the level of acceptable risk is personal. There will be an inevitable range of acceptable risk within a group. The wise Summer Mountaineering Leader will be aware of and address these differences.



Mont Blanc du Tacul, North Face

For example: rockfall on an alpine ice face

Naturally occurring rockfall is typically generated when temperatures rise, or wind or rain loosens rocks from ledges. Rocks are often dislodged by other parties.

Strategies to reduce the risk of rockfall:

- Reduce the likelihood of an occurrence.
  - Be first on the route – do not climb below other parties.
  - Monitor the temperature – climb when it is cold (below freezing.)
  - Monitor the weather for high winds or rain.
- Reduce the consequence of an occurrence.
  - Reduce exposure.
    - Use sheltered belay locations.
    - Reduce time spent in gullies.
    - Stick to ridges or ribs.
  - Reduce vulnerability.
    - Wear a helmet.

SITUATIONAL AWARENESS

Situational awareness refers to the Summer Mountaineering Leader's ability to recognize and mitigate hazards before they present a risk to the group. It is the responsibility of the Summer Mountaineering Leader to step back and evaluate all of the variables in a given situation, determine their interactions, and evaluate the potential for this to present a risk to the group.

- The leader must constantly evaluate the terrain.
  - Are there places that pose greater risks?
  - Are there any alternates?
  - Is it familiar terrain or new terrain?
  - How exposed is the group as it moves through the terrain?
  - Does the group have appropriate safety equipment for the terrain and conditions?
- The leader must constantly evaluate the weather.
  - What is the forecast?
  - Does the forecast seem to be right?
  - How rapidly is the weather changing?
  - Are conditions better or worse than expected?
- The leader must constantly evaluate the group.
  - Are the members performing as well as expected (Physical, mental and emotional)?
  - How well is the group interacting?
  - Are any conflicting personal goals emerging?

Seracs

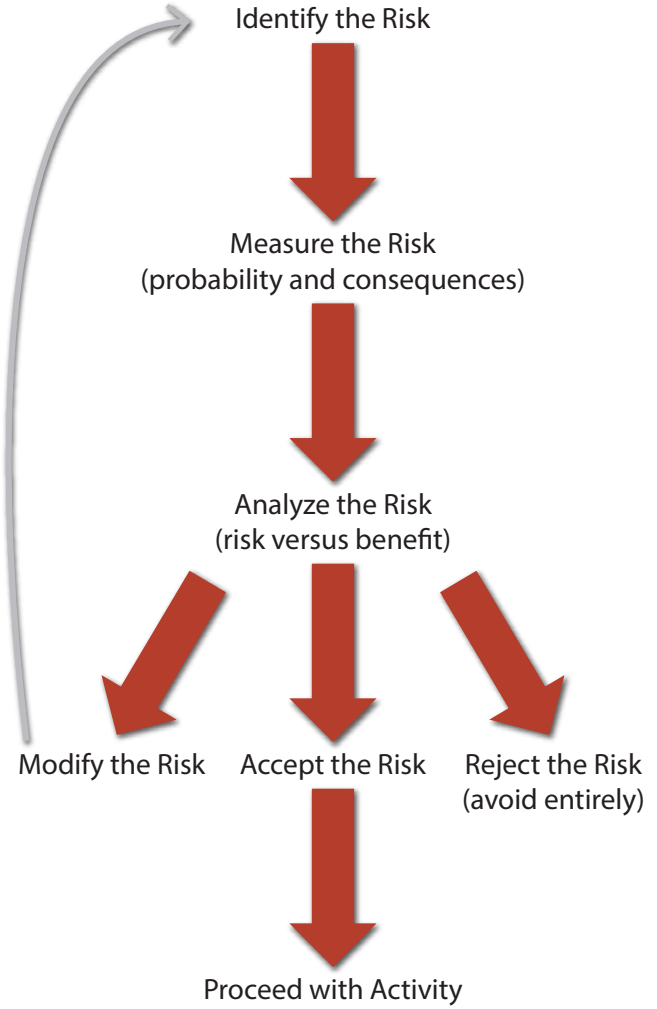
Situational awareness is closely tied to expertise. Higher levels of expertise allow the leader to more quickly recognize the events occurring around them and be better equipped to recognize potential risks. In the context of a summer mountaineering outing, situational awareness is the ability to recognize environmental, interpersonal, internal human factors, external human factors (other climbers and day users), and the relationship that these factors have on one another as well as any impacts this will have on the safety and success of the outing.

HAZARD RECOGNITION

Closely linked to situational awareness is the Summer Mountaineering Leader's ability to recognize hazards, and determine their probability and severity. Climbing is an inherently dangerous activity and therefore has some level of risk associated with it. The Summer Mountaineering Leader's role is not to entirely eliminate the risks associated with the activity, but rather to recognize them and ensure that they are well managed, mitigated, or avoided.

Common hazards for a Summer Mountaineering Leader to recognize include:

- Environmental
  - Very warm temperatures (heat exhaustion, heat stroke, sun burn, dehydration).
  - Very cool temperatures (hypothermia, loss of dexterity, lack of focus).
  - Overnight freeze and daytime warming cycles (natural rockfall).
  - High wind (increased rockfall, challenging communication, dehydration).
  - Precipitation (increased rockfall, slippery conditions, hypothermia).
  - Lightning (electrocution).
  - Animal encounters (animal attacks, disease transmission, anaphylaxis, rockfall generated by wildlife above the route).
- Interpersonal Risks:
  - Conflict (disagreements or altercations).
  - Group not following or listening to the leader.
- Internal human factors:
  - Intrinsic motivation (students not following directions of the leader or students pushing the leader to take risks that are out of context with the trip objectives).
  - Food, hydration, sleep, symptoms of drugs or alcohol.
  - Heuristic Biases - familiarity, acceptance, commitment, expert halo, tracks (scarcity), social proof – poorly applied simple rules or shortcuts (heuristics) that may affect decision-making.
  - Group Think – A desire for harmony, conformity and minimal group conflict, resulting in a loss of critical analysis. This may result in the illusion that the group's decision is correct.
  - Risky Shift – The risk accepted by the group, may be higher than any individual would accept on their own.
  - Fear - clouds objective decision making.
  - Risk Tolerance - a level of risk one may take.
  - Trust - trust (or lack of it) in the leader or other group members may influence decision-making with respect to risk management.
- External human factors:
  - Other users and groups (crowding, interruptions to the day's program).



HAZARD MITIGATION

Once hazards have been identified, their probability assessed, and their severity analyzed, the Summer Mountaineering Leader must determine an appropriate mitigation strategy. In some instances, this may involve avoiding the hazard entirely or modifying the situation to decrease the probability or severity of the hazard, or it may involve acceptance of the hazard and continuing forward.

Examples of common hazard mitigation strategies in a summer mountaineering context include:

- Wearing helmets anytime there is an overhead or fall hazard.
- Employing leader systems checks prior to participants commencing a climb.
- Ensuring periodic breaks occur throughout the day to eat, drink, and adjust clothing.
- Continually monitoring the weather to allow for adjustment of the program prior to weather changes.
- Planning and managing transitions or equipment changes to minimize time in areas of higher objective hazard.
- Recognizing group conflict and quickly addressing it.
- Recognizing participant distress and addressing it.

ROCKFALL HAZARD MANAGEMENT

Rockfall is the most significant hazard that must be managed by the Summer Mountaineering Leader. It must not be underestimated in either its frequency or consequence. Summer Mountaineering Leaders should actively engage in a process that reduces exposure and consequence.

- Identify specific routes or features that have notable rockfall potential.
- Maintain consistency between route selection and overall operational risk tolerance.
- Identify critical rockfall areas on the planned route and establish a management plan.
- Identify weather conditions that may make the situation worse.
- Maintain a high level of situational awareness.
- Personal protective equipment (helmets) may reduce the consequence and careful terrain selection and timing can reduce the exposure.
- Whenever possible, situate belays in protected spots.

Hazard Description

- Regular performers
  - Rock slides are areas where catastrophic failure has occurred in the past and there is usually scree/talus at the bottom.
  - Natural process of erosion as a trigger.
- Random performers
  - Random rockfall depends on terrain factors and rock characteristics.
  - Natural process of erosion as a trigger.
  - Early season – Rocks may have been loosened by multiple melt-freeze cycles over the winter.
  - Weather triggers such as
    - heavy rain,
    - the melt-freeze cycle, and
    - strong winds.

Rockfall on Half Dome, Yosemite

- Other Triggers
  - Humans
    - Parties above.
    - Leader knocks rocks on the second.
    - Poor route-finding.
    - A less experienced second may lack awareness.
    - New routes may have significant piles of loose rock.
  - Wildlife
- Certain locations within the terrain factors are more prone to rockfall.
  - Gullies
  - Rock faces/snow or ice
  - Ledges above
  - Scree/talus slopes
  - Boulder fields
- Rock type and quality are additional factors.
  - Many limestone areas are characterized by scree filled ledges and are susceptible to wind and rain events.
  - Granite areas may have fewer random performers, but are not exempt from rockfall events. Larger, more catastrophic events may occur, but at a lower frequency.

Participant demonstrated competency

The ability to assess the demonstrated competency of a participant is a vital component of a Summer Mountaineering Leader's hazard recognition and hazard mitigation strategy. Prior to giving participants risk related responsibilities, such as belaying or rappelling, it is important that participants demonstrate competency with the skills necessary to do so. Until participants have demonstrated adequate competence, it is imperative that the Summer Mountaineering Leader manage risk on their behalf. Common techniques used to support participant competence with specific skills include:

- Providing participants with the opportunity to practice skills in a risk-free context.
- Visually monitoring participants to ensure skills are being practiced and applied correctly.
- Verbally testing participants to gain an understanding of their comprehension of the skill.
- Applying the skill progressively or incrementally.
- Providing the participants with constructive feedback and coaching if they are struggling with a skill.
- Physically supporting the participant's application of the skill in instances where it will increase comfort, safety, or success.
- Monitoring the participant to ensure the application of the skill remains consistent over time and complacency and regression do not occur.

Ideally participants would demonstrate competency all the time, however, that is not a realistic expectation and often participants will need ongoing coaching, and/or instruction before they achieve independence with specific skills. For this reason, Summer Mountaineering Leaders will need to exercise good judgement and limit the level of responsibility offered to those who are unable to demonstrate competency with a skill. This ensures the level of risk presented to the participants remains consistent with the nature of the outing and the trip objectives. As mentioned earlier, the Summer Mountaineering Leader may choose terrain that has few consequences as a means for such skill development. While learning, errors will be made.

A 'kind' learning environment provides participants with high levels of quality feedback and minimal negative consequences. Ideally, the feedback comes from both people and the environment. The leader and more experienced members of the group provide a valuable resource from which to build competency. At the other end of the scale a 'wicked' environment provides minimal quality feedback and dire consequences. Providing an arena to make and learn from errors with little to no consequence reduces the overall vulnerability of the participant, and group, while providing valuable feedback and growth of specific skills. Once skills are acquired it is possible to move to terrain that challenges these skills while maintaining an appropriate safety bandwidth.

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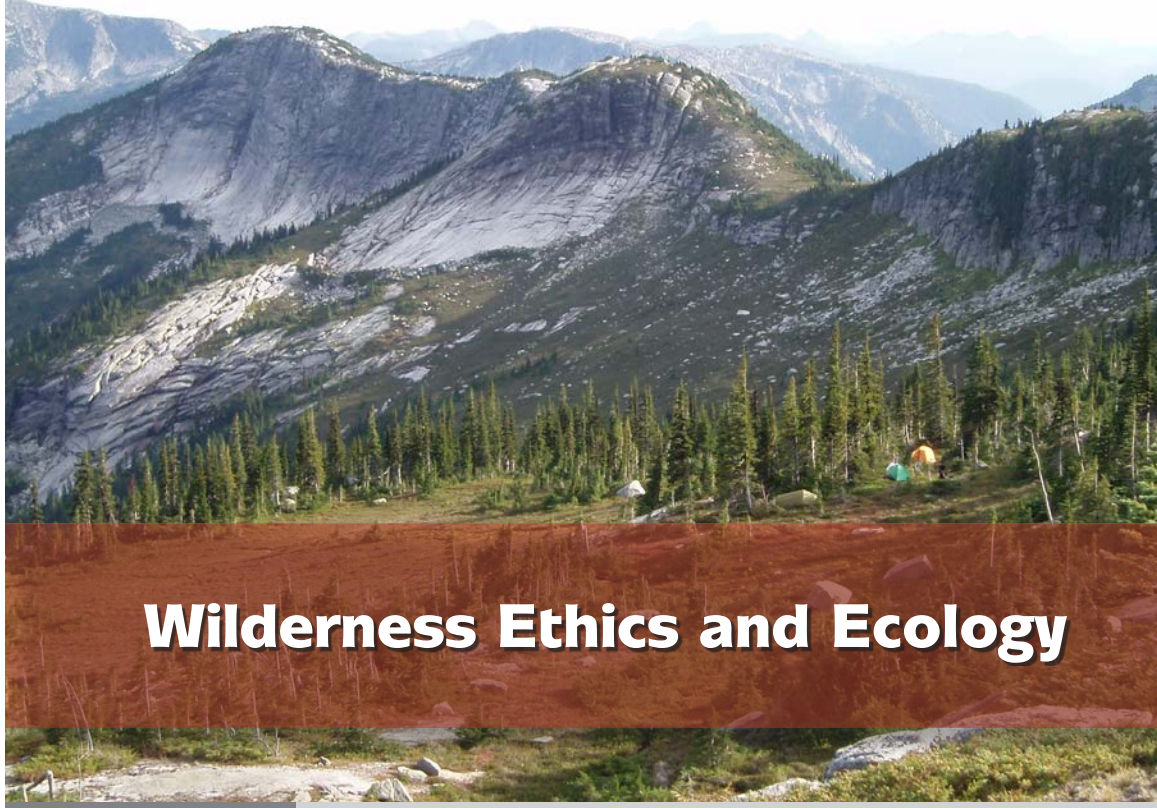


Wilderness Ethics and Ecology

Alpine meadows, such as those of lupine and paintbrush, exposed mountainous terrain such as buttresses, steep ridgelines and turquoise tarns and warmer temperatures create an idyllic summer mountain environment. Flora and fauna seize a short growing season and fauna feed and nurture their young. There is much to see and experience. With this opportunity, comes the responsibility to maintain low impact travel techniques and set a positive example with respect for localized environments. In this chapter we will explore several principles of low impact travel, basic wildlife precautions and interpretive knowledge, all related to a summer mountain environment.

Principles of low impact travel

Minimizing our impact when we travel in the backcountry is essential not only for our ecological impact, but also our aesthetic impact. The first step is to plan ahead and prepare as indicated by chapters one through three. Knowledge and skills help us to act in a way that will reduce both our impact on local environments as well as our visual impact for other user groups. As a Summer Mountaineering Leader, we are able to reinforce best practices in the backcountry with our groups.

SUMMER TRAVEL

Rock, scree, snow and established trails are all deemed to be durable surfaces with minimal impact to local environments. Plants in the sub-alpine and alpine endure harsh year-round temperature fluctuations and environmental challenges and are often slow to recover once damaged. Being intentional about where you place your foot creates both better movement skills and can also help to maintain pristine environments.

As mentioned, there are many surfaces in the sub-alpine and alpine that are sensitive to human impacts, such as alpine meadows, woody stemmed plants, and leafy lichens. Woody stemmed plants, such as mountain heather, can break under the weight of a mountaineer's footstep and leafy lichen will often crumble with very minimal impact. Mountain travellers can choose to avoid such sensitive flora, or when not possible, spread out your group so each member takes their own pathway. The greatest site-specific impact we make is where we camp, and specifically where we eat; campsite selection is therefore the most critical time to think about durable surfaces, local flora and the consequences of our impacts.

Hikers can create further erosion and impact by shortcutting a switchback. This creates an inefficient pathway, and water can further erode the existing trail and impact the localized environments. This should be avoided.

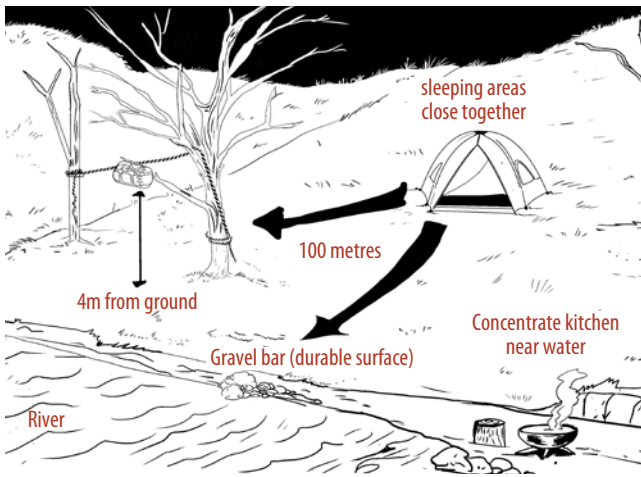
Another malpractice is the widening of trails or the increase in trails, often seen in alpine meadows to avoid the mud. If you encounter a maze of trails with your group, encourage your group members to choose the most impacted trail, strap on their gaiters and embrace the muddy wilderness experience!

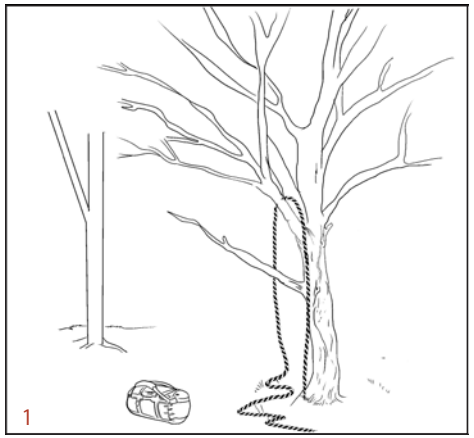
Travelling in a smaller group and being aware of noise, will allow your group to be more situationally aware of your surroundings. Make sure to encourage your group to look around and listen, cueing in to other animals in the area. This can help to prevent a surprise encounter with a feeding bear or a grazing mountain goat. Not only will this help your group to experience a greater connection to their environment, but it will also help to mitigate the social impact for other user groups. Travelling in smaller groups also helps by potentially reducing crowding in high use areas.

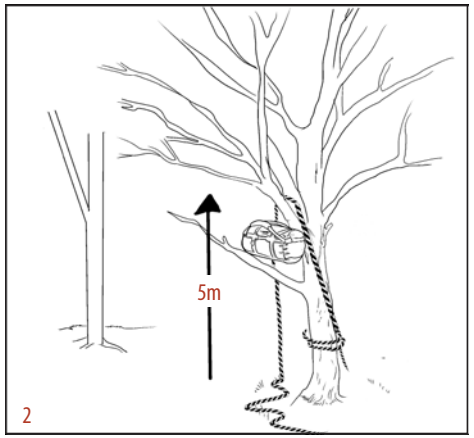
Where we sleep, cook, and dispose of our human waste has the greatest potential environmental and aesthetic impact.

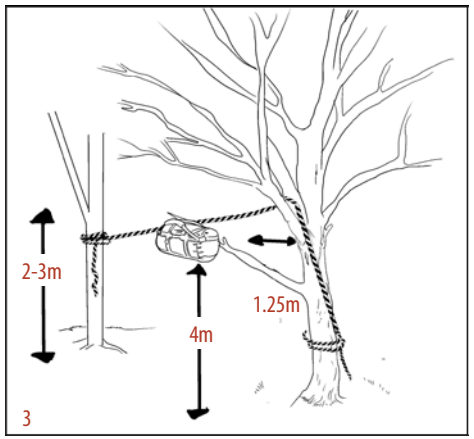
CAMPING

As the old saying goes, great campsites are found and not made. Where possible, choose a campsite that has already been previously impacted. Should you be in a more remote location, choose a campsite on a durable surface approximately 50m away from a freshwater source such as a lake or a stream. Avoid building structures or altering the environment to appear impacted by humans.









Storing food and disposing of food waste properly takes knowledge and skill. When in bear territory it is best to cook 100 m away from both where you sleep and where you store your food at night. This separates smells and perceived 'opportunity' for wild animals, small and large. All food scraps should be eaten or packed out (not buried), even compost. Dishes should not be washed in waterways, but instead water carried to the dishes. Inevitably there will be 'grey water' from dishes or straining pasta, and this can be disposed of with smaller groups by dispersing it, and with larger groups (or greater user days) in a 'sump hole' which is dug in active soil and is approximately 10-15 cm deep. Pine martins and rodents such as deer mice may also investigate your kitchen. Sealing pots and dishes as well as securing them in your food hang or overnight food storage location may prevent contamination and environmental impact.

Bear hangs can be tricky, especially where tree cover is limited. Where possible a bear hang is your best option at a height of 4 m. Creating a proper bear hang requires 20-30 m of rope, food bags or stuff sacks, and a pulley system can be aided with a carabiner. When a proper bear hang is not possible, separate your food from your sleeping and cooking areas and hang it in branches of a tree. While not ideal, this will at the very least separate smells, and possibly discourage scavengers, such as ravens or rodents.

Figures 1–3 show a single rope hang which works well in a variety of situations.

Fires in the sub-alpine and alpine can have significant environmental and aesthetic impacts and should be avoided. Should a campfire be built for emergency purposes or otherwise, monitor it very carefully and put it out completely. Once cool, distribute the ashes and return the environment to its' original aesthetics.

Double check or `sweep' your campsite prior to departure to ensure that you have left it clean of waste.

HUMAN WASTE

Poor disposal of human waste has the potential to impact the cleanliness of our waterways and spread infection amongst backcountry travellers. Check for best practices in your area and requirements from land managers. Considerations include user days in an area. For example, ten people for two days in one place equals 20 user days. A good rule of thumb is that over 20 user days in one area is a large impact of human waste to a wilderness area. The greater the number of user days, the less an area can handle the human waste impact.

It is best practice to dispose of urine and feces approximately 100m from any water source or existing trails. The most widely accepted practice for feces is to dig a 'cat hole' 10-15 cm deep in organic soil and cover it back up. Pack out all toilet paper and feminine hygiene products. While burning toilet paper is an option with a hot fire, burning it with a lighter is often an incomplete job, leaving remnants of toilet paper bits and potentially hazardous roving embers.

Depending on the land manager and best practices for the area, options may also include packing it out in a disposable bag for solid waste. Both individual and group systems are manufactured commercially with chemicals that work to solidify, decrease odour and eliminate the waste as a biohazard. Packing out solid waste is becoming more common and sometimes required in high use areas, especially those without active soil.

Hygiene is paramount and illness in the backcountry is often sourced to improper hand washing. Setting up a system to encourage yourself and your group members to use soap and water and/or hand sanitizer will limit transmission of fecal matter. If using soap, this should be used sparingly and over active soil, not directly in a water source.

GROUP SIZE

It is important for Summer Mountaineering Leaders to recognize that the size of the group will have an impact on both the environment and other users. The larger the size of the group, the more profound the impact will be on the environment and the more diligent the Summer Mountaineering Leader will need to be to ensure the impacts are minimized. Although the technical nature of the outing may dictate group size, consideration should also be given to travel in popular areas (social impact) as well as overnight outings (environmental impact). The Summer Mountaineering Leader should consult with the local land manager for regulations on group size to help make an informed decision on the number of participants suitable to the outing.

Wildlife issues

Educating participants on local wildlife can be for informative or social reasons, as well as for safety reasons. Encounters with humans can stress wild animals due to changes in their feeding or resting activities or using up valuable energy reserves that become no longer available to care for their young or escaping predators. Encouraging situational awareness and preparing your group in the unlikely event of a hazardous encounter with wildlife will build trust and educate on prevention and positive reactions should it be necessary.

Sightings and encounters with potentially dangerous wildlife must be treated seriously. All planned activities should be stopped, and the group removed from the area.

Encounters with large animals such as bears, cougars or moose are possible and can be a positive wilderness experience, especially at a distance. Encounters with smaller animals such as birds and rodents are more common and can greatly affect camping and travel practices. Wild animals, big and small, are unpredictable and close encounters should be avoided. Best practices in the case of a hazardous encounter should be discussed.

Travelling in groups of four or more statistically reduces your chance of a hazardous bear encounter, as does making your presence known when travelling in an area of reduced visibility (thick bush) or reduced sound (near a river). Should you encounter a larger animal such as a moose, cougar or a bear, give the animal space and back away. If there is aggressive behaviour make your presence known, gather in a large group and back away slowly. Bear spray and bear bangers should be easily accessible and carried. Knowing when and how to use these tools is essential, as is basic understanding of animal behaviour. Further research is recommended.

Never feed animals and ensure that human food is inaccessible. A fed animal often leads to habituated and hazardous animal behaviours.

As a Summer Mountaineering Leader, it is important to ensure that we do not further stress or impact the behaviours of animals. For example, the repeated flight of a grouse can create stress and compromise precious energy levels, and often leave a chick without an accompanying parent.

Interpretive skills

The ability of the Summer Mountaineering Leader to share specific area knowledge, seasonal understanding and human cultural history with their group is a significant value-added benefit for participants. Interpretation is about creating meaning through firsthand experience with natural and cultural history. Ideally it is informative, promotes understanding and curiosity, creates experiences and is potentially even inspirational. Interpretation takes practice—observing your surroundings, identifying flora and fauna, and learning specifics about the local geology, glaciology and ecology for instance. Good interpretation matches the interests of your audience and should be an enjoyable experience.

Common interpretation interests for the summer mountaineering traveller include understanding weather (covered in chapter 2), recognizing hazards (covered in chapter 3), understanding how mountains were formed, glaciology, observed flora and fauna, the night sky and human history in the area.

MOUNTAINS MORPHOLOGY

For the mountain traveller there can be endless curiosity of mountain morphology, geology and history of the land asking such questions as:

- Why do we have Precambrian (ocean creatures) fossils on our peaks?
- Why are there such distinct layers in these rocks?
- Why are all the east sides of the mountains steeper than the west in this range?
- Why are these mountains around the same height?
- What kind of rock is this and how did it form?

Basalt

Volcanic Crater

As a Summer Mountaineering Leader, you do not need to have all of the answers, however understanding some basics can be helpful for interpretation and to encourage connection to the landscape.

Simply put, mountains are formed due to the result of tectonic and volcanic forces. The particulars depend on the mountains in question. Essentially mountains are formed in either one, or a combination of three ways—block mountains that occur at the seam or rift between plates, plates folding under pressure, and volcanic action. The latter two are the most common in Canada.

Another key factor to the shape of our mountains are glacier ages with the last major one ending approximately 11,000 -13,000 years ago. The ice moves rocks and scrapes mountainsides. With the departure of the ice and the weight lifted (up to 3 km in some locales) off of the land, isostatic rebound occurs. Impressive features such as icefields, glaciers, large and steep U-shaped valleys and moraines remain. More subtle post-glacier features can also be found such as eskers, drumlins, kettles and tarns.

Finally, constant weathering subjects mountains to erosion and change from wind, water, ice, temperature and gravity. These forces are actively shaping our mountains.

Marmot

Grey Wolf

CANADIAN FAUNA

To quote naturalist Bill Gadd, "seasonal ecology's reward [is] guaranteed to amaze and delight, or your money back," as "everything you see around you is the product of 3.6 billion years of seasonal ecology" (1995, p. 674).

Porcupine

Mountain Goat

Summertime is a time for caring for young and feasting in anticipation of winter. Many animals can be seen and even experienced, as with prevalent summer mosquitoes. It is important to respect wildlife's space and habits, as even resting can be a survival need.

At higher elevations mountaineers may have the chance to see marmots, porcupine, wolves, coyotes, red foxes, black bears, bighorn sheep, or perhaps even the unlikely sighting of a cougar, North American badger or wolverine.

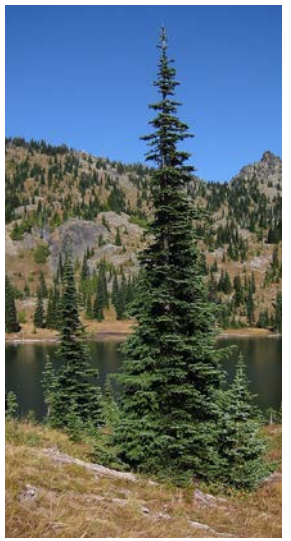
Understanding a few key facts about commonly experienced fauna, could be of great aid for interpretation!

CANADIAN FLORA

There is much to know and understand about sub-alpine and alpine ecologies, which can be an endless source of engagement.

The alpine zone extends from where the density of the trees decreases, otherwise known as the tree-line, up to the summit of the peaks. The sub-alpine zone occurs at and just below the tree-line. It is believed that tree line is most significantly influenced by low soil temperatures, wind and drought over the winter. Tree species will depend on the mountain region, however two tree species that may be found in sub-alpine zones are Sub-Alpine Fir and Englemann Spruce.

Englemann Spruce



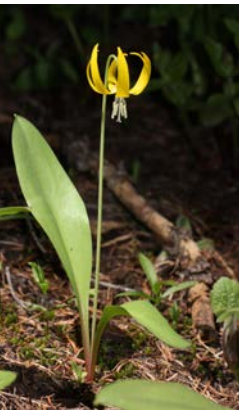
Sub-Alpine Fir

Moss Campion

White Mountain Avens

Kinnikinnik

Crocus



Avalanche Lily, also known as Yellow Glacier Lily (Erythronium grandiflorum)

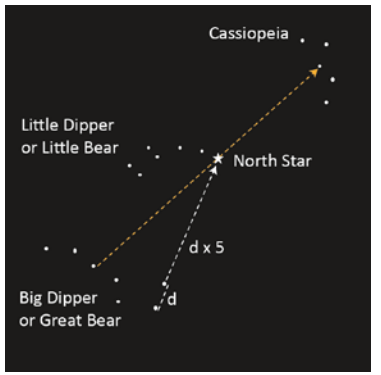
Krummholz is the name given for trees stunted and clumped in groups at a high elevation. These trees are often a mixture of different species, are often not able to reproduce and represent the highest elevation of tree growth in the area.

Sub-alpine and alpine organisms are well adapted to their environments including cold year-round temperatures, a short growing season, windy conditions, wet summers and dry winters. In the summer months, flora is exposed to great daily temperature fluctuations and increased solar radiation. Adaptations include:

- Growing low to the ground to avoid wind and moisture loss.
- Metabolizing at low temperatures to start early season growth.
- Early season blooming (such as with the Avalanche Lily poking through the snow).

Incredible colour and form can be found in alpine plant adaptations. Favorites may include such plants as Lupine (Lupinus arcticus), Paintbrush (Castilleja miniata), Yellow Glacier Lily (Erythronium grandiflorum), Moss Campion (Silene acaulis), Kinnikinnik (Arctostaphylos uva-ursi) and various forms of Stonecrop (family Crassulaceae).

THE NIGHT SKY

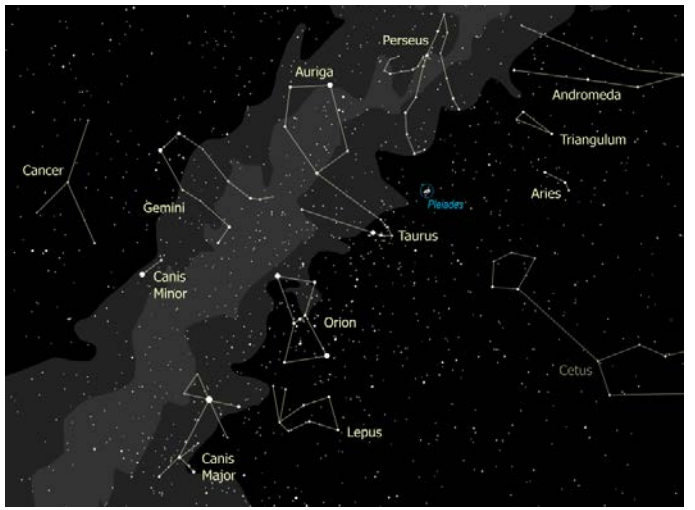


Understanding basics of the night sky can not only help with identifying north and therefore aid in navigation, but with a distance from urban lights, discussions of the night sky are often entertaining.

Start with finding the North Star (Polaris) and the Milky Way. Polaris sits at the handle end of the Little Dipper, also called Ursa Minor. Given that this constellation is not especially luminous, you can also look halfway between the Big Dipper of Ursa Major and the 'W' of Cassiopeia. The Milky Way shows the axis of our galaxy, of which our sun is only one star of potentially 100 billion.

The following constellations can be seen in both the winter and the summer night sky constellations:

- Ursa Major – The Great Bear (the big dipper being a smaller component).
- Ursa Minor – The Little Bear (the little dipper being a smaller component).
- Cassiopeia – The Queen.
- The Pleiades – Seven Sisters.
- Draco – The Dragon.
- Cepheus – The King.
- Andromeda – Daughter of Cassiopeia.



CULTURAL AND HUMAN HISTORY

Insight into local cultural and human history of the area in which you are travelling can help to build your team and create a greater understanding of the area. Invite others to contribute their knowledge, questions and interests.

Commonly shared cultural or human information may include:

- Indigenous history in the area pre and post European contact.
- Current Indigenous Territory and Cultural Information.
- Early settlement of Europeans.
- History of adventurers in the area including first ascents or descents, mountaineering adventures and wilderness living.
- Formation of parks, protected or conservation areas, current land managers and associated regulations and best practices.
- Current local ethical debates or issues.
- Other activities that occur in the area.
- Stories of travel, camping, travel in a mountain environment, risk management scenarios such as learning from others' successes, challenges and mistakes.

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Advanced Navigation Skills

Navigation is an essential part of travelling in the backcountry. The summer mountaineering leader will be practiced at a variety of navigation techniques using a variety of tools including the map and compass together with GPS and altimeter. This chapter will explore map and navigation concepts as well as some tools used to help the summer mountaineering leader with navigation on an outing.

Navigation skills are essential for Summer Mountaineering Leaders. These skills are needed to ensure the successful completion of trips. They become more significantly important as the weather deteriorates or the terrain becomes more complex. The key skills are: route planning, establishing a position (staying found), estimating distance, determining direction, identifying landmarks, identifying terrain barriers, estimating slope angles, determining land shapes, and picking out terrain features. The basis of quality navigation is the ability to integrate navigation tools such as the map and compass to the reality of travel in the terrain. Maps are the leader's primary navigational tool. Compasses, altimeters, and other instruments become useless without excellent map-reading abilities.

On the micro scale, successful navigation is based on careful terrain analysis. The map, compass and GPS work well to provide the general direction, but a 'terrain first' approach will lead to more efficient and precise route-finding. A good navigator will apply the terrain first approach as broadly as possible before adding sequential layers of technological complexity. Under conditions of reasonably good visibility, a competent navigator should not need to constantly refer to the map and compass, and certainly not the GPS.

On a macro scale, global navigation is based on latitude and longitude. This is useful for navigating over long distances such as aircraft and ocean-going ships. However, it is less useful for mountain travellers, as distances typically travelled in a day do not exceed 20 kilometres, so mountain maps typically use a more precise method grid system. The challenge for Summer Mountaineering Leaders is that although the latitude – longitude system is more difficult to use for foot travel, it is essential to comprehend the principles as it is the system used by helicopter pilots and rescue personnel.

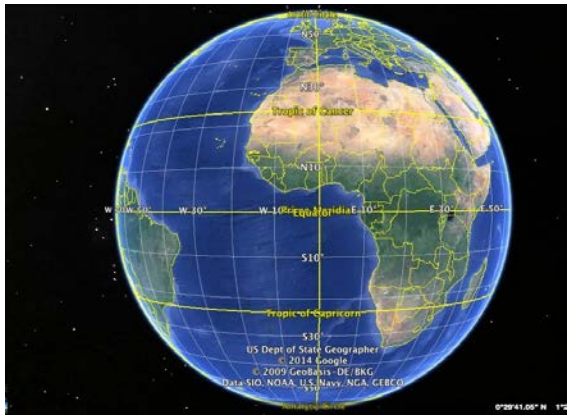
The weather and terrain will dictate the levels of navigation required. In good visibility, with good landmarks, terrain interpretation and straightforward map reading will typically suffice. With worsening weather, intermittent visibility, and fewer landmarks, precision navigation will become dependent on the map, compass, altimeter, and GPS. In poor weather conditions (particularly whiteouts), landmarks may be rarely seen. Intense map, compass, altimeter, and GPS use will be required.

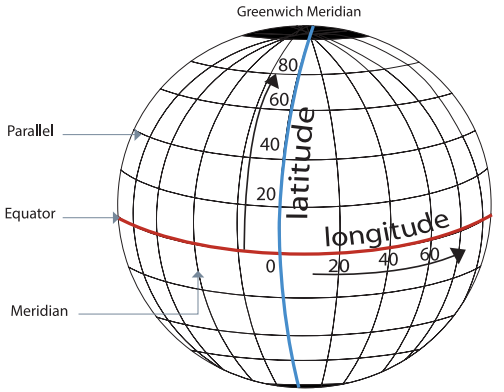
Latitude and longitude

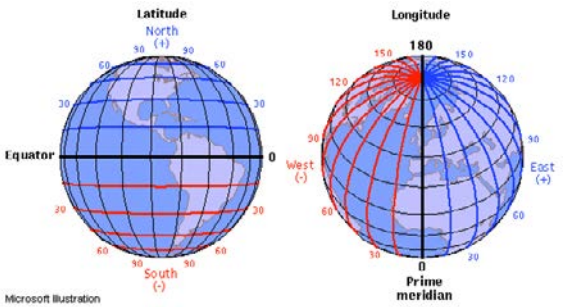
The Latitude and Longitude system has been in use for almost 2,000 years. Latitude and longitude lines are measured in degrees and minutes, with one degree equal to sixty minutes.

The equator is zero (0) degree latitude and splits the globe into north & south hemispheres. The vertical longitude lines are also known as meridians. The Prime meridian is zero (0) degree longitude and passes through Greenwich, England. Degrees continue all the way to the Anti-Meridian at 180° east and 180° west. Read latitude lines from the bottom (Equator) to top (North Pole) in the Northern Hemisphere. Example: 49 degrees 34 minutes 20 seconds. Read longitude lines from right to left. Example: 121 degrees 7 minutes 30 seconds.

Further division is possible, with one minute equaling sixty seconds. One minute of latitude also equals one nautical mile. As one nautical mile equals 1.15 statute miles; one degree equals 60 nautical miles which equals 69 miles or 111 kilometres. Longitude lines vary in distance from each other depending on how far north/south they are. At the equator longitude lines are 111 km apart.



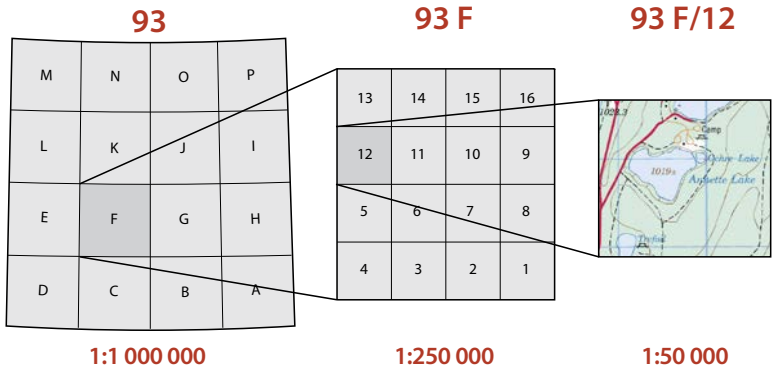




Maps

Maps are a two-dimensional representation of three-dimensional world. It is important to choose a map that fits with the proposed activity. Road maps may help with finding the correct trailhead but provide limited information about natural features and are of limited use in finding one's way across a glacier. Maps for mountain navigation in North America use the Universal Transverse Mercator (UTM) Projection. Transverse because the zone strips run north and south. The globe has a 360 degree circumference, or 60 zones that are six degrees wide. These zones are numbered 1-60. Canada is covered by Zones 7-22. The Zone number is followed by a letter which gives the north/south location from the equator.

Map edges fall on parallels (latitude) & meridians (longitude)



A Primary Quadrangle is a square with a scale of 1: 1,000,000 and given a number.

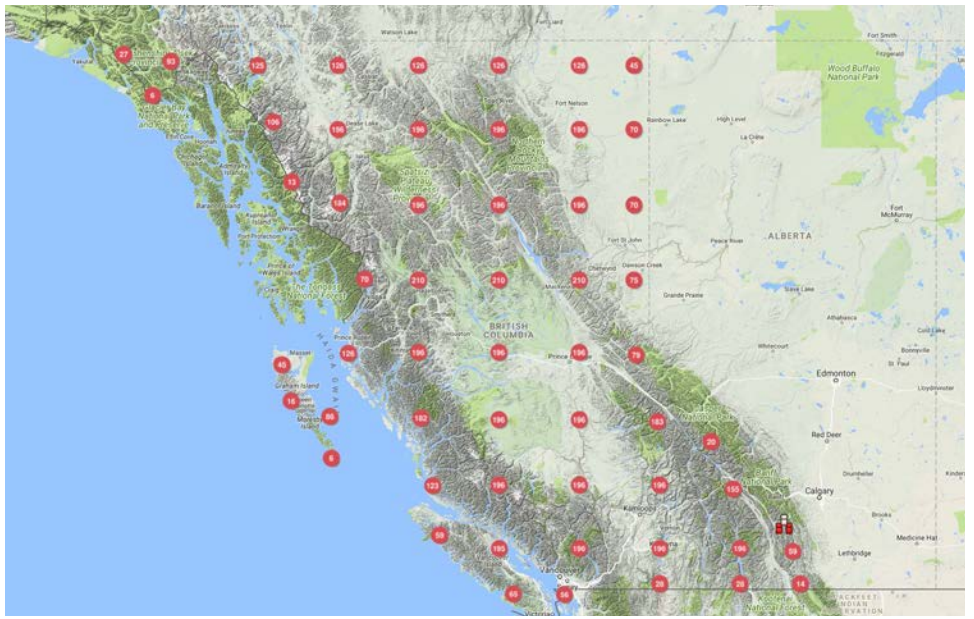
For example - 93

Each Primary Quadrangle is made up of 16 sections (squares) at 1:250,000 and given a number and a letter.

For example - 93 F

These squares in the Primary Quadrangle are then divided into 16 sections at 1:50,000 and given a number.

For example - 93 F/12



Whiteout

TOPOGRAPHIC MAPS

Topographic maps give more detailed information on natural features such as relief, glaciation, vegetation and hydrography, as well as man-made features such as roads and buildings. Each 1:50,000 topographic map covers 15 minutes of latitude (constant) and in Southern BC/Alberta approximately 30 minutes of longitude (variable). Each 1:50,000 topographic map covers approximately 28 km x 35 km = 980 square km.

Map accuracy

Mountain terrain is susceptible to erosion. Over time, mountain features will change. The rate of change appears to be accelerating to the point that even recent maps are already out of date. Of particular note is the reduction in both size and depth of glaciers.

The age of the information used to create a map is an important consideration. Many mountain areas have not been surveyed or photographed for a number of years and the information will be dated. The age of the information given on maps can be ascertained by looking for dates of air photographs, surveys, and culture checks used to produce the map. Canadian maps are based on interpretation of air photos taken during the summer. This information is generally printed on the map border. In popular areas, privately published maps can provide additional updated information.

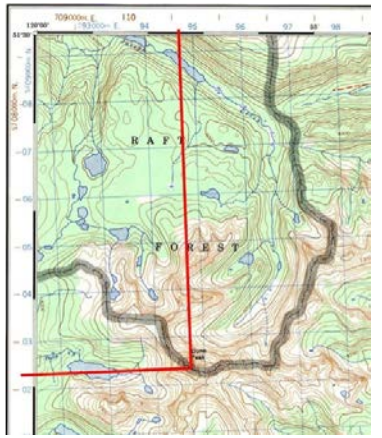
GRID REFERENCES

Each 1:50,000 topographic map is overlaid with a map grid system, the Universal Trans Mercator (UTM). The blue lines create two cm square grids, which equate to 1 km^2 or (1000 m x 1000 m). These grids are numbered from 00 to 99 along both the vertical and horizontal axis. They are read left to right in the horizontal axis; also called the 'easting'. They are read bottom to top in the vertical axis; also called the 'northing'. It is essential that they are referred to in the correct order. The horizontal axis is referenced first, then the vertical axis. A handy reference to remember the order is "cross the meadow, then climb the mountain". A four-number grid denotes an area of one km^2. The one-kilometre scale can be broken down further by dividing the two-centimeter side into 10 increments. This creates a six-number grid which would equate to a 100 m x 100 m square. The six-figure grid reference is the standard used for mountain navigation.

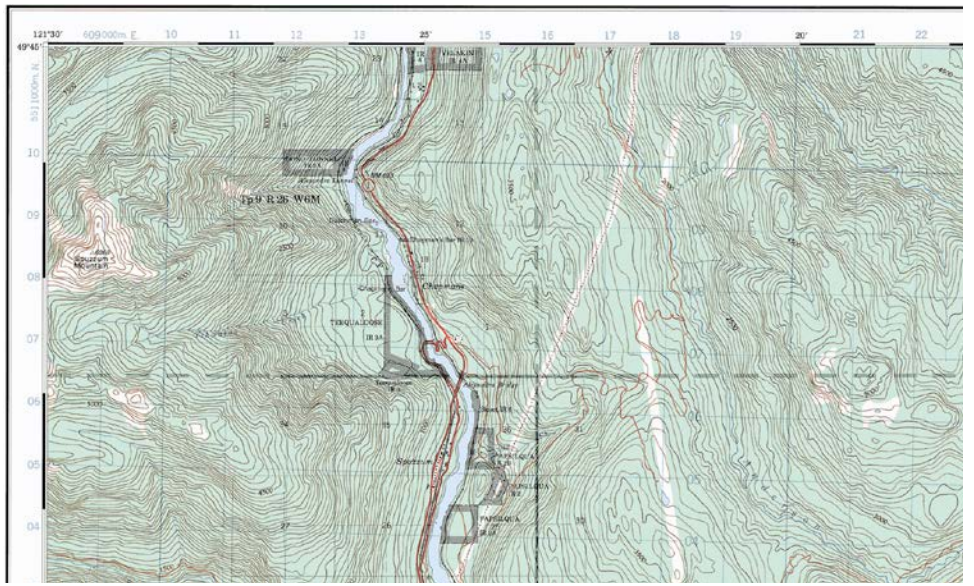
For example, the grid reference for Dunn Peak is 947023

A complete grid reference includes the map name, map number, and the six or eight-digit grid reference number.

The 1:50,000 topographic map is also overlaid with latitude and longitude marks along the edges; indicated by black numbers and black and white bars. Each bar is one minute.



Dunn Peak



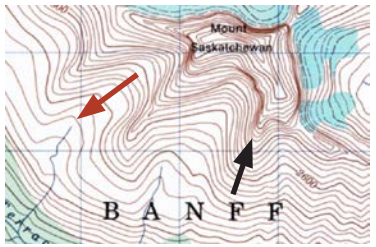
Latitude and Longitude

CONTOUR LINES

It takes many years to develop expertise in the interpretation of contour lines. It is an essential skill that requires diligent effort. Contour lines help a mountain traveller determine slope shape and slope angle. These two factors will aid in the differentiation between ridges and valleys and between summits and depressions. Direction, altitude is indicated on the main contour lines, normally with the top of the number pointing toward any summits.

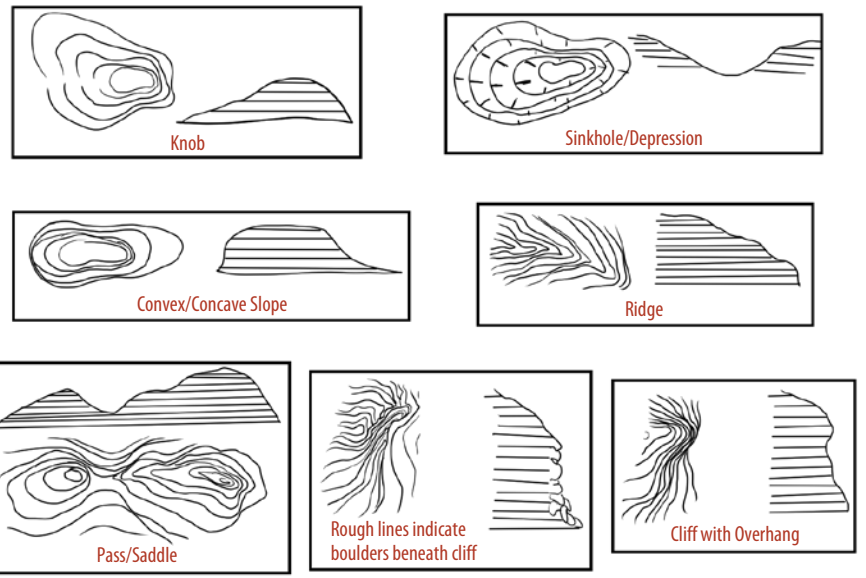
Contour lines indicate height above sea level. The closer the contour lines, the steeper the slope. The more widely spaced the contour lines, the gentler the slope. The vertical distance between contour lines is called the contour interval (C.I.) or the rise. Canadian topographic maps at 1:50,000 will have a metric interval of 20 or 40 metres. Older Imperial maps had a contour interval of 100 feet. The horizontal distance between contour lines is called the horizontal equivalent (H.E.) or the run.

It is hard to tell what is a ridge and what is a valley



The larger picture shows an arrow pointing downhill toward a stream and an arrow pointing uphill toward the summit

Contour lines and terrain shapes



Slope incline can be calculated by measuring the horizontal distance and counting the contour lines. The incline is expressed as a gradient or an angle. The gradient of a slope is expressed as a fraction or percentage. Incline can be expressed as Rise/Run.

For example – If the distance between two 40m contour lines is 80m,

Gradient = CI 40/HE 80 = ½

Slope Angle is the arc tangent of .5 = 27º

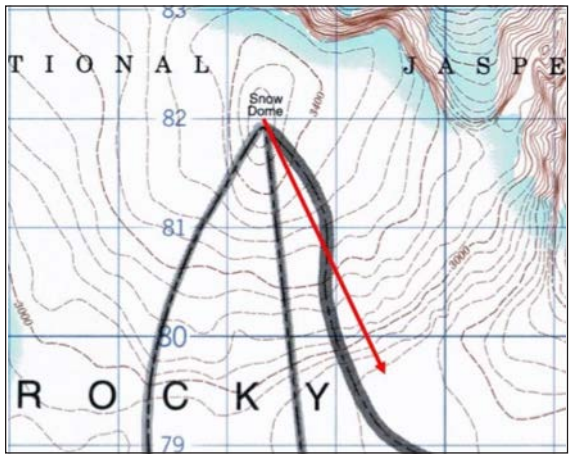
Another example – descending from the summit of Snowdome toward the Athabasca glacier exit.

The CI = 610 & HE = 2500

the gradient is 610/2500 = 24.4

Slope Angle is the arc tangent of 24.4 = 14º

Carry a slope gradient to angle conversion chart in your field book to simplify the calculation.

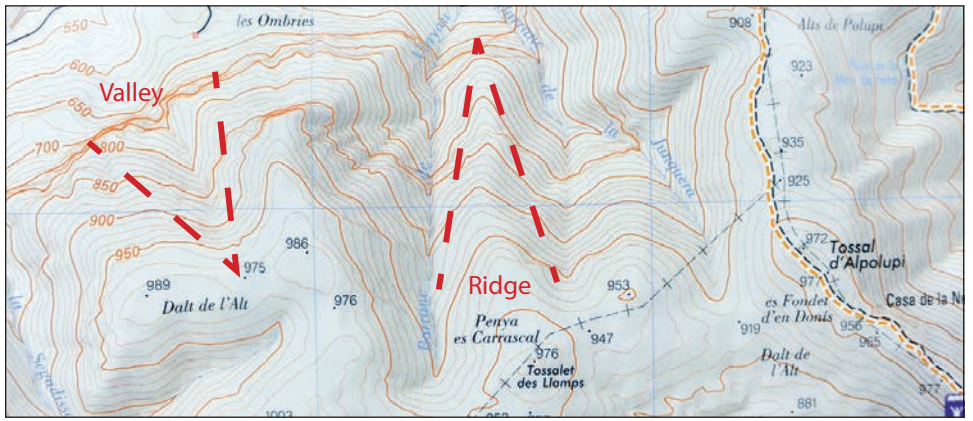


Slope Gradient Example — Snow Dome

Percent Grade	Slope Angle
20	12
25	14.5
30	17.5
35	19
40	22
45	25
50	27
55	29
60	31
65	33
70	35
75	37
80	39
85	41
90	42.5
95	44

Slope Gradient to Angle Conversion

Valleys and ridges can be differentiated by looking both at the V-shape of the contour line, and also Identifying the contour increment. V-shaped contours that point uphill are gullies and will often have streams indicated. V-shaped contours that point downhill indicate ridges.



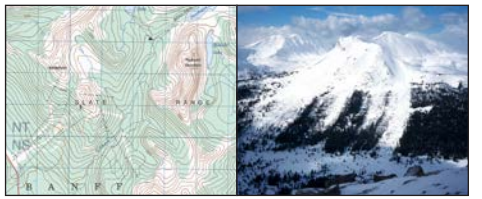
Relating map features to the terrain

The Summer Mountaineering Leader must be able to interpret map information and relate it to actual terrain. One of the challenges with this is that map information is a two-dimensional representation of terrain. Important to the success of relating map features to terrain is having the map oriented correctly. In other words, north on the map should be facing north on the terrain. This can be done using a compass or lining up terrain features that are very obvious (i.e. cliffs, well defined peaks, etc.). When practicing this skill, begin with obvious map features and visualize what the actual terrain shape would look like. Progress to more detailed and nuanced terrain shapes as your skill and confidence improves. A Summer Mountaineering Leader with good map interpretation skills can quickly and easily follow their position in terrain relative to the map.

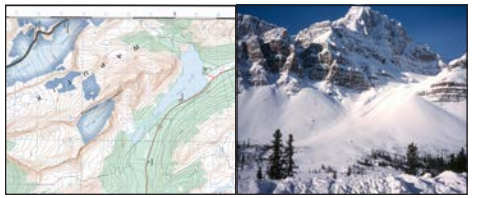
Relating terrain features to the map

Just as it is important for the Summer Mountaineering Leader to relate map features to the terrain, it is equally important to be able to relate identified terrain features to the map. This allows one to help identify and follow their position on a map. As with the previous section, start with obvious well-defined features and progress to more subtle and nuanced terrain. In periods of challenging visibility, slow down and take the necessary time to correctly identify a terrain feature. It is all too easy to convince oneself and force a piece of terrain to fit on the map incorrectly.

Saskatchewan Glacier

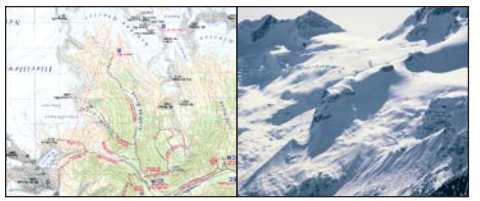


Richardson



Bow Summit

Robertson

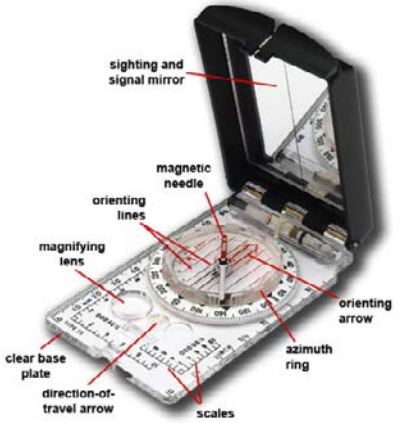


Sapphire

Gordon

Compass basics and types

There are a number of types of compasses, but for summer mountaineering needs a 'sighting' compass is best. Look for a compass that is fluid filled, has declination adjustment, has good mechanics and stability, and has an inclinometer



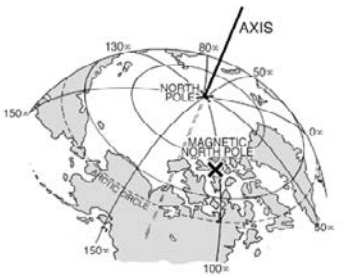
- The front of the compass is the end where the mirror is attached, and the bearing indicator is located.
- The base plate is used to align the compass with the points on the map between which bearings are to be measured.
- The mirror is used to aid in accurate sighting.
- The sighting notch is at the top centre of the mirror.
- The housing rotates and is marked with numbers indicating degrees.
- The orienting lines rotate with the azimuth ring housing and are used to align the compass to the map when transferring bearings from the field to the map.
- The magnetic needle floats in the housing and points to magnetic north. (Red end indicates north.)
- The orienting arrow is used to align the magnetic needle to magnetic north when taking bearings in the field.
- If the compass has a declination adjustment mechanism, the orienting arrow can be moved to adjust between magnetic and grid north.

A good sighting compass should cost in the $50 + / - range.

Don't put up with a hard to use, cheap compass. Your navigation accuracy will reflect this decision. Don't expect more than your calibration and information can deliver. A degree is about as good as it gets with most field compasses. Any further and results go up in a linear fashion and money goes up in an exponential fashion.

A simple solution to producing greater accuracy is to plan shorter legs, which should produce less potential error.

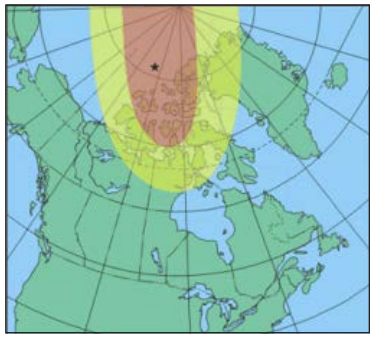
HOW MANY NORTHS ARE THERE?



How many norths?

There are three norths: true north (the North Pole), grid north (north established by grid lines on the map), and magnetic north (where the compass needle points to). The line where true north is the same as magnetic north runs up the east coast of Florida, through Ontario (Lake Superior & Nipigon) to the North Pole. Topographic maps are printed so that north is oriented to the top of the map. The north reference point used on maps is referred to as grid north. Grid north on a map varies slightly from true north in the field where the North Pole is the reference point. For the purposes of mountain navigation, where techniques are rudimentary, grid north is used as the reference point on maps. Magnetic north refers to the direction given by a compass needle. This difference is discussed in the section on declination.

Compass unreliability

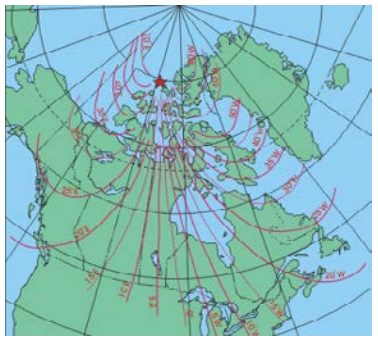

Compass Unreliability

The compass becomes increasingly erratic (yellow zone) and eventually unusable (red zone) as one approaches the North Magnetic Pole (marked with *)

Declination is the term that refers to the difference between magnetic north and grid north. The angle between the direction the compass needle points and the true-north line is called declination. This difference was first determined at around 720 AD. In 1700, Halley developed a declination cart of the Atlantic Ocean. The compass needle points to a location approximately 1,500 km south of the North Pole (Bathurst Island). This point is magnetic north. It is not a static location like grid north or true north. From western Canada the compass needle points south & east of the North Pole (east declination). Declination can be indicated on a map similar to a contour line. Variation is the change in declination over time. The annual change is estimated and indicated on the map legend. It can also be found using a web resource.

http://geomag.nrcan.gc.ca/calc/mdcal-en.php

The diagram on the topographic map sheet gives the value of the angle between magnetic north and grid north, which is referenced to the grid lines shown on the map. This angle is properly called grid declination. So, because we are working with, and referencing, grid lines as we navigate, we use the value between grid and magnetic north as the declination.

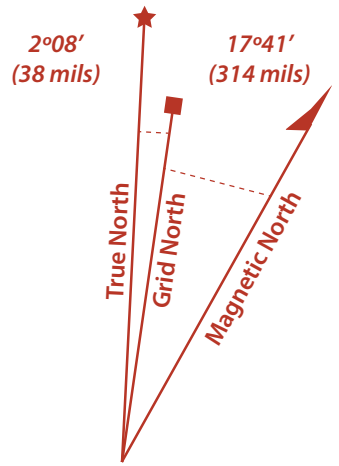


A simple declination chart

Note: The term deviation refers to changes that are due to localized iron content. Note that compasses are also affected by metal and electronic objects such as ice axes, cameras, avalanche transceivers and other compasses.

Topo map declination adjustment

Use diagram only to obtain numerical values. Approximate Mean Declination 2000 for centre of map. Annual change decreasing 6.9'



Setting the adjustable compass for declination

In western Canada the declination is east. In eastern Canada the declination is west.

Silva ranger style compass

Turn the adjustment screw so the orienting arrow in the base adds the declination amount.

For example, if the declination is 20° east the orienting arrow should be adjusted to read 20° (not 340°)

Accounting for declination in a non-adjustable compass (western Canada)

Transferring a map bearing to the field:

- Place the compass on the map to determine the bearing
- Subtract the declination amount from the bearing on the compass to get a lesser number
- Declination EAST - Compass LEAST
- Use the lesser compass bearing to follow in the field

Transferring a field bearing to the map:

- Shoot the bearing in the field (magnetic)
- Add the declination amount to the compass (true)
- Use the compass on the map

BEARINGS AND ACCURACY

Compass work accuracy is based on the measurements taken in the field and transferred to the map, and vice versa. When choosing a feature in the field, it is best to pick prominent, easily identified landmarks. Peaks are often good selections, especially if your choice is a sharp summit over a broad, rounded one. However, the field features must also be easily identifiable on the map.

Errors in map reading, taking a bearing or walking on a bearing will be magnified over larger distances. For example, a 5° error will magnify at a rate of 87m per km.

The importance of accuracy in compass bearings

Error Angle (degrees)	Distance (kilometres)	Error (meters)
1	1	17
1	5	87
1	10	170
2	1	34
2	5	170
2	10	340
3	1	87
3	5	425
3	10	850

Strategies to improve accuracy

- Use terrain handrails to reduce the reliance on just a compass bearing.
  - See below for handrail definition.
- Plan shorter legs.
- Use larger scale maps.

TAKING BEARINGS

The compass can be used to identify a direction to features in the field as well as relate field information to a map. The Summer Mountaineering Leader will be familiar and practiced with taking bearings as a means of navigation or determining their position.

When travelling in the backcountry with reasonable visibility, the leader would consider taking bearings of the feature she is travelling towards in the event the cloud cover increases and obscures the desired destination or reference point. To do this, the leader would simply hold the compass in front of herself at eye level and sight through the sighting notch with the sighting line on the mirror in alignment with the front and back bearing indicators on the base plate. Doing this reduces potential error (parallax error) in bearing accuracy. Once the feature has been identified, the compass housing is rotated so the magnetic orienting arrow is in alignment with the magnetic needle. The number at the bearing indicator is the bearing one would follow if visibility were reduced and travelling by compass were necessary. In this case, the leader would hold the compass in front of her and rotate her body so the magnetic needle sits overtop the magnetic orienting arrow. When travelling, it is then important to keep the magnetic needle inside the orienting arrow in order to stay on the correct course, or direction.

TRANSFERRING A BEARING FROM THE MAP TO THE FIELD

On occasion, the leader knows their position on the map and wants to travel to another specific location or grid reference on the map. To do this the leader would place their compass on the map 'from' the point they are 'towards' the point they are travelling towards. The next step is to rotate the compass housing so the grid lines on the housing are parallel with the grid lines on the map. It is important to turn north on the housing towards north on the map otherwise the bearing will be 180 degrees off (backwards). Once the housing and grid lines are parallel, the number indicated at the bearing indicator is the bearing the leader would follow to the next desired location. In this instance, follow the travelling description as per the above example. The process described assumes the leader is using a compass with declination adjustment. If not, the leader would determine the bearing and subtract the magnetic declination (assuming east declination) before proceeding to ensure they end up at the correct location.

A Summer Mountaineering Leader shoots a bearing to determine the group's location in the field.

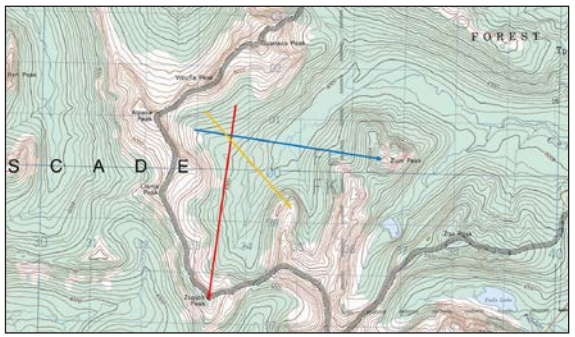
RESECTION

Resection is often mistakenly referred to as triangulation. It is used to determine one's position in the field by shooting bearings off identifiable land features and transferring them to the map. These features should be sharply defined points, identifiable both in the field and on the map, and 60° to 90° degrees apart for greatest accuracy.

- Shoot the bearings and transfer to the map by drawing a line along the edge of the base plate.
- Your location is at the intersection of the two bearings.
- Shoot additional bearings to increase accuracy.

A variety of clearly defined points or features can be used.

- Shoot a bearing to intersect a linear feature.
  - Physical – creek, ridge.
  - Cultural – trail, road.
- Shoot a bearing to Intersect an imaginary line or point.
  - Altimeter reading (contour line).
- Shoot a bearing to the Intersection of a linear feature and an imaginary point.
  - Ridge and altimeter.



in this resection example, the red and blue lines represent lines drawn along the edge of a compass baseplate after shooting bearings from the point where the interesct (the leader's location). The third (yellow) line represents an additional bearing for increased accuracy.

Altimeter

Altimeters measure barometric pressure. Barometric pressure varies with changes in elevation and may change due to weather systems that can render elevation readings inaccurate. The rate of change and degree of inaccuracy varies with the speed and intensity of the approaching weather system. To retain the highest degree of accuracy, altimeters should be reset whenever a location of known elevation is encountered such as a lake or pass. This is particularly important during times of variable weather conditions. Resetting altimeters requires accurate interpretation of the map. Altimeters are most useful for navigation on steeper slopes where horizontal movement results in noticeable changes in altitude.

Because they are affected by weather systems, altimeters can also be used as barometers. If stationary at a point of known elevation for a length of time changes in barometric pressure read as changes in elevation and provide important weather data, which can be used as a forecasting tool. For example, an increase in elevation reading indicates a decrease in barometric pressure and generally heralds deteriorating weather conditions. A decrease in elevation reading indicates an increase in barometric pressure. This is usually indicative of improving weather conditions. Although altimeters have some limitations, they provide valuable additional information when combined with information from the map and/or compass.

Whiteout navigation

Whiteout conditions are a reality of mountain travel. In some cases, the most prudent plan is to wait for an improvement in the weather. Navigating through whiteout conditions is an advanced skill that must be practiced. In a worst-case scenario, whiteout navigation requires a complete plan. This will greatly facilitate travel if conditions deteriorate.

HANDRAILS

The identification and use of handrails is an essential navigational skill. Handrails are terrain features that can be followed in poor visibility. The most useful handrails run parallel to the desired direction of travel. Examples of handrails include: ridges, streams, and cliff escarpments. Handrails need to be obvious enough to recognize in poor visibility. They can be as subtle as a significant change in slope angle.

The general principles of whiteout navigation are:

- Keep it simple.
- Use the map to plot a general route.
- Identify handrails and reference points along the route. These are well-defined features that can be recognized and followed even in poor visibility.
- Identify areas where navigation will be more difficult (i.e. No handrails).
- Determine lines of travel from one handrail or reference point to the next.
- Keep these lines as short as possible.
- Identify areas where deviations from straight line travel may be necessary due to hazards or terrain features (e.g. crevasses, cliffs).
- The most difficult way to end/start a leg is by trying to calculate distance travelled.

Accurate navigation by instruments in whiteout conditions begins with a known starting point. An accurate GPS receiver simplifies the problem of determining location and travelling in whiteout conditions, however, leaders are advised to have a complete whiteout plan ready as a GPS may not provide an accurate enough location. GPS units have their lowest accuracy on steep north facing terrain. It is essential to fix the position of the party whenever practical if travelling in terrain where whiteout navigation may be required. This fixed location serves as a starting point if navigating in poor visibility becomes necessary. Once the location of the party is established (e.g. by resection or GPS) upcoming travel is broken into sections. Each section is called a leg.

AIMING OFF

When a leg's destination is a small, specific point on a handrail, e.g. a col in a ridge or a hut at the base of a moraine, use the aiming off technique. Aiming off is a deliberate error built into the leg's bearing. If trying to arrive exactly at a small point on a large feature and the point is missed it can be difficult to tell in which direction one must go to find the missed point. By deliberately aiming off slightly (usually 3 - 5° are all that is required) to one side or the other it is ensured that the miss will be in a known direction. Thus, having found the handrail, which way to travel to get to the destination is clear. It must be stressed that aiming off works only when a handrail accompanies the point to be located; it will not work for a small point surrounded by nondescript terrain.

ROUTE CARDS *(Recording a whiteout navigation plan)*

A route card differs from a trip plan in that the route card describes the daily navigational details that are often broken down into shorter legs. During clear weather, navigation is typically straightforward. However, if visibility is poor, more precision navigation is required and the use of a route card will help speed up the leaders travel in that the navigational details have been identified in advance and as such, the route card becomes the 'cheat sheet'. Depending on the complexity of the outing, the route card may have several legs to help guide the mountaineering trip leader along the desired path envisioned on a map. As described earlier, shorter legs help reduce navigational errors. The mountaineering leader will identify significant features on a map to help break the overall daily outing into manageable and identifiable segments called legs. Such features could include lakes, creeks, ridges, cols, valley junctions, meadows, etc. If travelling with an altimeter, these features can also be combined with elevation to further refine the desired leg start or end point.

Each leg needs a definitive start point and an end point described by terrain, elevation, etc. In addition, data such as elevation gain/loss, bearing, back bearing, leg length, etc. is recorded for each leg. This information is carefully noted on a route card, in a fieldbook, or on the map so it is accessible when in the field. Drawing a whiteout route on the map provides a quick reference when travelling.

A preliminary route can be planned and recorded before leaving on a trip. If visibility is good upon arrival at an area where whiteout navigation may be required, it is wise to modify the route card based on the actual features (e.g. crevasse fields, unmarked cliffs, etc.) not identifiable on the map.

Example of whiteout navigation plan

Leg	Grid # at Start	Grid # at End	Elev at Start	Elev at End	Elev +/–	Bearing	Distance	Est. Time	Est. Cum. Time	Actual Time	Comments
1	*971 498*	*990 505*	*4300*	*5250*	*+950*	*67*	*2.0*	*90*	*90*		
2	*990 505*	*009 501*	*5250*	*5450*	*+200*	*102*	*2.0*	*45*	*135*		
3	*009 501*	*021 503*	*5450*	*5600*	*+150*	*75*	*1.3*	*35*	*170*		
4	*021*	*027*	*5600*	*5550*	*-50*	*104*	*0.6*	*15*	*185*		

WHITEOUT TRAVEL TECHNIQUES

Before travelling in whiteout conditions consider whether travel is necessary and/or whether it can be carried out within reasonable margins of safety:

- What is the severity of the whiteout?
- How complex is the travel plan?
- What type of terrain will be encountered?
- What hazards will affect the party while travelling?
- How necessary is it to travel?

These factors will help determine if travel in the whiteout are appropriate. It may be more prudent to stay in place and wait for an improvement in visibility rather than travel in severe whiteout when conditions are hazardous, or terrain is complex.

Walking a bearing

To walk a bearing on a snow-covered glacier:

- The rope team leader, carrying a compass, leads the group.
- The second team member also carries a compass and helps the team leader stay on track.
- Continual compass checks are required to ensure the party is staying on the bearing.
- Looking back regularly ensures the line of travel is straight.
- If maximum accuracy is required:
  - The leader marks position each rope length.
  - The last person calls out when they reach the mark.
  - If the last person also has a compass, he/she can ensure that the party is travelling in a straight line. If not, the rope team leader can use a back-bearing on the last member.

Measuring distance travelled

If it is necessary to measure distance, clearly mark your position every ropelength and have the last person call out when they reach your mark. Count the number of ropelengths travelled and multiply by the distance between the first and last person on the rope. This is a very tedious process and should not be underestimated.

Dead reckoning

Current location can also be estimated using dead reckoning. Based on an accurate start position, an accurate bearing, and an accurate speed calculation, elapsed time will generate a position. However, accuracy degenerates over time and distance. The greatest challenge for the Summer Mountaineering Leader is determining an accurate speed calculation. Variations in terrain and surface conditions can have drastic effects on the speed of travel. Dead reckoning is at best an educated guess.

Navigating around obstacles

Adjusting the line of travel when obstacles or hazards are encountered requires a carefully measured detour.

- Make a right angle turn from the bearing being travelled.
- Note the new bearing and calculate its back bearing.
- Measure the distance travelled out on the new bearing.
- Make a right angle turn and travel until past the obstruction.
- Once past the obstruction:
  - Make a right angle turn to the back bearing calculated in step 2. You should now be headed back towards the original line of travel.
  - Measure the distance back to the original line of travel.
  - The distance back should equal the distance out.
- Having travelled the correct distance back, make a final right angle turn to regain the original line of travel.
- When travelling on a glacier (depending on the orientation of the crevasses), it may be safer to make an angle change of 45º out and then back again.

Navigating through a crevasse field.

Whiteout

Verifying the route

Whenever a break in the weather or visibility occurs, location should be verified, and the route adjusted if required. Consider taking a new bearing or revising the route based on actual observations rather than using a predetermined plan based on theoretical data.

TIME PLANNING GUIDELINES

- On Good Trails
  - 5 km/hr
- Off Trail
  - 3 km/hr in open terrain
  - 1 – 2 km/h in rough terrain
  - < 1 km/hr in dense bush
- Additional Time Requirements
  - 10 min/hr for rest breaks
- Vertical Gain
  - Add 1 hr / 300m (1,000 ft)
- Descent
  - Add 10 min / 300m (1,000 ft)

OTHER CONSIDERATIONS

- If using a route card – add 10 min for each leg transition.
- Breaks – estimate approximately 10 min for breaks each hour.
- Travelling with a multi-day pack will typically be slower that travel with a day pack.
- Travel slower with those new to the activity to preserve energy for the entire outing as they will likely be less efficient in their movement skills.
- Travel through relatively open forest is faster than through dense forest.
- Poor visibility requires a slower rate of travel.

WANDS

Wands are a useful aid to whiteout navigation when using a route multiple times, or when returning via the same route. A GPS is a superior solution to most of the solutions offered by wands, however there are times that wands are a better option. For example, on a steep crevassed glacier, a GPS may not be accurate enough to identify a key crevasse bridge, whereas a set of wands will work. Bamboo tomato stakes are cheap and biodegradable. They should be at least 100 cm long. Add some flagging tape to the top.

- Mark the route
  - Many wands are needed if an entire route is flagged. A better option is to mark key points on a route.
- Mark a hazard
  - Crevasses, cornices, etc.
- Mark a camp, cache
  - Add a line of wands out from the camp at 90º to the direction of travel. The wands should be angled toward the camp. This will make for a larger object to find in the white.
  - Add an extra tall (double or triple length) wand to a cache that is left for any length of time and snow is anticipated.
- Shortcomings
  - Wands can fall over, blow over, melt out, or be covered by snow.

Global Positioning Systems (GPS)

GPS technology has advanced over the years to where GPS units are smaller and provide more information to the user including showing one's position on a map on the GPS screen, rate of travel, estimated time of arrival to a specific point etc. The global positioning system is based on the interaction of three components: a satellite array, a ground-based coordinating system, and the user's handheld device. There are thirty satellites in orbit @ 20,200 km. At any one time at least twenty-four will be operational. The satellites produce a signal that tells the receiver the time, date and a timing code. This allows the GPS unit to calculate its distance from the satellite. Three satellites will allow two-dimensional location calculation and four satellites will generate a three-dimensional location.

GPS signals are not bothered by fog, clouds, altitude, darkness, weather, etc.

However, signals are line-of-sight and are degraded by trees, rocks, cliffs, buildings etc.

Although GPS is a worldwide system, it functions with greater accuracy closer to the equator due an increased concentration of satellites in over the lower latitudes.

Integration of a GPS unit and a map

Using both map and compass together with a GPS allows the leader to be much more versatile in their navigation techniques. In a whiteout for example, the GPS can indicate the leader's position thus confirming direction and rate of travel. This may allow the leader to travel at a faster rate and with more confidence than strictly using map and compass.

It is essential to enter the correct map datum into the GPS. Tell the unit which map you are using. What year was the information gathered? The standard map datum for Canadian maps is the North American 1983 datum (NAD83). Older maps used NAD27. The coordinate systems are different, so if your GPS is set up on NAD27 map datum, a UTM grid reference will place you several hundred metres away from where the map places you.

The GPS can also mark points along a route (waypoints) such as hazards or specific safety or travel features, which can be useful for future trips or if the outing is an 'out and back' trip. It is also possible to enter waypoints of a particular outing in advance (or via computer connection) so the Summer Mountaineering Leader has their route all set to go in the event of poor visibility conditions.

A GPS unit will:

- Tell you where you are.
- Track where you have been.
- 'Go to' an entered waypoint.
- Tell you direction of travel.
- Tell you how far it is to a waypoint.
- Tell your average speed.
- Tell elapsed and estimated times.

A GPS cannot 'read' terrain – that's up to you! A GPS will take you on a straight line directly to your destination. It will not manage obstacles such as cliffs or crevasses.

Other apps as navigation aids

Some navigation apps draw heavily on the phone's battery capacity. Cold weather also reduces the battery charge longevity. Carry a spare battery or paper map as a backup.

One of the advantages of the digital age and available apps for one's smart phone is that there is more information available to assist the Summer Mountaineering Leader with navigation. One of the challenges is that there are many apps available and one needs to filter out those apps that are less useful. This takes a bit of time, and a good way to spend a stormy evening where you have an Internet connection. There are a few navigation apps the Summer Mountaineering Leader may find useful and want to search for:

- Declination – apps that let the user drop a pin on your location for the current declination.
- Map apps – there are a variety of map apps, including some that are free, that allow one to download topographic maps. Different apps have different functionality and map resolutions.
  - Canada Topo (free).
  - Topo Maps (paid) – there are a couple of versions of this. Map resolution is excellent.
  - Gaia (paid)
- Sunrise and Sunset – this may be useful for determining potential start times and daylight times for winter outings. Particularly useful for early season trips.

Summary

Navigation can range from simple to complex. Although this is primarily based on the route selected, the complexity can vary tremendously based on the weather conditions. A skilled leader has the ability to visualize terrain and possible routes, read and interpret maps, and relate the information to terrain. When weather conditions make route travel more difficult, the leader must be able to use the map, compass, altimeter and GPS to problem solve and error correct. The use of navigational tools should fit with the complexity of the terrain and the weather conditions. In simple terrain, in good weather, the occasional glance at the map should suffice. Whereas travelling through complex terrain in a whiteout will require all the tools in the box. When these tools are insufficient, the Summer Mountaineering Leader must be willing and able to set up camp and wait for better weather.

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Camping in a Summer Mountaineering Environment

Many summer mountaineering objectives are multi-day affairs that require competency in summer camping skills. A well situated and properly set-up camp sets the team up for a higher likelihood of success in the achievement of the mountaineering objective. A well-defined mountaineering objective will dictate the type of camping equipment needed. For example, a light and fast peak traverse with a high bivouac will restrict the volume and weight equipment carried, while a more leisurely approach to a treeline camp, with an up and back ascent may allow for greater luxuries to be carried.

Introduction

Many summer mountaineering objectives are multi-day affairs that require competency in summer camping skills. A well situated and properly set-up camp sets the team up for a higher likelihood of success in the achievement of the mountaineering objective. A well-defined mountaineering objective will dictate the type of camping equipment needed. For example, a light and fast peak traverse with a high bivouac will restrict the volume and weight equipment carried, while a more leisurely approach to a treeline camp, with an up and back ascent may allow for greater luxuries to be carried.

The objectives of this chapter are to describe how to prepare a camping site, plan meals, prepare meals and build emergency shelters.

Left: Three-season tent
Right: Four-season tent

TYPES OF SHELTERS

Tents - three-season vs four-season

As a mountaineering camp may be subjected to extremes in wind and precipitation, a sturdy three or four-season tent is preferred. Tents should have multiple guylines. A four-season tent typically has windows that can be unzipped to allow air circulation, while a three-season tent has mesh panels that cannot be closed. Three-season tents can be used in protected campsites. Four-season tents will stand up to horizontally driven rain and snow. Four-season tents are as a result generally heavier but provide a greater haven from inclement weather.

Single wall vs double wall

Most tents utilize an inner nylon tent body suspended by an aluminum pole frame, with a waterproof exterior fly draped over it. Tents are also available with a single wall construction. Single wall tents are typically much lighter, even though they are a four-season design. The material used is a waterproof, breathable fabric. However, there are limits to both the waterproofness and the breathability. Condensation can also be a problem. Single wall tents are most appropriate for light and fast ascents when weight takes precedence over comfort.

Size

Consideration must be given to the size of the tent and the number of people it is 'rated' for. The length and objective of the trip will provide parameters as to the size and style of tent needed. It can be very useful to have a tent with two doors and a large vestibule at one end.

Single wall tent

Tarps

Mountaineering groups should be carrying guide's tarps to shelter the group if caught by bad weather in an exposed place. The guide's tarp is a sheet of waterproof nylon with grommets at the corners and along the edges and two to three-meter sections of 2 mm or 3 mm cord attached. The tarp is carried by the group when travelling away from the tents. It can also be used as a cooking shelter. However, it must be taken down and carried with the group during the peak ascent.

Cooking area.

A guide's tarp can be slept under.

Guide's tarp rain shelter.

Sleeping tarps

As a lighter alternative to carrying a full tent, the guide's tarp can be slept under. Often this is paired with a bivi sac. This shelter setup does not work well in windy or exposed locations. Some companies produce tent-style tarps that provide greater protection

Emergency shelters

Unplanned bivouac skills are an essential tool. Groups travelling in the alpine should at minimum carry a guide's tarp. Guide's tarps come in a variety of sizes and materials. A 2-meter by 3-meter tarp works well for most applications. Siltarp material is considerably lighter than nylon but is also more expensive. Below treeline, natural shelters can be constructed from branches. Often shelter can be found below large conifer trees.

SLEEPING SYSTEMS

Sleeping bags come in a variety of weights (warmth rating) and materials.

Sleeping bags have a warmth rating. This might be 0 degrees, -20 degrees, -40 degrees, etc. The rating is based on an 'average' person getting eight hours of sleep at a particular temperature.

Down is an excellent insulator for its weight, however loses virtually all of its insulating properties when wet. Synthetic insulation retains most of its insulating properties when wet but is heavier and bulkier than a down bag with an equivalent warmth rating. Down bags maintain their warmth ratings over time, while synthetic bags tend to pack out and lose insulating capacity. Over the long haul, the cost difference/longevity tends to balance out.

Sleeping pads are an integral part of a sleeping system, providing both insulation and comfort.

- Closed cell foam is the most basic. It is a durable and cost-effective material but is not as comfortable as other options. It is light and bulky.
- Open cell foam is also cost effective, but not as durable. However open cell foam absorbs water and is not a good option for mountaineering. It is light and bulky.
- Inflatable mattresses rely on a sealable system. Four types of construction are used.
  - Air mattresses rely on just air to provide high levels of comfort and low levels of insulation. They are light and compact.
  - Inflatable open cell foam mattresses provide high levels of comfort and varying levels of insulation based on the thickness of the foam. They are heavier and bulkier than air mattresses.
  - Inflatable synthetic filled mattresses provide high levels of comfort and varying levels of insulation based on the amount of synthetic fill. They are heavier and bulkier than air mattresses, but lighter than inflatable open cell mattresses.
  - Inflatable down filled mattresses provide high levels of comfort and varying levels of insulation based on the amount of down. They are heavier and bulkier than air mattresses but lighter than inflatable synthetic fill mattresses.

The method of inflation is an important consideration. Inflatable open cell foam mattresses will self-inflate to a point but may need a few puffs

of air to fully inflate. Air mattresses are fully dependent on air being blown into them. This can be achieved by mouth or mechanical device. Blowing into the pad by mouth may introduce moisture and bacteria. Over time this may become a problem. The mechanical inflation devices employ a variety of strategies from battery operated fans to stuff sacks.

CAMPSITE SITE SELECTION & PREPARATION

Treeline and Alpine considerations

Site selection at treeline should be based on finding durable surfaces and away from riparian areas. The environment is fragile and easily damaged. Camping in a beautiful alpine meadow for a week will leave long lasting impressions and signs of wear.

Below tree line the environment is more durable and can recover more quickly from camping impacts. (See Chapter 4 for additional environmental considerations)

CAMPING CONSIDERATIONS

It is often desirable to set up a summer mountaineering camp at treeline or above to reduce the travel time to the alpine objective on summit day. These camps may be set up for only one night, or as a base camp for multiple objectives. Basecamps require considerable additional preparation and effort to minimize impact. Durable tent platforms can often be constructed using flat rocks to level uneven scree and moraine debris. In popular areas, tent platforms may already exist. When striking camp; do a sweep to ensure no garbage has been left behind and to return the site to the condition it was before use.

KITCHENS

A well-organized kitchen area will simplify food preparation and facilitate FoodSafe practices. The production of high quality food does not require a complex kitchen set-up. However, poor food handling or storage can easily lead to food poisoning and an unforgettable trip. Hand washing capacity is an essential first step.

For additional information see Chapter 4.

Note: Human food is an attractant for wild animals from bears to pack rats, so careful storage of food is important. The kitchens should be located downwind from the sleeping area so that wild animals are not drawn toward the sleeping area by food odours.

MEAL PREPARATION FOR A SUMMER ENVIRONMENT

Capacity for food preparation will vary based on the trip objectives. For example, a light and fast overnight alpine objective will include limited meal preparation capacity compared to a week-long, heli-established mountaineering camp. The group size will dictate whether smaller cooking groups will be needed. It is simpler and more efficient to prepare meals in smaller groups of up to four people.

Stove considerations

Backpackable, single burner stoves are available in two general types, based on fuel type - liquid and canister.

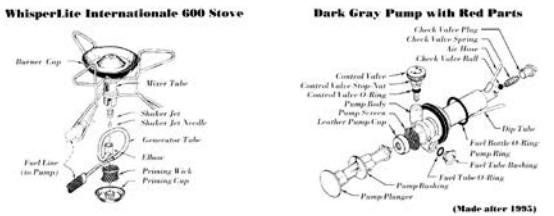
Most liquid fuel stoves burn Naptha (white gas), however some stoves such as the MSR XGK are multi-fuel capable. With a simple change of the jet, the stove is capable of burning Naptha, kerosene, stove oil, or gasoline. Multi-fuel stoves are generally preferred for international trips where Naptha may be unavailable.

Liquid stoves have lighting and use procedures that will help to maintain efficient running and minimal maintenance. Proper pre-heating and stove shut down will reduce carbon build-up in the fuel jet. A yellow flame is indicative of poor combustion.

Liquid fuel stoves require regular maintenance. The fuel jet will become clogged over time and need cleaning. Some stoves have built in cleaning jets, while others will need to be disassembled.

Left to Right: MSR Whisperlite, XGK and canister stove .

Burning old or dirty fuels such as kerosene will increase maintenance requirements. Naptha fuel that has been exposed to low temperatures (-20 degrees or colder) may result in wax precipitates settling out. These wax precipitates may clog the fuel line and or jet. With some stoves, it may necessary to also clean the fuel line assembly. Pull the cable out, wipe it clean, blow air through hose, and reinsert the cable.



MSR Stove Parts Illustration

Canister stoves are much easier to use and maintain. However, fuel canisters are more expensive than the equivalent liquid gas heat output. Additionally, performance drops with decreasing ambient temperature.

Fuel considerations

Naptha – readily available in North America, relatively cheap, relatively easy to preheat and light.

Kerosene – available worldwide, cheap, requires more frequent stove maintenance, difficult to preheat in cold temperatures.

Canisters – available in mountain shops worldwide, relatively expensive, bulky, easy to light, susceptible to cold temperatures.

Consumption rates

Consumption rates will vary based on ambient temperature, stove model and fuel type. A conservative estimate for liquid fuel stoves is 150 ml/person/day. The consumption may go as high as 300 ml/person/day if snow must be melted for drinking water in addition to cooking needs.

Ventilation

Stove require oxygen for combustion. A limited flow of oxygen will result in incomplete combustion and the production of carbon monoxide, which is lethal. Inclement weather typically promotes the desire to cook in a sheltered area. The tent is an obvious solution; however careful consideration must be given. In addition to the threat of carbon monoxide poisoning, tent fabric is flammable.

Pot selection will depend on cooking group size. A team of two may get by with a single two litre pot, whereas a group of four will be better served by having a two-litre and a three-litre pot. Stainless steel pots are preferred as they are durable and cheap. Titanium pots are lighter; however, they are much more expensive and do not transfer heat as well as stainless steel.

MEAL PLANNING

Food is a critical element and will often make or break a trip. Inappropriate food quantities, poor selection, or poorly prepared food may cause a trip to fail. Whereas brilliant meals can create positive memories of weather beaten and defeated trips. The critical elements of food planning include: cost, weight, bulk, packaging, cooking complexity, and taste. The ideal meal will be cheap, light, involve minimal cooking and taste great. The relative significance of each element will vary based on the trip scenario. If everything is to be carried in by the participants, the emphasis will be placed on weight. A base camp scenario might have a focus that includes more elaborate preparation.

Food selection and packaging

Most supermarket foods can be stripped of excess packaging or even repackaged. Excess packaging just becomes waste to be carried out. A food dehydrator is an excellent way of reducing weight and bulk, while retaining flavour. Fruits, vegetables and meats can all be dehydrated. As water boils at a lower temperature as altitude increases, cooking times must be adjusted accordingly. Some foods such as long-grain rice with a cooking time of 40 minutes are inappropriate for meals that are being prepared on a single burner stove. Quinoa is a much better choice as the cooking time is substantially shorter.

Meal preparation

Poorly stored and/or poorly prepared food can easily lead to gastrointestinal problems. A severe case of food poisoning will likely mean an early end to a trip. Foodsafe principles must be used to ensure that people do not get sick. This includes proper hand washing and the use of clean utensils. Raw meats must be handled and stored separately from raw vegetables and fruits.

Is dinner ready yet?

Examples of different water purification devices: an MSR water filter, Steripen UV sterilizer, and chemical water treatment tablets.

Water sources

Water sources in many popular alpine areas may be contaminated by human or animal waste. It is difficult to determine whether water is contaminated, so water purification is recommended in areas that have regular human activity. Methods of purification include: chemical, physical filters, exposure to UV, and boiling. Not all methods are equally effective.

- Chemicals are available in either tablet form or liquid. The chemical reaction takes longer to complete with colder water. Chemicals often leave a taste.
- Physical filters come in a variety of styles; from straws to pumps. A good pump will provide the greatest level of protection and is capable of a high level of throughput, however it is the most expensive option.
- The SteriPen uses UV-C light to sterilize water. It is light, easy to use, quick and effective. It is not as expensive as the best pumps. It does not work well in silty water.
- Boiling water is a simple yet effective method of sterilization. Bring the water to the boil and turn off the stove. This works well during meal preparation times but is less efficient if drinking water is needed during the day. Some forethought and planning are needed.

Silt laden glacier fed streams may also produce uncomfortable gastrointestinal problems. Let the water stand in a pot or bottle. The silt will begin to settle to the bottom. Pour off and use the top. Only a physical filter will remove all the silt. However, pushing significant volumes of silty water through a filter will shorten the lifespan of the membrane and the cartridge will need to be replaced sooner.

Fires

Campfire use is discouraged due to the scarring left behind. If fires are considered necessary, build the fire on gravel or rock surfaces. Fires may be appropriate in established campsites with fire boxes. Do not burn plastic garbage or food waste. However, fire lighting is a skill that must be practiced. The emergency bivouac is a situation where a fire may make the difference between a moderately uncomfortable night and a severely uncomfortable night. Fire starter material will greatly facilitate the process. Commercial products are available, but a few strips of bicycle inner tube are light and do not absorb water, so will work when wet.

PERSONAL HYGIENE

Although mountaineers may have a reputation for minimal personal hygiene, this does not need to be the case. However, some hygiene products can be harmful to the environment. Products such as biodegradable soap still contain a chemical that needs active soil to decompose. Use this sparingly or use an alcohol-based hand cleaner as an alternative. If washing, do so at least 30 meters from water sources. Toothpaste should be treated as food and disposed of as such.

Used personal items (band aids etc.) are packed out.

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Expedition Techniques

Summer mountaineering expeditions are among the most rewarding, and perhaps most challenging outings for a Summer Mountaineering Leader to deliver successfully. The time spent in the mountain environment make logistics complex. Managing group dynamics can become much more involved. Medical issues that may be easier to manage on a day trip or in close proximity may be much more serious on a remote expedition. Adding to these challenges and complexity are the general environmental challenges in remote areas, on bigger peaks and at high altitude.

What is an expedition?

Generally, an expedition is thought to be a trip that is extended in duration and remote in location. The length of time spent on a mountain and its remoteness contribute to the seriousness of the undertaking. Logistics become more complex and group dynamics become more important. Medical considerations can play a much more significant role. Staying healthy and not getting injured become key contributors to success on the mountain.

Considerations for group management on extended trips

Group dynamics play a huge role in the success or failure of a mountain expedition. A shared common vision that defines success is an essential building block. The climbing team consists of individuals who have come together to form an interdependent peer group with a common objective. All actions occur within this social environment. In an expedition setting the group may be isolated from other social interactions. Members may display both their positive and negative interpersonal behaviours. The leadership of this group must be prepared to manage these behaviours.

LEADERSHIP

Situational Leadership is based on the assumption that there is a correct tool for each job. The leader adapts her behaviour to meet the demands of the task and the needs of the group. The leader uses both task oriented behaviours and relationship oriented behaviours to help the group achieve a positive outcome.

Task oriented behaviours involve clearly telling people what to do, how to do it, where to do it, when to do it, and then closely supervising their performance. The behaviours that help move a group towards their goals include: asking for information from the group, giving information, and defining directions.

Relationship oriented behaviours are supportive in nature. They involve listening to people, providing support and encouragement for their efforts, and then facilitating their involvement in problem-solving and decision-making. These behaviours keep group relationships positive and might include: supporting a group member, helping to identify and solve a problem, looking for value in every experience, and treating each-other with respect.

The leader's choice of task or relationship oriented behaviour is based on an assessment of the team members' development levels. This is determined by the follower's maturity and state of readiness to perform a specific task, essentially their competence and commitment.

Group cohesiveness is considered one of the keys to success, however it cannot be implemented or forced onto a group. It must evolve organically from within the group. Essential elements that will help to foster this environment include: a strong social support structure, positively resolved dissonance or conflict, and a compatibility of personal goals that have evolved into a clear set of group goals.

ACC participants on a North Face summer leadership course.

THE LIFE-CYCLE MODEL OF A GROUP

Expeditionary teams that are drawn together for the common purpose of attaining a summit will likely experience a group development process that moves through a life-cycle. The individuals will form a group with a common goal, strive towards that goal and then break apart and go their separate ways. During this process, identifiable stages will be encountered. These stages can be described as:

- Forming – The initial encounter; also known as the honeymoon phase. People tend to be on their best behaviour.
- Norming – Acceptable norms for interaction are negotiated.
- Storming – Conflict may develop as members test boundaries and attempt to assert influence.
- Performing – The group members come together to perform at a high level.
- Separation – The group breaks up and the members head their separate ways. This can be either a stressful time or a joyous time.

CONFLICT

Conflict is an inherent part of the development of the group and when managed properly, can lead to higher levels of productivity. Conflict is often initiated through ineffective group dynamics such as poor communication and static leadership. Conflicts happen when one person's wants and needs are quite different from another person's needs/wants.

It is important to note that there are costs to avoiding conflict. Gossip, griping and general discontent may lead to the building up of anger within one or more team members. The result is stress or tension.

There are numerous potential sources of conflict. They include:

- Differing goals.
- Differing levels of risk tolerance.
- Differing philosophies.
- Differing perceptions.
- Clashing emotional needs.
- Limited commodities.
- Unclear roles and responsibilities.
- Differing ways of doing things.

The wise trip leader will avoid excessive use of authority or threatening. Ignoring the conflict will not make it go away, nor will sarcasm. Proposing a 'Win – Win' resolution, which encourages a sharing of the 'other side' and a sharing of needs and concerns may help the group to collaborate to generate solutions.

FRAMEWORK FOR DEBRIEFING

A three-step process of debriefing an issue or challenging scenario may help to generate solutions.

Step 1 – Describe the event(s) so that everyone has a clear picture of what happened. Keep this to just the facts.

Step 2 – Evaluative the team performance. How well did we do?

Step 3 – Prescribe where we go from here. What is the next step?

Planning logistics for extended trips

There are numerous logistical considerations for extended trips requiring more extensive planning including: medical, rescue, communication, access, food, fuel, and equipment.

MEDICAL

A medical and dental exam will expose potential problems prior to trip. It may be possible to deal with problems before leaving home. Secure a personal supply of medications and keep a list of their potential complications. All participants must have travel medical and evacuation insurance appropriate for mountaineering.

A medical plan should be completed for the group. This will include:

- Relevant medical history (blood type)
- Medical and evacuation insurance numbers
- Dietary considerations
- Disease hazards
- Immunizations
- Rescue resources
- Medical training
- First aid kits
- Drugs

An expedition medical kit.

A list of rescue resources will include:

- Rescue
  - What are the immediate resources?
  - Is there a local rescue service?
  - Do we need insurance for it?
- First Aid
  - What level of training do group members have? (More training may be needed.)
- Transport
  - What forms are available?
  - Poor weather options?
- Hospital
  - What type of facilities are available?
  - How good are the staff?
- Transportation options to home.

The size and extent of the first aid kit will be trip specific, based on the medical training of the team members, types of hazards, length of trip, and distance from care. A variety of kits and sizes may be needed with large kits for base and smaller ones for the upper mountain. Consideration must be given to the types of drugs included in the kit. Drug allergies should be listed in the medical plan. A physician must be consulted to secure prescription medications. Include a list of drugs in the first aid kit that describes all uses, indications and contraindications.

COMMUNICATION

There is a wide range of communication devices available. Unit functionality will depend on the area. Satellite phones will work in most areas. Satellite GPS messengers have greater reliability as they will function with weaker signal than is needed for a satellite phone call. Cellular coverage ranges widely. Generally, there is only coverage in less remote areas. However, there is a cell tower at 5200 m just below Everest providing coverage to the summit.

See Chapter 8 – Responding to Emergencies for further discussion.




ACCESS

Access to more remote areas often involves helicopter or fixed wing flights. These flights are dependent on weather and aircraft availability. Flights are expensive. The load capacity will be dictated by the available aircraft. Increases in either bulk or weight will add to the cost. Careful planning should result in an optimal load/cost/person equation, as the cost starts at around $2000/hour for a small helicopter.

FOOD

Food is the essential building block of any expedition. Insufficient quantity, spoiled, poorly cooked (burnt), poor selection, insufficient variety, or poor-quality food will stop and expedition in its tracks. On an extended trip there is likely no or limited opportunity to acquire more or different food. The exception to this is fishing and gathering.

Long-term food storage may be an issue. In warmer temperatures, food may spoil or go bad. Wildlife, from rodents to bears to birds will take advantage of poorly stored food caches. Food stress is a major potential detractor from an expedition.

Too much food is also an issue. Loads that are too heavy with food are a safety issue. Back or knee issues may be exacerbated. Technical climbing becomes more difficult.

FUEL

Accurate calculation of stove burn rates is important. Climatic conditions will influence stove performance. Cold and wind will result in longer cooking times and greater fuel consumption. Food selection also plays a role as some foods (such as long grain rice) require excessive cooking time. Foods should be selected that require minimal cooking time and optimal flavour and calories.

Choice of stove/fuel type and amounts required vary depending on the length of trip, group needs, anticipated conditions and local availability.

A pulk is an example of specialized equipment that might be needed on a longer trip.

EQUIPMENT

Some specialized equipment may be needed for longer trips. Each team member will have a finite carrying capacity. If the load exceeds the carrying capacity, alternate solutions are needed. Multiple carries are one solution. Sleds are another solution. The options for sleds range from $10 children's plastic toboggans to custom designed fiberglass rigs with all the bells and whistles. The cheaper options work fine for flat glaciers and simple travel. They do not work well on any terrain that involves steep ascents, descents and sidehills. If travelling through heavily crevassed terrain, the sled must be secured to the rope so that if the climber falls in a crevasse the sled does not follow.

Adaptation to environmental stresses

ALTITUDE

Altitude related challenges are an inherent part of mountaineering. Altitude sickness is caused by a lack of oxygen (hypoxia) in the human circulatory system. Air contains 21% oxygen and 78% nitrogen. The percentage of oxygen in the air does not change as a climber ascends a mountain. However, the atmospheric pressure and the partial pressure of oxygen decrease, resulting in fewer oxygen molecules per unit volume. This creates a challenge for climbers to maintain adequate oxygen saturation in the bloodstream.

Fortunately, the human body is able to adapt, however this is a slow process with full acclimatization to 6000 m taking up to four weeks. This means that a patient approach is needed, as the result of going up too fast is altitude sickness, which comes in three forms:

- Acute Mountain Sickness (AMS)
- High Altitude Pulmonary Edema
- High Altitude Cerebral Edema

Responses to altitude

In the short-term the body responds with an increase in respiration rate, increased pulse rate, loss of appetite, difficulty sleeping, increased urine output and decreased blood volume.

Over the long-term acclimatization occurs. These responses include:

- Increased red blood cell count (increased blood viscosity).
- Increased oxygen carrying capacity.

There are a number of strategies that can be used to minimize the effects of altitude.

- What is your starting point? Where do you live, Breckenridge, Colorado at 2926 m or Vancouver at sea level? If you live at sea level spend some time up in a mountain town before heading to the mountain objective.
- Build a base. Add slowly 300 m per day up to 4000 m.
- Climb high and sleep low. Oxygen saturation is lowest while sleeping.
- After 10-14 days spend some recovery time at lower elevations (below 4000 m).
- Hydration is an essential as dehydration will occur due to perspiration, respiration, and urination.
- A water bladder with a hose will help to maintain hydration.

SYMPTOMS OF ALTITUDE SICKNESS

Acute mountain sickness

AMS is an indicator of hypoxic distress which results in mild swelling of the brain.

Symptoms include:

- Headache.
- Loss of appetite, nausea, or vomiting.
- Fatigue or weakness.
- Dizziness or light-headedness.
- Difficulty sleeping.
- Feels like a bad hangover.

High Altitude Pulmonary Edema

HAPE is an accumulation of fluid in the lungs, much like pneumonia.

Symptoms include:

- Extreme fatigue.
- Breathlessness at rest.
- Fast, shallow breathing.
- Cough, possibly productive of frothy or pink sputum.
- Gurgling or rattling breaths.
- Chest tightness, fullness, or congestion.
- Blue or gray lips or fingernails.
- Drowsiness.

High Altitude Cerebral Edema

HACE is an accumulation of fluid in the brain.

Symptoms include:

- Rapid onset.
- Ataxia - staggering walk.
- Confusion, changes in behaviour, or lethargy.

TREATMENT

There is a singular treatment for all types of altitude sickness – descend. It may be possible to treat mild AMS in place. If a rapid ingestion of fluids and NSAID's produces an immediate reduction in symptoms, it may not be necessary to descend. There are also more powerful prescription drugs that may slow the onset of HAPE or HACE long enough for the climber to descend. This is particularly important if bad weather delays the descent.

AMS

- Fluids.
- Acetaminophen, aspirin, or ibuprofen.
- Descend as soon as possible.

HAPE

- Descend immediately.

HACE

- Descend immediately.

Drug treatment

Acetazolamide

- Forces the kidneys to excrete bicarbonate.
- Acts as a respiratory stimulant.
- Accelerates acclimatization.

Dexamethasone

- Potent steroid used to treat brain edema.
- Treats the symptoms.
- Does not aid acclimatization.

Sildenafil (Viagra)

- Vasodilator.
- Improves high altitude exercise performance up to 45%.

A Gamow Bag in use.

Hyperbaric therapy

On final solution is the creation of a pressurized atmosphere. The Gamow Bag is a pressurized bag that can be transported to an afflicted climber. The climber is placed inside the bag. Foot pumps are used to create an atmosphere equivalent to a much lower altitude.

References and further reading

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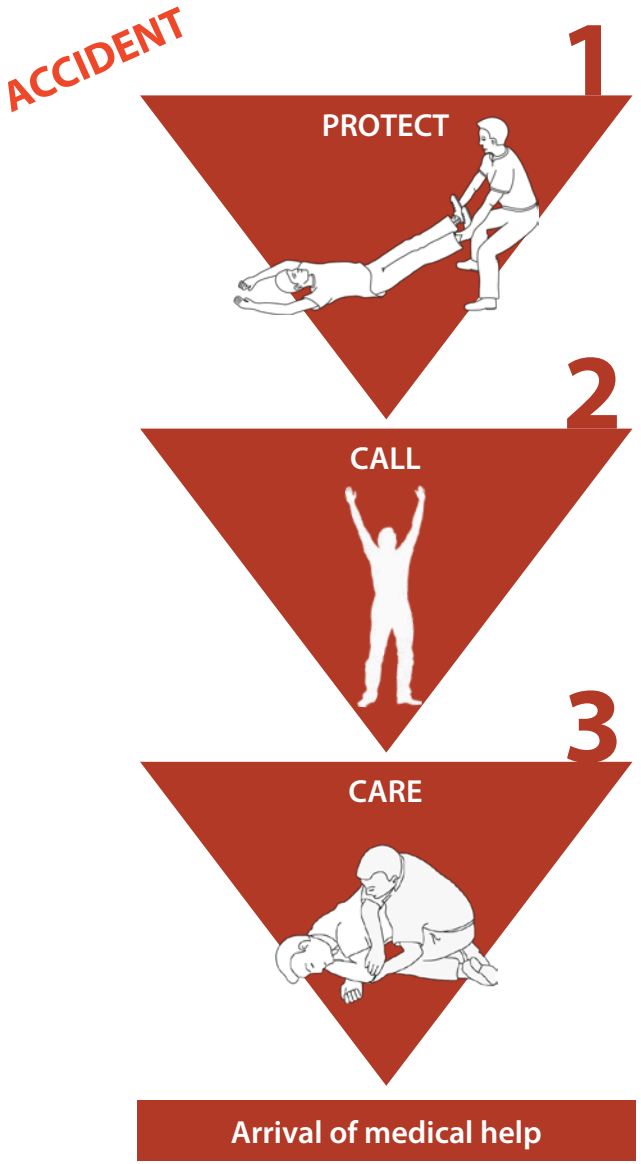
Notes:

Notes:

Responding to Emergencies

Despite best laid plans, Summer Mountaineering Leaders may at times be required to respond to accidents or emergencies within their group or other climbing groups in the area. It is therefore imperative that Summer Mountaineering Leaders maintain first aid currency and be properly equipped to manage the initial stages of emergencies and if necessary seek the assistance of organized rescue for the resolution of more major emergencies. There are many approaches to managing emergencies, in this chapter we will explore the basics of first aid, emergency communication, and how to manage the group if an accident occurs. The basic principles outlined in this chapter are not a replacement for formal first aid training; all Summer Mountaineering Leaders should possess current standard first aid and CPR certificates.



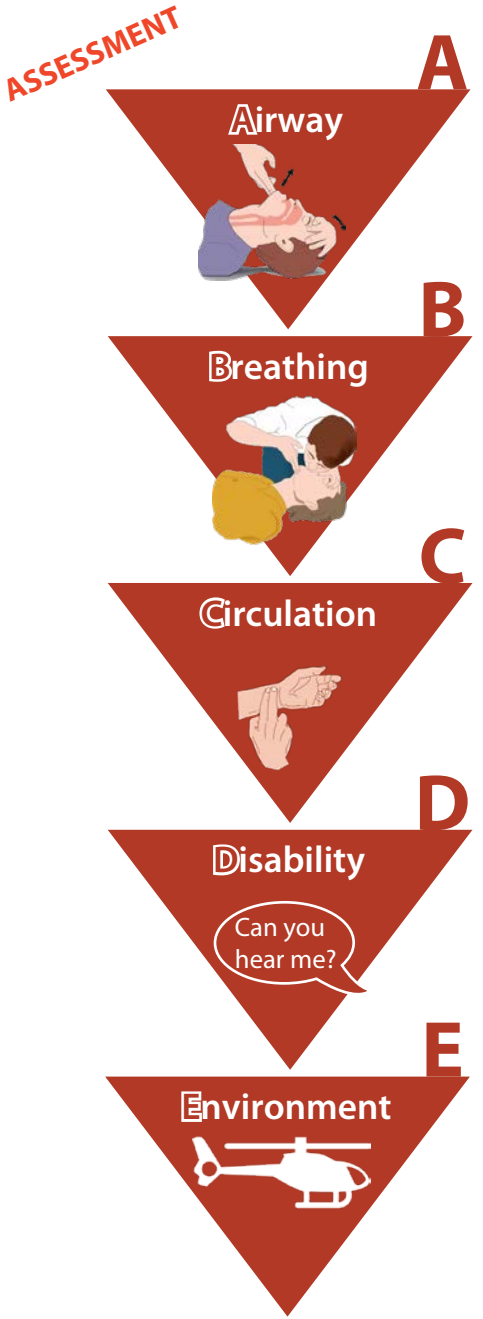
The underlying principles in any emergency situation include; protecting the patient, calling for help if required, and providing initial care and treatment.

Performing first aid

Once the scene has been assessed and deemed safe, or the patient has been moved to a safe location and a call for organized rescue (if required) has been made, the Summer Mountaineering Leader can then provide initial first aid to the victim. Depending on the severity of the injury the general first aid procedures include:

- A (airway), ensuring the patient's airway is unobstructed;
- B (breathing), establishing that the victim is breathing and determining the quality of breath;
- C (circulation), checking for a pulse and the general heart rate over the period of one minute in addition to a quick check for severe bleeding;
- D (disability), determining the victim's level of consciousness and awareness, checking for sensation in all extremities; and
- E (environment), determining the effects the weather will have on the ability to treat the patient, effectuate a rescue, and manage the remaining group members.

Due to the nature of mountaineering activities, the most common accidents are trauma related, and involve bleeding and/or fractures. In the case of bleeding, direct pressure should be applied to the wound site using sterile, non-stick dressings, and if practical the wound elevated above the heart. When dealing with bleeding injuries, the Summer Mountaineering Leader should ensure they protect themselves



Documenting patient information, in the event of an accident, can be beneficial in determining whether the patient's condition is improving or deteriorating, can be useful for organized rescue and emergency medical services, and can occupy a member of the group during an emergency.

and their victim from blood-borne pathogens by wearing gloves. In the case of fractures, small bones should be splinted, immobilized and sensation below the break should be confirmed. Fractures of long bones, such as the femur, require immediate evacuation and may necessitate gentle traction to ensure continuous blood flow below the break to the extremity of the leg.

Common items to include in a first aid kit for a day of mountaineering include:

- Latex gloves
- Antiseptic wipes
- Pressure bandages or dressings
- A good selection of adhesive bandages
- Sterile non-stick pads
- Adhesive elastic bandage
- Non-adhesive elastic bandage
- Medical tape
- Steri-strips
- Moleskin or second skin
- Small scissors
- Nail clippers
- Compact moldable splint
- Triangular bandages

Common medical issues

FEET

The ability to travel on a summer mountaineering trip is entirely dependent on proper foot care. Poorly fitting, overly stiff or just simply unfamiliar boots can be enough to end a trip for a participant. Travelling uphill puts considerable pressure on the heels. This is exacerbated by a stiff boot. Blisters may be the result. Downhill travel puts pressure on the toes. A boot that is too small and or untrimmed toenails may result in bruised and bloody toes.

Prevention

This can be avoided by using a boot that fits well. Both the boot and the foot must be 'broken in'. Feet need to be toughened up in preparation for mountaineering endeavours. During the period that the boot and feet are being broken in, blisters are more likely. A participant with brand new boots (or borrowed boots that do not fit well) and who does not climb on a regular basis will probably get blisters unless preventative measures are taken.

The compounding factors that cause blistering are:

- Friction or pressure
  - This is generated by the quality of the fit between the foot and the boot. It can be adjusted by adding or removing socks. Ideally the boot should be fitted with two socks; a thin sock and a medium to heavy sock.
- Movement
  - Too much movement creates the environment for friction and chafing.
  - Too little movement may cause bruising.
- Moisture
  - Uphill travel typically produces hot and sweaty feet. This moisture softens the skin and makes it more susceptible to blistering.

Treatment

- Prevention is key. Stop the blistering process before it becomes an issue and skin damage occurs.
  - Use good, well-fitting boots.
  - Train your feet.
  - Use two pairs of clean socks and change them regularly.
  - Tape and or pad likely areas before starting.
  - Start with clean and dry skin.
    - Prep the skin with an adhesive.
    - Cut out a Moleskin pad to completely cover the area.
    - Cover the Moleskin with white athletic tape.
    - Commercial blister pads work well too.
- If a hot spot develops, this is an early warning sign of a blister forming.
  - Stop and treat immediately.
    - A ten-minute stop early in the day will translate in to more efficient travel for the remainder of the day.
- If a hot spot has been ignored and a blister has formed:
  - Clean and dry the area.
  - Drain the blister.
  - Apply a skin adhesive.
  - Cut a donut shaped Moleskin pad large enough to protect the affected area.
  - Cover the donut with another layer of Moleskin.
  - Cover with athletic tape.
  - In severe cases, use Second Skin as the first layer.
    - Cover with a donut as above.

Blisters can become debilitating and even life threatening. As an open wound, infection is possible. On a longer mountaineering trip, ongoing wound care is essential. Do not leave the initial bandaging on for several days. Remove, clean and re-dress on a daily basis.

SUN

Solar radiation is both a short-term and a long-term health hazard. Sun damage occurs to both exposed skin and to eyes. The intensity of the solar effect increases with altitude as the atmosphere becomes thinner. The intensity is also magnified by the Albedo Effect as the sun reflects off the white surface of the snow. This can lead to blistering of the roof of the mouth and inside the nostrils.

Prevention is key. Sun exposure is unavoidable, but harm as a result of that exposure is manageable.

Prevention

Sunscreen

- Use SPF 30+ sunscreen (60 SPF is recommended).
- Apply one hour before sun exposure.
- Re-apply regularly (particularly if sweating heavily).
- Use a sun block such as zinc on lips an nose.
- Wash hands after applying, if rock climbing to avoid slippery hands.

Sun hat

- Use a wide brimmed hat.
- Use a cap with neck protection under your helmet.

Sunglasses

- Use mountain sunglasses that have side protection and dark lenses.
- Use a nose flap in severe conditions.

Treatment

- Sun burn
  - Reduce, or better, eliminate sun exposure to the affected area.
  - Apply Aloe Vera cream.
- Snow blindness (Photokeratitis)
  - Sunburned cornea resulting in temporary loss of vision.
  - Eyes will feel irritated, burning, watery and sensitive to light.
  - Eliminate sun exposure.
  - Apply cool wet compresses (tea bags work well).
  - Moisten with saline solution (contact lens solution).

BURNS

On outings where stoves and or fires may be used, the Summer Mountaineering Leader should be prepared for first aid that involves burns. The most common backcountry cooking injury is scalding as a result of pots tipping over. The important consideration with any burn is the risk of infection.

Names	Layers	Appearance	Healing Time	Complications
First Degree Burn Superficial	Skin	Redness	2 – 3 days	Increase risk of skin cancer
Second Degree Burn Superficial Partial Thickness	Extends superficial into dermis	Red with clear blister	1 – 2 weeks	Local infection
Second Degree Burn Deep Partial Thickness	Extends deep into dermis	Red with white bloody blisters	3 – 4 weeks	Scarring contractures and skin grafting
Third Degree Burn	Extends through the entire dermis	Stiff and white/ brown	Prolonged	Scarring, contractures and amputation
Fourth Degree Burn	Extends through the skin, tissue, muscle and bone	Black or charred	Requires excision	Amputation, functional impairment, gangrene and death

Treatment

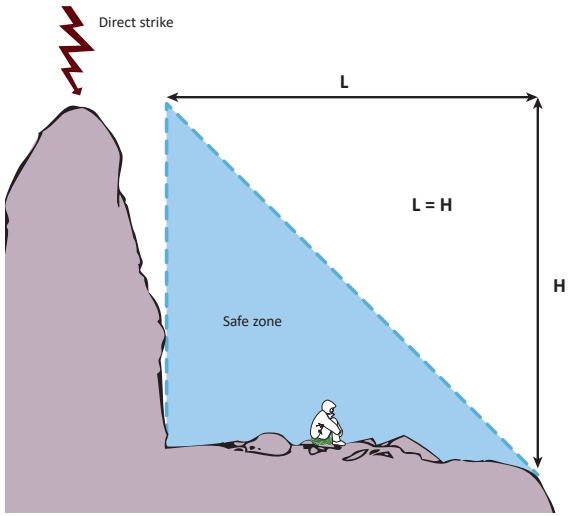
Burns should be immersed in cold, clean water or covered with a cold damp cloth for about 10 minutes followed by covering with dry sterile non-stick dressing. Depending on the severity and location, evacuation may need to be considered.

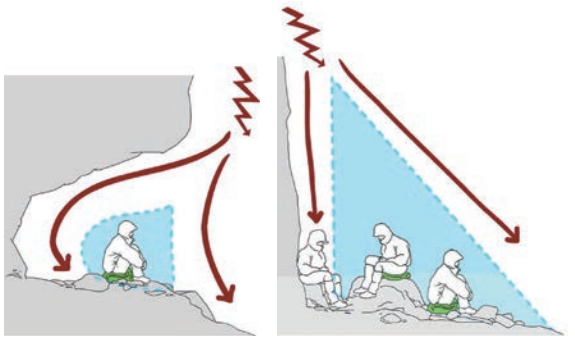
LIGHTNING

Thunder storms are violent and intense events. Caught high on an alpine ridge with minimal retreat options, they can become fatal. Get a good weather forecast and plan ahead for retreat options.

There are a number of mechanisms of injury.

- Direct strike – high likelihood of death, lethal cardiac injury.
  - Will cause partial or full thickness burns.
  - Some degree of protection can be found by hiding next to a high point that is at least 20 metres high. Insulate yourself from the ground.
- Ground strike – fewer major problems.
  - May cause asystole, (cardiac arrest), or respiratory arrest.
  - Spark gap.
- A ground current will arc across small gaps.
- If you are sheltering in a cave, ensure that you are at least a metre back from the opening.





Treatment

Initiate CPR if needed and treat burns.

HYPOTHERMIA

Hypothermia is the lowering of the core body temperature. Although normally thought of as more of a winter hazard, the Summer Mountaineering Leader must also be vigilant. Heat transfer occurs through; convection, conduction, evaporation, radiation and respiration.

Different stages of hypothermia

- **Moderate hypothermia: 35 to 32° C.**
  - Intense shivering.
  - Taciturnity, difficulty speaking.
  - Stumbling, risk of falling.
  - Cannot execute complex movements.

  This is the only stage of hypothermia during which it is possible to warm a victim back up in the field.
- **Severe hypothermia: 32 to 28° C.**
  - Shivering stops.
  - Walking becomes impossible, muscles become rigid.
  - Tendency to curl into the foetal position.
  - Impaired consciousness, stupor.
  - Cardiopulmonary slowdown.
- **Deep hypothermia: 28 to 24° C.**
  - Hypertonic coma.
  - Dilated pupils.
- **Less than 24° C: lifeless appearance.**
  - Cardiac and respiratory arrest.
  - Probable death, but death may occur at higher or lower temperatures.
  - Heart and respiratory rates very low
  - Major risk of cardiac arrest.

Prevention

Hypothermia can become a concern for the Summer Mountaineering Leader, particularly when two forms of heat loss occur at the same time. The combination of wet and wind is a potent force. An afternoon thunderstorm with heavy rain and wind will be enough to induce hypothermia in a poorly clad mountaineer.

Wind in particular can play a significant role in the effect of cold temperatures. Wind chill is the perceived lowering of temperature due to wind. The wind chill effect is amplified as the temperature drops.

Although the Summer Mountaineering Leader may desire to move light and fast; good rain gear, insulation that remains warm when wet and a guide's tarp will go a long way to reducing the potential for hypothermia.

"There is no bad weather in the mountains, only poorly equipped climbers."

Wind Chill Factor / Index

Wind speed (km/h)	What to look for when estimating wind speed	Temperature measured in ° C (first row) and perceived temperature (other rows)									
		0	-5	-10	-15	-20	-25	-30	-35	-40	-45
10	Wind perceptible on face; wind vane begins to move.	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57
20	Small flags flap in the breeze.	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62
30	Wind blows loose paper, large flags flap and small tree branches wave.	-6	-13	-20	-26	-33	-39	-45	-52	-59	-65
40	Small trees begin to sway, and large flags extend and flap strongly.	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68
50	Large tree branches move, telephone lines whistle and it is hard to use an umbrella.	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69
60	Trees bend, and walking against the wind is difficult.	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71

Source: Environment Canada

Recommendations
Slight increase in discomfort. Dress warmly. Stay dry.
Uncomfortable. Risk of hypothermia if outside for long periods without adequate protection. Dress in layers of warm clothing, adding an outer wind-resistant layer. Wear a hat, mittens or insulated gloves, a scarf and insulated, waterproof footwear. Stay dry. Keep active.
Risk of frostnip or frostbite: check face and extremities for numbness or whiteness. Risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold. Dress in layers of warm clothing, with a wind-resistant outer layer. Cover exposed skin. Wear a hat, mittens or insulated gloves, a scarf, neck warmer or face mask, and insulated, waterproof footwear. Stay dry. Keep active.
High risk of frostbite: check face and extremities for numbness or whiteness. Risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold. Dress in layers of warm clothing, with a wind-resistant outer layer. Cover all exposed skin. Wear a hat, mittens or insulated gloves, a scarf, neck warmer or face mask, and insulated, waterproof footwear. Stay dry. Keep active.
Very high risk of frostbite: check face and extremities frequently for numbness or whiteness. Serious risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold. Be careful. Dress very warmly in layers of clothing, with a wind-resistant outer layer. Cover all exposed skin. Wear a hat, mittens or insulated gloves, a scarf, neck warmer or face mask, and insulated, waterproof footwear. Be ready to curtail or cancel outdoor activities. Stay dry. Keep active.
DANGER! Outdoor conditions are hazardous. Stay indoors.

Note: see http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=5FBF816A-1

Treatment

Stop the heat loss. Seek shelter with the guide's tarp. Remove wet base layers and replace with dry insulating layers. Drink hot fluids.

Emergency communications

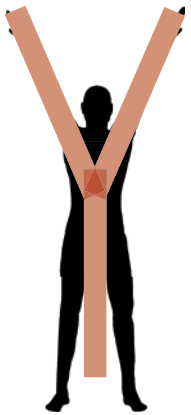
If organized rescue is deemed necessary, communication should be initiated immediately, and the following information provided to the local agency:

- The exact location of the patient.
- The caller's name and telephone number, if the communication is being initiated by phone.
- The nature of the accident and the number of patients.
- The severity of the patient's injuries, if known.
- The level of consciousness of the patient.
- The time of the accident.
- The local weather conditions.
- The size of the group.
- Any first aid actions that have been initiated.

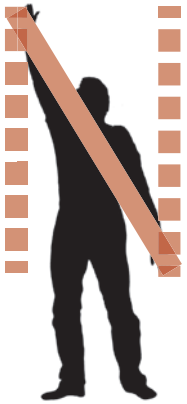
Table to keep in first aid kit:

WHO?	Your first and last name, and where you can be reached.
WHY?	Nature of the accident, number of victims, seriousness of the situation. Is the victim conscious?
WHERE?	Location, route, altitude, etc.
WHEN?	Time of the accident.
CURRENT WEATHER CONDITIONS?	Winds, visibility, etc.

Ensuring that contact information for organized rescue is readily accessible is of crucial importance if an emergency necessitates this service. Phone numbers, radio frequencies and communication devices should be kept together and placed in an easily accessible location in the Summer Mountaineering Leader's pack. Further, the leader should instruct participants in the use of all communication devices at the start of the outing, so they can initiate the call for help if required.



Call for a rescue (Yes)



No need for a rescue (No)

Communication devices

Whether on a day trip or a multi-day outing, preparing for emergency communication is an important step should such an event take place.

Communication devices can include:

- Radios (FRS and VHF)
- Cell Phones
- SPOT
- inReach
- Satellite Phones

Each device has its advantages and disadvantages including cost, ability to connect, and one or two-way communication capabilities. It is important for the Summer Mountaineering Leader to recognize where the outing is to take place and the effectiveness of the chosen communication device being considered.

	Type of Comm.	Advantage	Disadvantage	Cost
Cell Phone	2 way	Conversation	Cell shadows	Low
Radio – VHF	2 way	Conversation	Radio shadows License to use Permission for frequencies	Low to Medium
Radio – FRS	2 way	Conversation – short range	Frequencies outside normal commercial agencies (wardens, lodges etc.)	Low
SPOT	1 way or 2 way (text) depending on model	OK or help signal, 2 way (text) on some models	1 way communication on simple/earlier models	Medium
inReach	2 way (text)	2 way text	May be unsure if or when msg is received	Medium +
Sat Phone	2 way	Conversation	Satellite coverage	High

If organized rescue is coming by ground, designating one or two runners from the group to meet rescue personnel at the trailhead and direct them to the accident site is advisable when the site is difficult to locate or unfamiliar to rescue personnel.

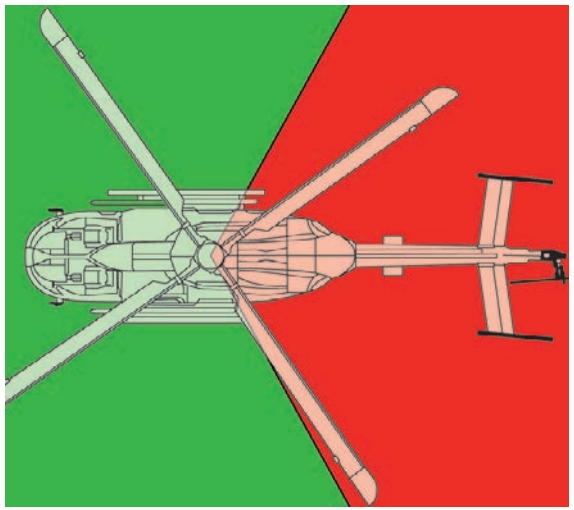
Helicopters

Helicopters are typically the first choice for emergency evacuation. A skilled pilot and rescue team can extricate an injured climber from technical terrain, however there are limitations. The primary reasons that a helicopter cannot perform a rescue are poor weather and darkness. Most rescue helicopters in Canada are only equipped for VFR (Visual Flight Regulations). The Summer Mountaineering Leader must consider the weather, the altitude of the landing area and the type of helicopter that might be available (as this will influence the payload and range). Helicopter pilots are capable of inserting their aircraft into some incredible places, however there are limitations. An awareness of the both capabilities and limitations is essential when requesting assistance.

SAFETY AROUND THE HELICOPTER

There are two components to safety around a helicopter; safety to people and safety to the helicopter. Both the main rotor and the tail rotor are close enough to the ground to strike a person. This is typically fatal. Only approach a running helicopter from the front and only after the pilot has indicated that it is safe. Helicopters are by design an optimal balance of weight and power. This means that many of the parts on a helicopter are easily damaged and when damaged often mean that the machine cannot fly.

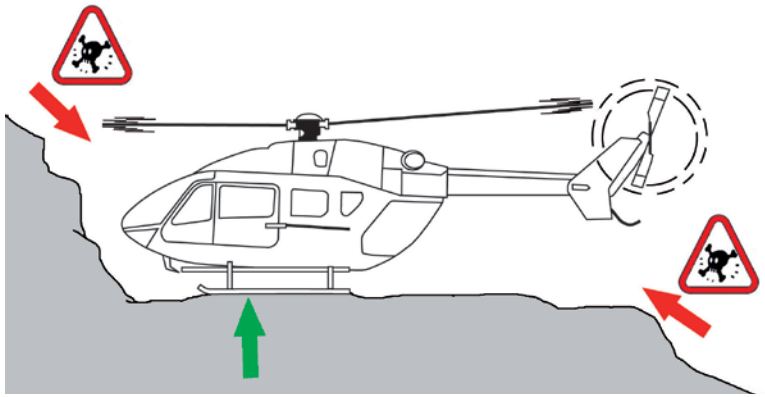
As the helicopter is making its final approach:



- Do a final check for loose objects.
- Wear eye and ear protection.
- Remain stationary.
- Watch the helicopter land.

SELECTING A LANDING ZONE

- Flight lines
  - Both the approach and takeoff flight lines must be considered when selecting a landing area. The pilot will need a fixed visual reference at the landing spot. This can be a one-metre-high stake, ski pole or tree that will not blow away. The best visual reference is a person. Stand with your back to the wind and your arms pointing in the direction that the wind is blowing to.
- Wind intensity and direction
  - Helicopters should be facing into the wind for landing and takeoff. Helicopters can land in fairly strong winds as long as the wind is consistent in both intensity and direction.
- Surface condition
  - The ideal landing pad is flat, solid and debris free.
- Rotor clearance
  - Ensure that there is adequate rotor clearance from trees, rock or snow. In alpine terrain, the pilot may be able to 'toe-in' to a ledge if there is adequate rotor clearance to the rock. If the ledge is not big enough to fully land, the pilot will need to hold power. On a snow slope, dig out a ledge for the skid.
- Equipment
  - Ensure that all equipment is secured and will not blow away or up into the rotors.



Emergency survival skills

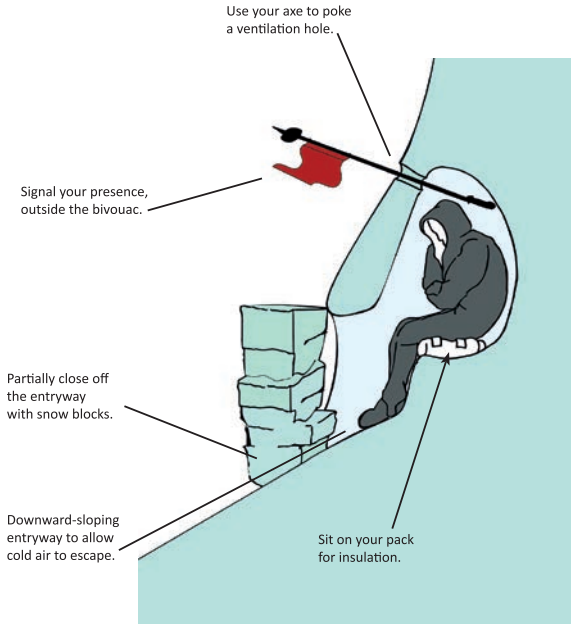
In the event of an unplanned bivouac or an accident, the Summer Mountaineering Leader must be able to provide shelter for the group. This is much easier to achieve below treeline as both a shelter and fire can be constructed.

EMERGENCY SHELTERS

Emergency shelters must protect the group from precipitation and wind. Look for overhanging boulders, caves and natural feature that provide protection. If possible, select a site on rock.

The go-to emergency shelter for summer mountaineering is the guide's tarp. This should be carried on all climbs. It must be large enough to shelter the whole group. Multiple tarps will be needed for larger groups. However, a guide's tarp alone is rarely sufficient. It must be used in conjunction with some form of wind block. This can be the lee side of a wind exposed ridge, or a wall constructed from rocks or snow.

Snow shelters can also be constructed. However, dense summer snow can be difficult and time consuming to work with, particularly with just an ice axe. A shovel will dramatically accelerate the construction process. A huge amount of energy may be needed to construct an adequate shelter. Move the least amount of snow possible. Look for sites at the edge of snow slopes. Often a moat can be enhanced to provide shelter.



FIRE LIGHTING

When at treeline or below, fires are an additional resource to provide warmth, cooking, melting snow for water, and or psychological comfort in the event of an emergency. Practiced fire lighting skills are an essential component of the Summer Mountaineering Leader's toolkit that will increase the group's comfort level in an emergency situation. If it appears that the group will be spending the night out in an emergency situation, sufficient wood must be gathered to sustain the fire through the night. It will take more wood than anticipated to sustain a fire throughout a night and it is much more challenging to collect wood when it is dark, hence enlisting the assistance of participants as soon as it is evident a night out is likely. Although starting fires with natural material is an essential skill, the Summer Mountaineering Leader should carry some form of fire-starting material. Small strips of bicycle inner tube are lightweight and compact.

Group management in emergency situations

Summer mountaineering leaders need to be cognizant of all group members in the event of an accident. While the patient may require immediate attention, uninjured members of the party often also require care and monitoring. If possible and practical, providing uninjured group members with tasks that assist in the management of the emergency situation may help occupy them. Common tasks group members could complete in an emergency include:

- Assisting with first aid and documenting patient history and vitals.
- Monitoring patients with non-life threatening injuries.
- Creating a shelter and or fire.
- Meeting organized rescue at the trail head.
- Inventorying the group's collective resources (gear, supplies and individual skills/training).
- Safety oversight (people can do unexpected and unpredictable things when adrenaline is flowing – safety of the responders remains the first priority).
- Technical oversight i.e. building anchors, fixed lines, hauling/lowering systems, etc.
- Constructing a flat landing pad for a helicopter.

Normally, the leader would personally handle the content of external communications, but circumstances may suggest also delegating this under supervision. The leader may consider delegating the technical aspects of establishing and maintaining external communications links with rescue agencies if communication cannot be established from the accident site. When doing so, the leader should write specific notes, so important information remains consistent in the communication process.

If conditions allow, it is desirable that the leader remain in a supervisory, hands-off role. This will allow the leader to maintain oversight of the entire scene, plan ahead, allocate tasks and resources, and supervise. This will only work when there are group members with appropriate skills (training) in advanced first aid, shelter construction, technical skills etc. An effective leader is sensible, seeks advice, delegates wisely and, most importantly, takes charge and makes decisions.

References and further reading

Dill, J., 2000, *Staying Alive, Yosemite Valley Free Climbs,* (pp. 22-31), SuperTopo, Mill Valley, CA

UIAA (2013), *Alpine Skills Summer: Basic knowledge – Alpine hiking – Climbing – Alpinism*, The Petzl Foundation

Wilkerson, J., Moore, E., & Zafren, K., (Eds) (2010) *Medicine for Mountaineering and Other Wilderness Activities 6th Edition*, The Mountaineers Books, Seattle, WA.

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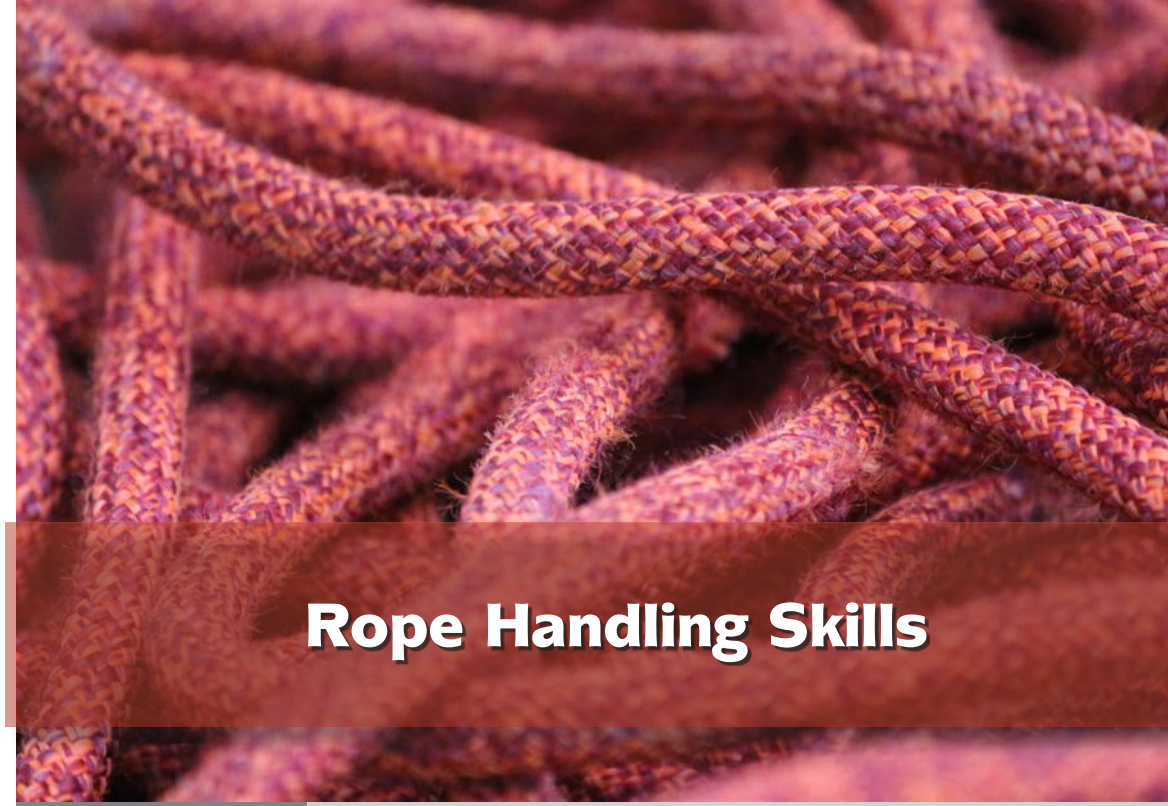


Rope Handling Skills

In this chapter we will explore the rope handling skills needed to create the full range of technical systems used by a Summer Mountaineering Leader. This includes tying climbing knots, constructing anchors, setting up a rappel, lowering a climber, ascending a fixed rope and descent and belay techniques for lead climbers and seconds.

Equipment

With the exception of helmets and personal gear, most technical equipment can be classified into one of two categories: either hard goods such as carabiners and belay/rappel devices; or soft goods such as ropes, cord and slings.

SOFT GOODS

Ropes

Ropes come in two varieties: Climbing (dynamic) ropes which are designed to absorb force and dissipate it through their elongation; and Rescue (low stretch and static) ropes which are designed for hauling and lowering applications and need to minimize stretch.

Static and low stretch ropes have a listed breaking strength.

Dynamic Rope Designations

Dynamic ropes do not have a listed breaking strength. Instead they are tested for dynamic elongation and impact force. They must be able to hold at least five standard UIAA test falls. Read the hang tag on your rope to ensure that you have the right tool for the job.

Rope diameter	Static Breaking Strength
5 mm Tech	22.7 kN
6 mm	7.7 kN
7 mm	13.3 kN
8 mm	17.3 kN
11 mm	36.3 kN

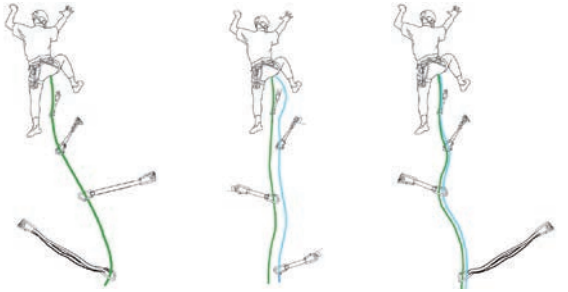
(See Chapter 11 for more information on Climbing Physics)

Single – Used by itself as a lead rope. Thicker ropes are more abrasion resistant and resistant to cutting over a sharp edge.

Designation	Diameter	Test Falls Held	Test Load	Impact Force	Dynamic Elongation
Single	8.6-11	5+	80 kg (single strand)	8-9 kN	25-28%
Double	7.3-9.1	5+	55 kg (single strand)	5-7 kN	29-35%
Twin	6.9-8.6	5+	80 kg (double strand)	8-9 kN	27-32%

Half – Double rope techniques. Used in pairs for lead climbing on hard technical rock routes that wander. Reduces rope drag. Only one rope is clipped into each protection piece.

Twin – Used in pairs. Both ropes are clipped into each protection piece. Usually lightest combination when two ropes are needed for the descent.



In the mountaineering context, dynamic ropes rated by the manufacturer as 'single ropes' should be used for all belayed climbing activities. In an effort to make dynamic climbing ropes lighter, many rope manufacturers have developed lower diameter single dynamic climbing ropes. These ropes have been tested for all three UIAA designations.

Lightweight low diameter dynamic climbing ropes have many applications in the multi-pitch climbing environment, particularly alpine climbing and glacier travel. For durability, ease of handling, and belaying purposes, dynamic climbing ropes in the 9.6 millimetre to 10.4 millimetre range are recommended for traditional multipitch climbing, 9 mm to 9.6 mm for alpine ice and glacier travel. A relatively 'fat' rope (9-10 mm) is easier to grasp when used in short-roping applications.

Materials

Accessory cord and webbing are available in two types of materials – nylon and Ultra High Molecular Weight Polyethylene (UHMWP). The brand names for UHMWP include Dyneema®, Spectra® and Dynex®.

Cord

Cord, commonly referred to as accessory cord, is lower diameter static rope that can be used to create hitches. Seven-millimetre nylon cord is the preferred diameter for rope ascending, anchor construction, and for improvised rescue applications. Due to its lower diameter it is important that the Summer Mountaineering Leader understand the strength limitations of cord, and ensure that in any full-load bearing application the cord is doubled. Two five-metre lengths, and one 1.75 metre section of cord are commonly carried by Summer Mountaineering Leaders.

Slings

Slings are commercially sewn closed loops of nylon or Dyneema material that come in a variety of lengths. They are commonly used to connect carabiners to create an extension from a protection point to the rope, to construct anchors, or as a lanyard when tethering to an anchor. Slings and webbing work well for slinging horns as they are more resistant to rolling than cord.

Properties	Nylon	UHMWP (Dyneema)
Knots	Ends can be joined with a knot. Loses less strength when knotted.	Ends must be sewn together. Loses more strength when knotted.
Stretch	Higher stretch	Lower stretch
Static Strength	Lower strength for a given diameter.	Higher strength for a given diameter.
Melting Point	245° C	145° C
Yield Temps.	Considerably lower than melting point.	80° C
Lifespan	5 years	3 years
Cost	Lower	Higher

Webbing

Whenever practical it is preferable to use commercially sewn slings rather than bulk nylon webbing. However, having a 3-4 metre section of webbing in your pack is an economical alternative to leave behind for a rappel anchor.

Webbing examples: Left to right - bulk nylon webbing, a sewn Dyneema sling, and sewn nylon sling.

Harness

Mountaineering harnesses need to be commercially manufactured sit harnesses designed for climbing. They must have a designated waist belt, leg loops, a vertically oriented belay loop, and gear loops. The leg loops need to be adjustable so that they can fit over boots and crampons. It is also useful to have the ability to drop the back of the leg loops in case nature calls. Look for a harness that is low on weight and bulk, and high on adjustability.

Weakening, damage and deterioration of soft goods

There are numerous ways to weaken, damage or shorten the lifespan of soft goods.

- Nylon ropes, cord and webbing lose up to 30% of their static strength and 70% of their dynamic strength when wet or frozen.
  - They will also be harder to use.
  - Note: Dyneema absorbs less water and does not lose strength when wet.
- Ropes, cord and webbing will melt, but will not sustain significant damage in a typical climbing scenario. The one scenario that will cause significant damage is nylon running over nylon over a prolonged period. Pulling a rappel rope through a nylon sling once will cause minor damage. Doing it many times will eventually compromise the integrity of the sling.
  - Nylon melts at 245° C.
  - Dyneema and Spectra (Ultra High Molecular Weight Polyethylene) melt at 145°C.
  - A heavy climber, doing a high-speed rappel will generate up to 135°C at the rappel device.
- Fine grained rock dust and debris will work its way into the core of a rope and cause damage to fibres.

- The ultraviolet radiation in sunlight will weaken soft goods over time. Materials become bleached and stiff. UV rays are more intense at altitude, so the deterioration is accelerated.
- Chemicals can cause significant damage, particularly acids.
  - Battery acid and even fumes will leave no visible damage but the material will not hold body weight.
  - Uric acid (urine) will cause damage. Do not pee on your gear!
  - Gasoline will only cause minimal damage.

HARD GOODS

Carabiners

Carabiners can be either locking or non-locking and are constructed of aluminum. The majority of carabiners used in modern climbing activities are aluminum due to their lightweight properties in comparison to steel.

Non-locking carabiners may be used at non-critical connection points. These are the connection points in a technical system that would not have catastrophic consequences if they were to fail. All critical connection points in a technical system should employ locking carabiners. In situations where movement of the critical connection point is anticipated, such as the clip in point to the harness for glacier travel, a triple locking action carabiner, or two locking carabiners should be used.

Belay and rappel devices

Belay and rappel devices can be either manual braking (i.e. ATC) or assisted braking (i.e. Gri-gri). Manual braking belay devices create friction by forcing tight bends into the rope. Assisted braking belay devices employ either a moving component, or binding action on the rope to create friction. In some instances, the use of assisted braking belay devices may be preferable as these devices can increase participant comfort and safety. Manual belay and rappel devices may be preferable for rappelling activities or for instances where participant belayers have previously demonstrated competency in their belay skills.

Helmet

Helmets designed for the purpose of climbing must be worn at all times when a fall or overhead hazard is present.

INSPECTIONS AND LIFESPANS

Prior to using any equipment, it should be visually and manually inspected to ensure it is fully operational and in good repair.

Equipment inspections

Soft goods such as ropes, slings, and harnesses should be visually inspected and manually manipulated to check for excessive wear, and/ or inconsistencies in material shape or feel prior to use. Notable hard spots, soft spots, signs of excessive abrasion, melting, and/ or inconsistent feel are indicators of damage and the need for the equipment to be removed from use. Climbing helmets should be checked for cracks in the outer shell, damage to inner foam, and proper functioning of all sizing and fitting components. Hard goods such as carabiners and belay devices should also be inspected prior to use. Excessively worn carabiners and belay devices (more than 25% of the material diameter), sharp edges created by wear, and poor operation of moving components such as carabiner and assisted braking device hinges, all indicate damage and removal from use.

Many modern climbing harnesses are constructed with 'wear indicators' at the tie-in points. When wear indicator 'threads' appear at tie-in points, this signifies the need to remove the harness from further use.

Equipment lifespans

All commercially manufactured soft goods are given a maximum usable lifespan. For most nylon goods this is five years from the date of manufacture. Inspection records and date of manufacture should be tracked for all soft goods being used for mountaineering activities. In situations where a piece of equipment has attained the manufacturer's maximum usable life span, it must be retired even if it appears to be in good repair. Hard goods have a longer lifespan and should be retired once there are visible signs of damage or significant wear.

Due to the nylon chin strap and degrading properties of the foam used in climbing helmets, their maximum usable lifespan is often consistent with that of other soft goods.

Knots

Knots are used in ropes and sling material for three main purposes: to create closed loops that allow the connection of various components in a technical system; to create a barrier at the end of a rope; and to connect two pieces of material together.

Bight loop knot.

Terminology

Knot – Attaches rope or webbing to itself.
Bend – Connects the ends of two ropes or webbing.
Hitch – Attaches rope or webbing to another object.
Bight – A bight is an open loop.
Loop – Similar to a bight but the material crosses itself and forms a closed loop.
Running End – The free end of the rope that is used to create the knot.
Tail – The free end of rope after the knot has been formed.

Well dressed knot vs poorly dressed knot

Dressing and setting

Maximise the strength of the knot by dressing it properly. Avoid any unnecessary crosses in the knot. Pull each strand individually to tighten the knot.

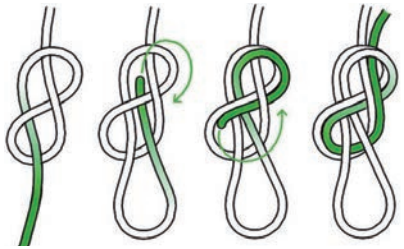


Figure Eight Follow Through

Figure Eight Follow Through

The figure eight follow through knot is the preferred tie-in knot. It is easy to inspect, relatively easy to untie after being loaded by body weight, and it is a highly secure knot that will not untie without external manipulation. A properly tied figure eight follow through knot will possess the following characteristics: minimal twists in the rope throughout the knot; tight and consistent bends throughout the knot; and a minimum of ten centimetres of 'tail' extending from the knot. The figure eight follow through knot can also be used to connect a rope to a natural anchor point such as a boulder or tree.

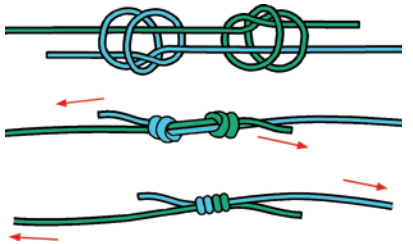
Figure Eight on a Bight

The figure eight on a bight is an efficient means of creating a closed loop in the end of a rope when the end does not need to be passed through or around an object. A properly tied figure eight on a bight will possess the same characteristics as a properly tied figure eight follow through knot.

Figure Eight on a Bight

Double Fisherman's (Double overhand bend)

The double fisherman's knot is an in-line knot that is used to join two ends of similar diameter rope together. In the mountaineering context its primary applications are to create a closed loop in cord. A properly tied double fisherman's knot will demonstrate the opposing double overhand knots seated together in unison; and each knot will possess a minimum of 10 centimetres of tail.

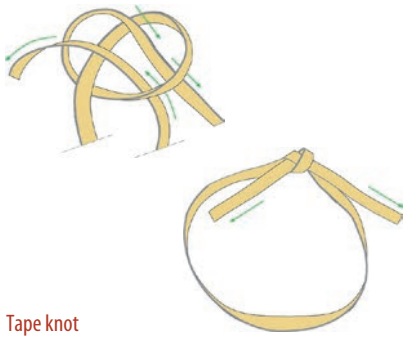


Double Fisherman's Knot

Flat Overhand Bend

In low-load scenarios that are 6-8 kN or less, a flat overhand knot can be used to connect two ends of similar diameter rope. It is the preferred knot for joining two rappel ropes together, as the knot will 'stand up' and roll over edges. A second flat overhand should be tied behind the first and a minimum of 30 centimetres of tail should be present. The flat overhand is also used to create closed loops in the tails of a 5-metre prusik cord or to connect a short prusik cord to the harness as a rappel back-up. A properly tied flat overhand will be free of excessive twists, possess tight and consistent bends, and a minimum of 10 centimetres of tail.

Flat Overhand Bend

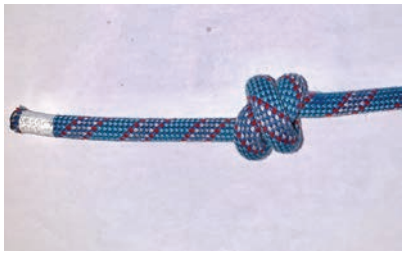


Tape knot

Tape knot (water knot, ring bend)

The tape knot, is used to tie the ends of webbing into a closed loop, or to connect two pieces of webbing together. A properly tied tape knot will sit flat with no twists and possess a minimum 10 centimetres of tail extending from both sides of the knot. Tape knots left tied in webbing will 'creep' and loosen over time, for this reason it is recommended that they be removed following each outing.

Double overhand knot



Double overhand knot

The double overhand knot is used as a blocking knot in the end of either a dynamic climbing rope to prevent the rope from passing through a belay/rappel device. It is commonly used in lead climbing and rappelling applications. A properly tied double overhand knot will create an 'X' pattern in the rope, be tight on itself, and possess a minimum of 10 centimetres of tail.

Hitches

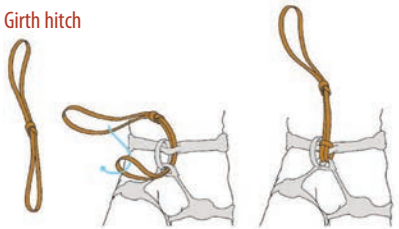
A hitch is similar to a knot however it has the ability to conform to the size and shape of the object to which it is connected.

Basket hitch

Clove hitch

Basket hitch

The basket hitch is commonly used to connect natural anchor points into a large anchor configuration, or to extend the focal point of an anchor. It is the least complex of all the hitches and involves little more than wrapping the hitch material around a fixed object.



Girth hitch

Girth hitch

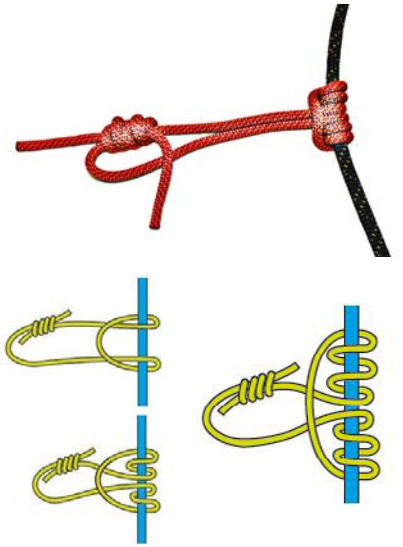
The girth hitch is commonly used to connect a sling to the tie-in points of the climbing harness for lanyard and rappel applications.

Clove hitch

The clove hitch is commonly used to attach to an anchor with the climbing rope.

Prusik

The prusik is a multidirectional hitch commonly constructed with cord, that provides rope grabbing properties. It is used to ascend both loaded and unloaded ropes, as a means of backing up a rappel, and in rescue applications. Two or three wraps may be required depending on the difference in diameter between the cord and the climbing rope, or whether the prusik is being used in a load-bearing application or as a back-up. In load-bearing applications, a three wrap prusik should be used. In non-load bearing applications where the prusik is acting solely as a back-up, such as rappelling with a prusik below the rappel device, two wraps may be preferable. Cord suppleness also plays a role. Some cords are more tightly woven and do not grab as effectively as a more supple weave.



Prusik

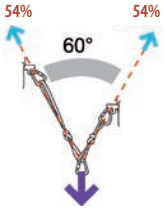
Italian Hitch

The Italian hitch is a multidirectional, friction-creating hitch that can be constructed on any large locking carabiner. It is used for lead belaying, lowering or belaying a second. Compared to modern manual braking belay devices, the Italian hitch has relatively low friction creating properties. Similar to modern belay devices the Italian hitch creates friction by forcing bends into the climbing rope. Unlike manual and assisted braking belay devices, the friction creating properties of the Italian hitch are maximized when the brake rope is placed parallel to the rope connected to the climber. For this reason, the hand pattern used when belaying with an Italian hitch differs somewhat from typical belay techniques. The brake hand must continuously maintain control of the brake rope; however, it should do so in a manner that keeps the brake rope parallel to the rope connected to the climber at all times.

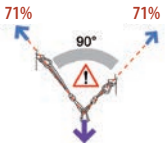
Italian hitch

Anchors

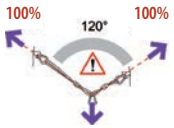
Less than 45 degrees - This is ideal: the anchors share the load equally, at 50 percent.



60 degrees - Still acceptable, because the load is distributed nicely between the anchors.



90 degrees - Barely acceptable.



120 degrees or more - Load distribution is unsafe—each piece may be subjected to greater forces than if left unequalized.

A well-constructed anchor is one that is: able to withstand all potential forces; is efficient to construct; and requires a minimal amount of equipment. The anchor should also be positioned to facilitate belaying the second up and potential rescue.

ANCHOR CRITERIA

The overall quality of a constructed anchor can be assessed by ensuring it meets all of the criteria listed below.

Integrity

Integrity refers to the overall strength of the material and anchor points used throughout the anchor configuration. When building large anchors from natural protection such as trees and boulders, where the integrity is unknown, caution should be used to ensure that these anchor points will unquestionably hold all anticipated loads.

Doubled

Doubled refers to the principle of redundancy within the anchor configuration. This means that there should ideally be a minimum of two anchor points, and that the master point of the anchor is comprised of a minimum of two strands of anchor material. However, there will be mountaineering situations where a single anchor point is used and the redundancy comes from other movement strategies such as using a piece of terrain to reduce the load on the anchor.

Equalized

Equalized refers to the load being evenly distributed to each anchor point. This can be achieved by ensuring that the master point evenly bisects the angle created by the anchor arms. Due to the many variables that affect load distribution on an anchor, it is nearly impossible to attain true equalization. A Summer Mountaineering Leader should strive towards distributing the anticipated load as evenly as possible on each anchor point, recognizing that true equalization may not be achieved.

Angle

In order to minimize the multiplication of force on the anchor points, the angle between the anchor arms should be kept between 20 and 60 degrees when practical. At no point should the angle exceed 90 degrees.

Limited extension

Any potential extension, and subsequent shock loading of the anchor that could occur due to the failure of an anchor point, needs to be limited. In the case of a unidirectional anchor this can be achieved by creating a master point. Whereas in a multidirectional anchor configuration, extension limiting knots must be used.

Sharp eEdges

Any sharp edges in contact with an anchor should be addressed. This can be done by ensuring that no moving components within an anchor are laying or abrading against or over a sharp edge.

BELAY ANCHOR CONFIGURATIONS

Anchors can be constructed in one of two manners, either in a unidirectional configuration that is designed to take force in a single direction only, or in a multidirectional configuration that is designed to hold loads in all directions.

Unidirectional anchors

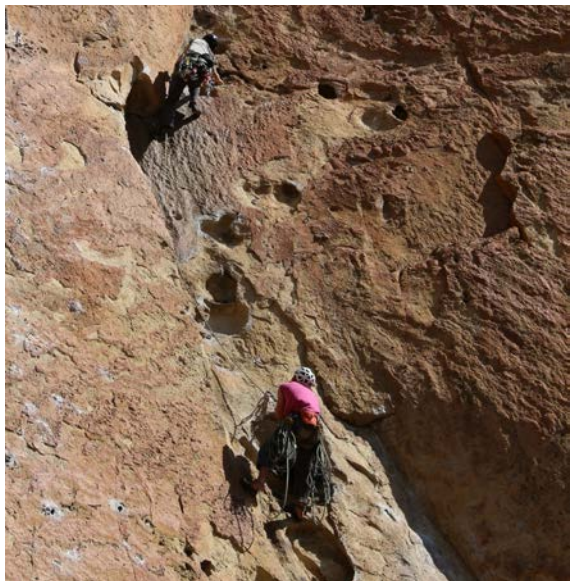
Unidirectional anchors are used to hold only a downward pull. They are used for rappels, single pitch climbs, or when transitioning from technical climbing to walking or short-roping terrain.

Multi-directional anchors

Multidirectional anchors are needed when there is any chance that the belayer will be pulled upward. All anchors used for multi-pitch climbing must be multidirectional. Bolts and pitons are inherently multidirectional, but traditional gear anchors are typically not. Nuts and cams are oriented in the direction of load. A nut oriented for a downward force will rip out if it is exposed to an upward force.

Multidirectional anchors will be covered in Chapter 11.

Lead Belaying on Zebra Zion



Belaying

Belaying is a means of moving the climbing rope through a belay device or friction creating hitch, avoiding unnecessary slack in the climbing system and minimizing the potential distance a climber would fall.

LEAD BELAYING

Manual braking devices are preferred for traditional rock climbing and alpine climbing, while assisted braking devices have added benefits for sport climbing. It is easier to provide a dynamic belay with a manual braking device, which puts less stress on the protection pieces. The belayer needs to be attentive to the needs of the lead climber. If the climber is highly competent and moving quickly, the belayer must keep pace with feeding the rope quickly enough. If the climber is hesitant and may fall off, the belayer must be ready to catch. Watching the climber will provide hints as to how the lead is going, but once the climber is out of sight, the belayer relies on clear verbal communication. Many of the recent climbing accidents are the result of poor communication.

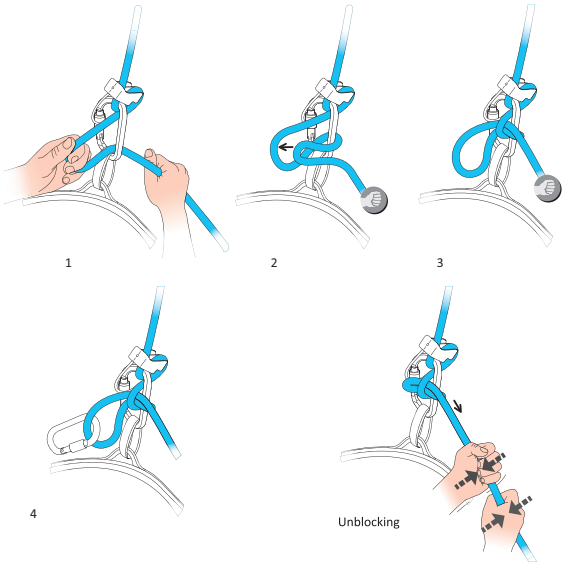
- Make sure the rope is flaked out and will feed smoothly.
- Conduct a partner check to ensure that everything is correct.
- Wear leather gloves to preserve your hands.
- Spot the climber up to the first piece of protection.
- Keep the rope fairly snug once the first piece is clipped.
- Stand close to the wall.
- Assume a brace position to avoid being slammed into the wall.
- Be prepared to feed rope when the climber wants to clip the next piece.

Manual and assisted braking belay devices

When belaying with either a manual or assisted braking belay device, the friction creating properties of the device are maximized by forcing tight bends into the rope, or enabling the binding action of the belay device to properly engage. Regardless of the device used, the belay pattern should remain consistent and involve the belayer's brake hand continuously in control of the brake rope. The brake hand should also be positioned below the device in the most mechanically advantageous position any time slack is not being removed from the climbing system.

Belay device tie-off

Tying off a belay device is an essential skill. It is often one of the first steps in completing a rescue from above as it secures the injured climber. It is always desirable for a tie-off to be releasable under load, the preferred method for tying off a belay device is to tie an overhand slip knot around the loaded rope with the brake rope and then secure the tail of the slip knot by tying the bight around both the load and brake strands of the rope with an overhand knot.



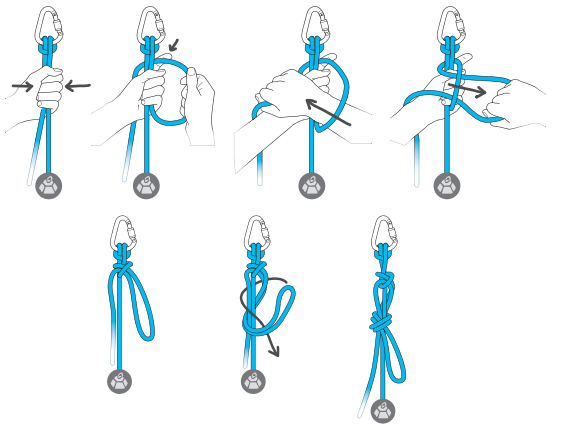
Tying of a belay device so it is releasable under load. The brake is pulled through the belay carabiner and an overhand slip knot tied with it around the carabiner. The loop of the slip knot is secured with a carabiner to block it from coming undone. Alternately, the tail of the slip knot could be secured with an overhand knot on a bight similar to the example shown in the next diagram sequence below. Unblocking the knot is accomplished as shown.

BELAYING THE SECOND

It is preferable to belay directly off the anchor with an auto-blocking style device. However, there will be situations where it will be better to redirect the rope through the anchor and belay off the belayer's harness.

Direct anchor belay

Italian Hitches and 'guide style' belay devices can be used to belay directly off the anchor. The Italian Hitch requires constant management; however, it can be easily flipped into lowering mode. The auto-blocking mode of a 'guide style' device makes it easier for the belayer to multi-task; assessing the route ahead, lap coiling or stacking the rope, etc. while still maintaining a



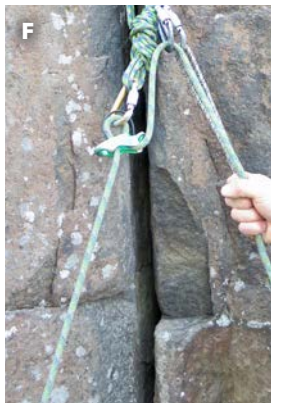
Tying off an Italian hitch belay. An overhand slip knot is tied around the loaded rope with the brake rope. The tail of the slip knot is then secured by tying the bight around both the load and brake strands of the rope with an overhand knot.

quality belay for the second. It also places less physical demand on the belayer. Two climbers can be belayed simultaneously.

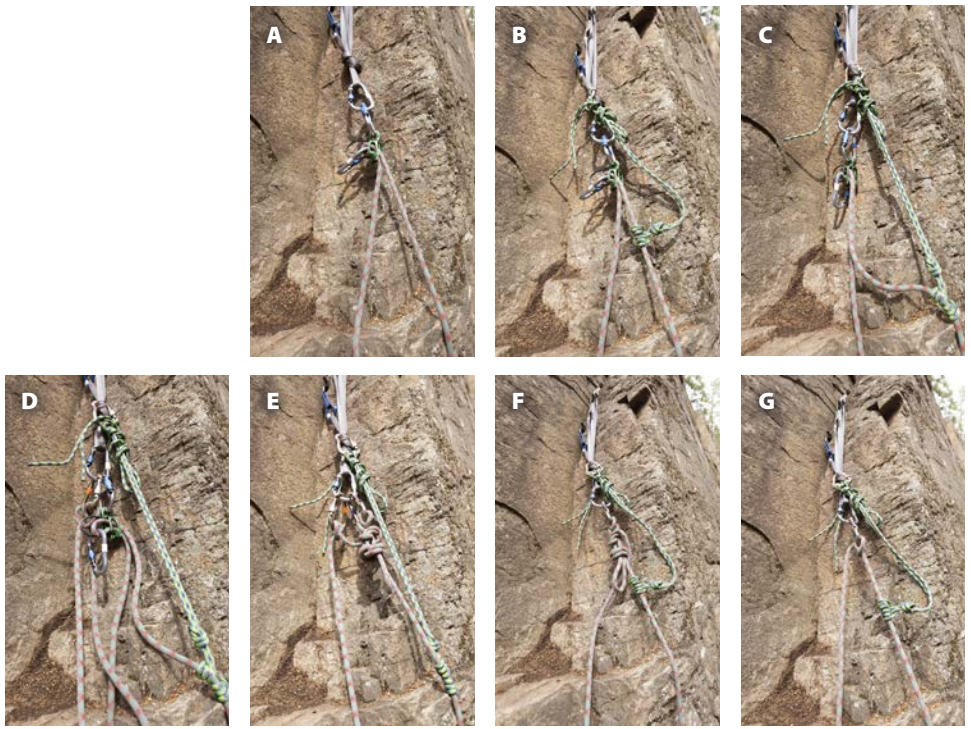
The disadvantage of the device is that it is not easy to lower the climber. If the rope is not under load, slack can be fed out. However, if the climber falls and needs to be lowered the device has shortcomings.

Methods for lowering

- Method 1
  - Ratcheting the back carabiner will release a small amount of rope, but is inefficient for a long lower.
  - Extreme caution is warranted when using this technique. Anecdotally there have been several close calls where the rope has slipped and much more rope than planned has been released quickly resulting in the second being lowered too rapidly or further than intended.
  - Use of a catastrophe knot is recommended when using the ratcheting technique to prevent unintended slips or accidents. Ratcheting is generally not the preferred method for lowering using an auto-block device.
- Method 2
  - The auto-block release hole must be used carefully. The nose of a carabiner or a thin spectra sling is inserted into the hole. This allows the device to be levered up, releasing the rope. The release comes quickly, so an additional method of controlling the rope is necessary.
    - Redirect the spectra sling through the anchor and clip it to your belay loop.
    - Redirect the brake strand through the anchor (shelf or focal point).
    - Add a prusik or an Italian hitch to the brake rope and clip it to your harness belay loop.
    - Lean back to release the blocked device.
    - Slowly feed out the brake rope.
  - Lean in to allow the auto block to re-engage.
- Method 3
  - Tie a catastrophe knot to back up the system during the load transfer (B).
  - Attach a prusik to the loaded rope (C).
  - Attach the prusik to the anchor (shelf or focal point) with a tied off Italian hitch; or if using a Purcell prusik clip the shortened loop to the anchor (C).
  - Release the load onto the prusik (Method 1 – ratcheting) (C).
  - Clip the autoblock device to the focal point of the anchor so it is in traditional belay/lower mode (not autolocking mode) and the top belay hole is no longer clipped to the anchor (D).
  - Redirect the brake strand through another carabiner clipped to the shelf or an upper piece on the anchor (E).
  - Take the slack out of the brake rope and ease the load onto the brake rope by releasing the tied off Italian hitch or, if using a Purcell prusik, sliding the doubled prusik (E).
  - Either remove the prusik, or leave it in place as a backup while lowering (it will need tending).
  - Lower a short distance to verify the system is working as planned, and if so, release the catastrophe knot.
  - Lower (F).
  - Should it become necessary, you can easily switch back to autolocking belay mode by clipping the carabiner in the top belay hole onto the anchor shelf.



- Method 4 – Convert to a direct anchor Italian hitch lower
  - Attach a prusik to the loaded rope (B).
  - Attach the prusik to the anchor (shelf) with a tied-off Italian hitch, or Purcell prusik (B).
  - Release the load onto the prusik (Method 1 - ratcheting) (C).
  - Attach the rope to the anchor with a clove hitch (1.5 meters from the belay device) (D).
  - Add a tied-off Italian hitch with the rope, between the belay device and the prusik (E).
  - Remove the belay device (F).
  - Transfer the load from the prusik to the rope (onto the tied-off Italian hitch) (G).
  - Remove the clove hitch.
  - Remove the Italian hitch tie-off.
  - Lower while managing the prusik.



Rappelling

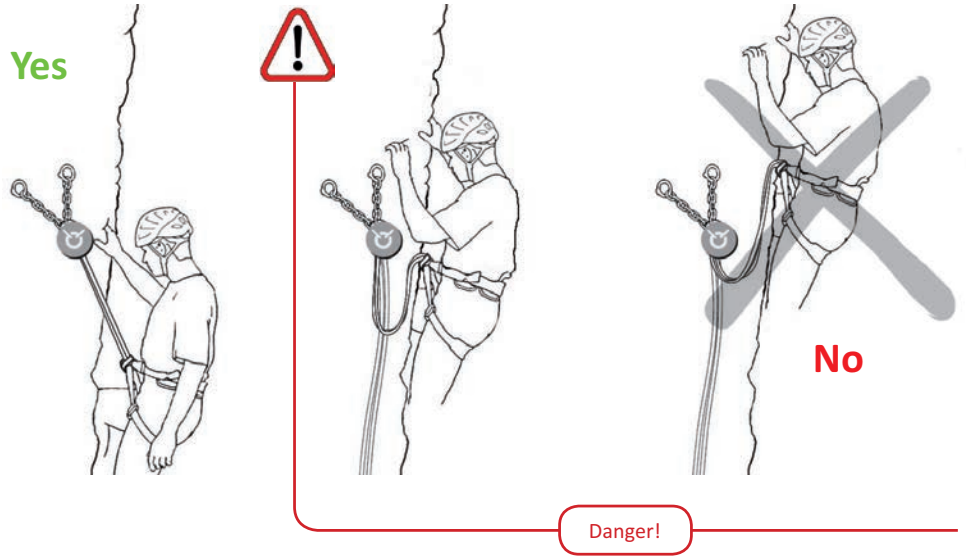
Rappelling is a method of quickly and efficiently descending. Rappelling requires the use of a manual or assisted braking device, and can be completed on a single fixed line or a doubled rope threaded through an anchor. If using a manual braking device, the rappel also requires a back-up. If the back-up is a personal prusik, then the belay device should be separated from prusik. This can be achieved by either extending the rappel device from the harness using a girth hitched sling and attaching the prusik directly to the belay loop, or by attaching the rappel device to the belay loop and tying the personal prusik to the leg loop.

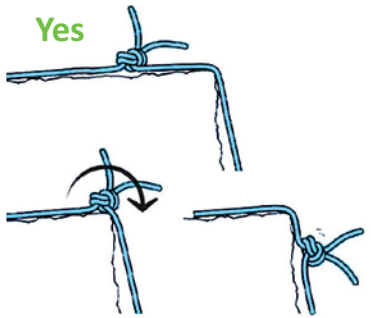
SYSTEM SET-UP

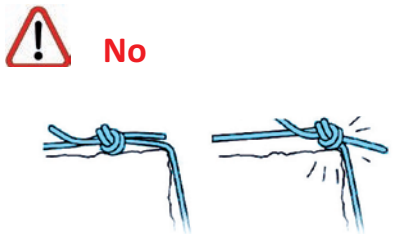
Double rope rappel set-up

A double rope rappel can be completed by threading the rope through the master point of an anchor, or a set of rappel rings. When threading an anchor to rappel the climber should be attached to the anchor with a lanyard. For this configuration a dynamic tether such as a Purcell prusik, Petzl Connect Adjust, or similar, should be girth hitched through the harness tie-in points, and a locking carabiner used to connect the sling to the master point of the anchor.

Climbers attached to rappel anchors with lanyards must not climb above the rappel anchor. Doing so can result in a factor 2 fall directly on the anchor, causing injury or anchor failure. The risk is even higher when using a static lanyard such as a Dyneema sling, which is why their use is discouraged for this purpose.







Do not use the water knot, which gets stuck more easily.

Using a flat overhand bend is preferred over a water knot or similar inline knot to tie two rappel ropes together. The flat overhand bend will 'stand up' and roll over smaller ledges and obstructions when pulling the ropes, reducing the likelyhood of the knot jamming in a crack or obstruction resulting in stuck ropes.

Throwing the rope.

- Thread the rope through the anchor to the mid-point, or
- Thread the end of one rope through the anchor and tie the other rope to it with a flat overhand bend.
- Take one of the ropes coming from the anchor and butterfly coil 15 metres.
- Keep the coils small.
- Throw it down toward the next anchor.
- Lower 10-15 metres of rope.
- Butterfly coil and throw the next 15-20 metres.
- Butterfly coil the final 10-15 meters (with a knot in the end).
- Use an overhand pitch to throw the rope down with force.
- Repeat with the other rope.

Note: Windy conditions can make it difficult to get the rope cleanly down the face.

Note: On low angle terrain it can be difficult to keep the rope from hanging up on ledges. Loose rocks on the ledges will add to the hazard.

Other strategies include lowering the first person or having the first person take the ropes down. The ropes are loop coiled and hung off the harness with 60 cm slings.

Both ropes are then placed into a manual braking belay device which is then connected to the belay loop of the climber's harness, or a sling if extending the rappel device, with a locking carabiner.

Backing up a rappel

With a prusik:

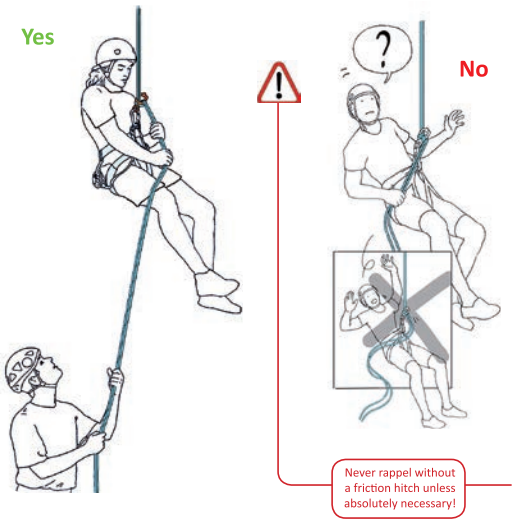
A rappel can be backed up quickly and effectively by adding a friction hitch to the brake strand(s) below the belay device. This can be a prusik, autobloc or klemheist. The advantage of adding the prusik below the rappel device is that the prusik only needs to grip the rope hard enough to provide a braking force. If a prusik is used above the rappel device, it will have to hold full body weight. Once loaded it will be difficult, if not impossible to free, without unloading it. This usually means adding a foot prusik and standing up. The prusik-above is the preferred method when planning to re-ascend the rope, such as when rappelling into a crevasse to render first aid.

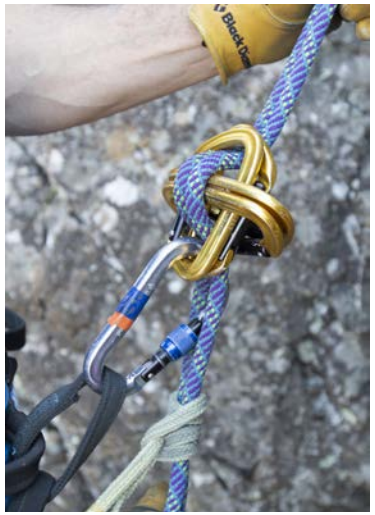
A two-wrap prusik may be used for a double rope rappel, and a three-wrap prusik should be used for a single rope rappel. If the rappel device has been extended with a sling, then the prusik is connected to the harness by tying it to the belay loop with a flat overhand knot. If the rappel device is attached to the belay loop, then the prusik is attached to a leg loop. If the leg loop is adjustable, tie the prusik to the inside of the leg loop, away from the buckle. It is imperative that the distance between the prusik and the knot connecting it to the belay loop be kept to approximately 10 centimetres, so that the belay device does not accidentally mind the prusik.

With a belay from below (Fireman's Belay):

A rappel can be backed up from below. In the event that the descent needs to be stopped, the individual on the ground applies tension to the brake rope(s) thus acting as a set of brake hands.

When rappelling with a prusik self-belay, attach the prusik first, then pull the rappel rope up through the prusik to create a loop of slack. The prusik grabs and holds the weight of the hanging rope. Thread the rope through the rappel device.





Example of a carabiner brake.

Final safety check

A final safety check ensures that all components of the system are in place and ready. Use a Top-to-Bottom check or BRAKES acronym.

The Top-to-bottom check is a sequential assessment that begins with the anchor, then moves down to the joining knot, rappel device treading, carabiner locked, harness, prusik self-belay, and finally knotted rope ends.

The BRAKES acronym covers all the same components but in a different order: Buckles, Rappel device, Anchor, Knots, rope Ends, and Safety backup.

Improvised rappel

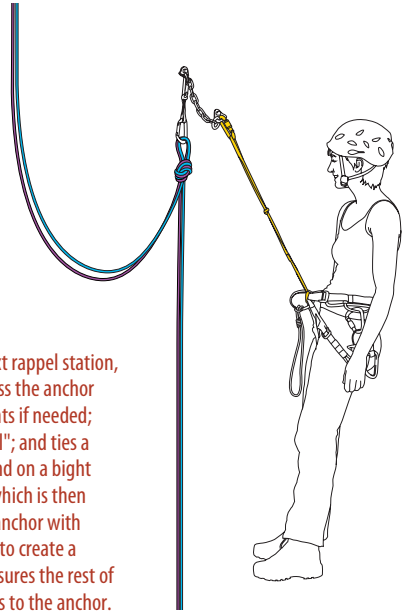
There are a number of solutions if a rappel device is dropped by one member of the party. One person can simply be lowered. There are other considerations that may also make this option preferred (i.e. such as very windy days).

- Use an Italian hitch (note: this may introduce twists into the rope)
- Use a carabiner brake

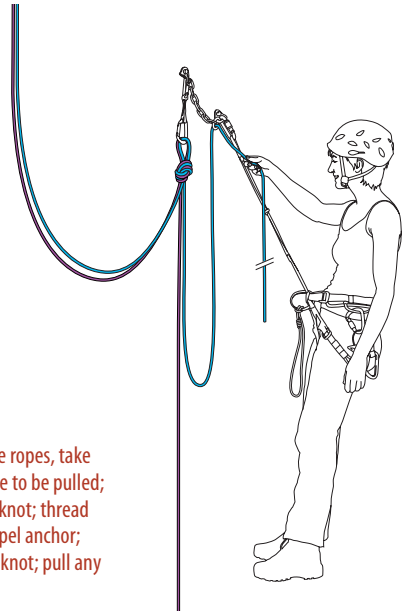
MULTIPLE RAPPELS

It is essential to be systematic when descending multiple rappels. Rappelling the ascent route provides more options if things go wrong. If the descent route goes down through unclimbable terrain, there is less margin for error.

- Set everyone up with a lanyard.
  - Use a dynamic lanyard such as Purcell prusik if possible. If using a sewn sling, be particularly careful to minimize the potential for participants to have slack in the lanyards as they move around at rappel anchors.
  - If sewn slings must be used, Nylon is preferred over HMPE (Dyneema) as they provide a small amount of stretch to reduce any shock loading potential. A Purcell prusik has superior shock absorption potential. Regardless of material used, slings are still less preferable as tethers and participants must always avoid slack in them when attached to a rappel anchor.
- Use a sling to set up an anchor with a focal point.
  - If there are more than two people rappelling, use a locking carabiner as the focal point.
- Thread and throw the ropes as described above.
  - Make sure there are knots in the ropes - one metre from the end.
  - If the rope has hung up on terrain, stop above the problem and sort it out.
- The leader goes first if the rappel is into unknown terrain, or the next anchor needs to be set up.
  - The leader attaches rappel device and personal prusik and descends.
  - Clip the lanyard on the rope that will be pulled.
    - It can be hard to remember by the 10th rappel.
- If the other climbers do not have demonstrated rappel competency.
  - Pre-rig the other climbers in a 'stacked' rappel.
  - Attach their devices – extended with an overhand knot in a dynamic connection (Purcell prusik), or with a sewn sling from the belay loop.
- Once at the next station,
  - Assess the fixed anchor points. Supplement if needed.
  - Use a sling to construct a focal point from the fixed pieces.
  - Clip in with a lanyard and pull three metres of rope through the rappel device.
  - Yell off rappel.
  - Tie a double overhand on a bight in both ropes and clip it into the anchor.
    - This creates a J-Loop and ensures that the rest of the team come to the station.
  - Yell "on belay" and provide a fireman's belay.
  - Take the end of the rope to be pulled.
    - Untie the stopper knot.
    - Thread it through the rappel anchor.
    - Retie the stopper knot.
    - Pull any slack through.
- The next climber rappels.
  - When the climber gets to the station,
    - Clip in to the focal point with a lanyard.
- Once everyone is at the station – make sure there are no twists in the rope above.
  - Pull the rope until it is almost weightless.
    - Then give it a sharp tug.
    - Watch for falling rocks dislodged by the rope.



Once at the next rappel station, the leader assess the anchor and supplements if needed; yells "off rappel"; and ties a double overhand on a bight in both ropes which is then clipped to the anchor with sufficient slack to create a J-Loop. This ensures the rest of the team comes to the anchor.

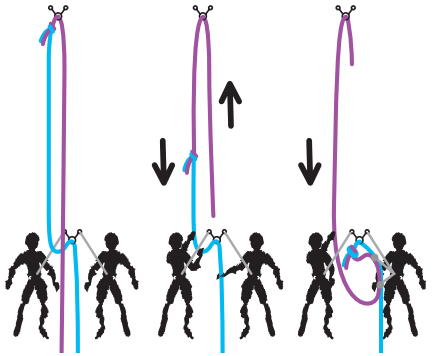


Prior to pulling the ropes, take the end of the rope to be pulled; untie the stopper knot; thread it through the rappel anchor; re-tie the stopper knot; pull any slack through.

If the rope hangs up:

- Try to flick it free.
- Pull gently to free it.
- Pull hard to free it.
- If none of the strategies work.
  - If you still have both ends,
    - Prusik up the rope.
  - If you only have one end,
    - Tie into the end that you have.
    - Get your partner to put you on belay.
    - Lead back up to the other end.
    - Once you have both ends, you can try to free it,
    - Or prusik higher until you can free it.

If you have only one end and the terrain above is unclimbable, you will need to cut the rope and descend with what you have left. This will probably mean short rappels and leaving lots of gear behind.



The last climber to rappel can clip a spare sling or quickdraw on the rope to be pulled as a reminder. Before pulling the rope(s), untie the stopper knot and thread the rope through the anchor, retie the stopper knot, and thread it through the anchor as the rope is pulled from the previous anchor.

Lowering

There are situations when it is better to lower a climber.

- The climber has not demonstrated competency in rappelling.
  - Or is injured or lacks a rappel device.
- It is too windy to throw the ropes.
- A large group of inexperienced climbers need to get down efficiently.

SET-UP

Lowering is done directly off the anchor with a prusik backup. The prusik can be attached to the brake strand and the lowerer's harness, or to the loaded strand and the anchor. On low angle terrain, the Italian hitch will provide sufficient friction. In instances where an Italian hitch has insufficient friction, a second locking carabiner of identical size can be connected to the anchor and incorporated into the hitch to increase the friction.

THE LOWER

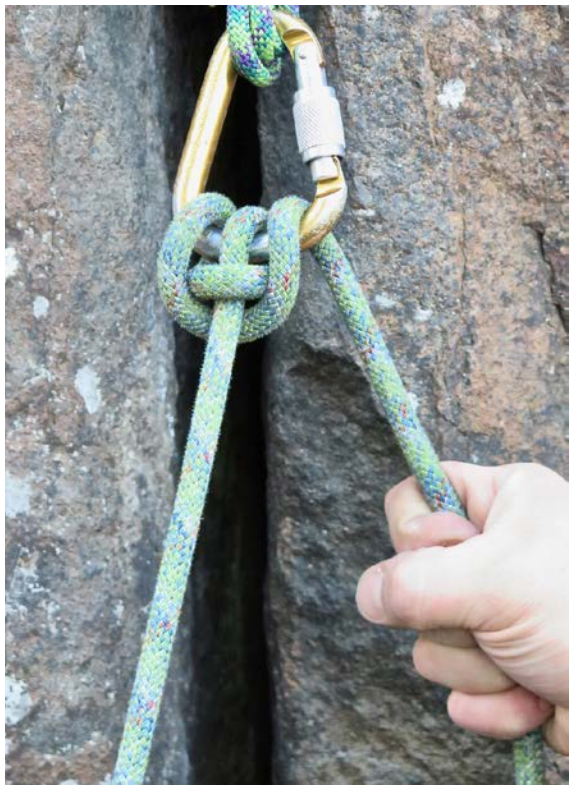
Most people hate to be lowered. For novices, it may be a very stressful situation. Clear communication and the establishment of trust are key.

- Do a full top-to-bottom system check.
- Have the climber lean back to tension the system.
- Slowly commence the lower, particularly the edge transition.
- Once the climber is over the edge transition, speed up to a reasonable pace.
  - No need to set speed records. Slow and smooth lowers establish trust and will be most comfortable for participants that are uncomfortable being lowered.
- If multiple people are to be lowered,
  - Use the second rope as well.
    - Tie the second climber into the end of the second rope, while the first climber is untying at the bottom.
      - Make sure the figure-eight knot is fully removed.
    - Lower the second climber.
    - Pull up the first rope and tie in the third climber…
  - Another strategy is to just use both ends of one rope.
    - This removes the need to pull up the first end.

ITALIAN HITCH

The Italian hitch can introduce severe twists and kinks into the rope after multiple lowers if not used properly. To avoid twists:

- Align the brake strand parallel to the loaded strand.
- Push twists into the Italian hitch.
  - Do not let the backup down the unloaded brake strand.



Double Italian Hitch.

DOUBLE ITALIAN HITCH

On high angle terrain, or with a heavy climber, use the double Italian hitch. The double Italian hitch creates more friction than the single Italian hitch. It also reduces the twisting effect on the rope that can occur with the single Italian hitch. It is only used for lowering. It is also an excellent tool for lowering a two-person load.

- Tie an Italian hitch with the running end closest to the spine of the carabiner.
- Pass the running end around the back of the live strand then back up through the carabiner.
- The live strand will be captured between wraps from each side.
- If rope is taken in, the hitch will flip twice before rope begins to pass through.

Rope ascending

Rope ascending can be strenuous. There are many different setups and systems that work. The core safety principle is for the climber to have two attachments from the rope to the harness. Take to time to set the system up properly, as this will result in greater efficiency and success. The key element is to set up a personal system and learn how to optimize the efficiency. The most basic system uses two 5 metre sections of 7 millimetre cord.

TEXAS PRUSIK SET-UP

- The upper prusik is set at roughly wrist height when an arm is extended above the head.
  - The upper prusik is connected to the tie-in points of the harness with an overhand knot.
- The second (foot) prusik should be set beneath the first.
  - Option 1
    - An overhand knot should be created in the tails of the lower prusik 20 centimetres below the prusik knot.
    - A second overhand knot is set roughly 15 centimetres below foot height with a bent knee.
    - The loop created between the two overhand knots is clipped into the belay loop.
  - Option 2
    - Offset the length of the strands.
    - Tie an isolation knot as close to the prusik hitch as possible.
    - The short strand is clipped to the harness with a locking carabiner.
    - Tie an overhand on a bight at the end of the long strand.
      - Girth hitch the loop to a foot.

ASCENDING THE ROPE

Maximizing the throw between the upper and lower prusiks will increase the speed of ascent. However there becomes a trade-off point where it becomes overly strenuous and generally less efficient.

Using a prusik set-up to ascend a rope.

- Slide the top prusik as high as possible.
  - Sit back and let the harness take the weight.
- Slide the lower prusik as high as possible.
- Stand up.
  - Brace with the free leg against the wall.
- Loosen the top prusik and slide it up as high as possible.
  - Sit back and let the harness take the weight.
- Repeat.
- On a long ascent, stop every 5-7 metres and tie a backup knot and clip it into the belay loop on the harness.

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Glacier Travel Skills

A highlight for many participants on summer mountaineering outings is the opportunity to travel on glaciers. Safely travelling among crevasses and observing features such as moulins and seracs leaves many in awe of the glaciated mountain environment. Recognizing and interpreting glacial features and a basic understanding of glaciology, combined with experience, allows the summer mountaineering leader to safely navigate glacial terrain. Understanding and regularly practicing crevasse rescue is a necessary skill for anyone leading summer mountaineering outings involving glacier travel.

Glaciology

Glaciers are fascinating for mountain travellers, perhaps because of their quiet beauty and power, sense of unpredictability or the unknown, and the representation of the landscape's history. A glacier is a large body of ice that forms on land and slowly flows or deforms under the stress of its own weight. Snow accumulates, and through pressure, changes density to form ice. Crevasses are formed at the surface of the glacier where the ice is more brittle. They typically occur where the glacier is stretched as it moves over a convexity, turns a corner or where the landscape widens. This being said, their occurrence is not predictable. Crevasses are named via their location on the glacier and their orientation to the flow of the glacier, as for example radial, longitudinal and transverse.

Radial Crevasses

TERMINOLOGY

Zone of accumulation

Above a certain altitude, more snow falls than melts each year, adding to the glacier's mass. The snow accumulates and compresses into ice; the force of gravity pulls the ice and snow toward the valleys.

Zone of ablation

Below a certain altitude, the ice melts and evaporates more rapidly than the rate at which it flows downhill due to gravity. The ablation zone—the lower portion of the glacier—doesn't hold snow in late summer. Mountaineers travel on bare ice partially covered by rock debris of various sizes (from gravel to large boulders).

Snow line (Firn line)

The line marking the boundary between the glacier's accumulation zone and the ablation zone, where snow melts faster than it accumulates. Also,

Bergschrund

This is a crevasse of variable width (from several centimeters to several meters) marking the upper boundary between the moving glacier and the ice slope above.

Moat

Similar to a bergschrund, except the snow or ice slope has pulled away from the rock wall above rather than the upper ice face.

Seracs

On steep glaciers the ice is not sufficiently plastic to move over convex rolls without fracturing and creating crevasses. Multiple intersecting crevasses create towers of unstable ice called seracs, which may reach tens of meters in height.

Transversal crevasses

These appear when the glacier's slope angle changes slightly, forming zones of crevasses that run perpendicular to the glacial flow. These fissures are often 30 to 40 meters deep.

Longitudinal crevasses

Because ice flows faster in the middle of the glacier than along the

sides, crevasses form along the glacier's edges. A glacier's convex shape, caused by lateral melting where the ice contacts the rocks, increases the formation of longitudinal crevasses. These crevasses run parallel to the glacial flow.

Nunatak

An isolated peak that sticks out above an ice sheet.

Lateral moraines

These consist of boulders torn from rock walls by erosion and carried by the glacier. Formed on the sides of glaciers, they are often steep (40 degrees) and unstable.

Medial moraine

When glaciers flowing out of two different valleys meet, the lateral rock debris from each glacier is pushed together to form a medial moraine.

Terminal moraine

At its foot, a glacier will deposit all the debris it has encountered on its path. This terminal moraine is composed of glacial till (mud and boulders). Vegetation spreads rapidly across the moraine; the first plants grow only 20 meters from the foot of the glacier.

Snout of the glacier

This is where the glacier thins and ends. Here, melting and evaporation stop the glacier from continuing its journey down valley. An advancing glacier has a bulging foot, while a receding glacier has a flat, tongue-shaped foot. During the summer, a glacial stream flows from the mouth of the glacier, often issuing from a large cave.

A rope team navigates a complex section of glacier with transveral and longitudinal crevasses.

CLIMATE CHANGE

Glaciers are affected by climate change. Since the mid-twentieth century, global warming has accelerated glacial melting. Glacial retreat and climate change have numerous consequences for mountaineers:

- The premature loss of snow cover results in more open bergschrunds and crevasses. This can complicate routes and render them impassable.
- In early summer, some snow routes change to ice. Former snow, ice and mixed routes are no longer frozen together and are ravaged by rockfall.
- The first pitch of rock routes begins lower as the glacier ice level drops.
- Access on or off glaciers requires specialized equipment (chains, ladders, via ferrata).
- Greater frequency of rockfall and collapse of lateral moraines caused by the melting of the permafrost (permanently frozen ground).
- Water supply/availability at huts and designated camping areas may become unreliable.

Glacial retreat at the Adamants.

Equipment for glacier travel

The principle of moving together across a crevassed glacier is based on the rope remaining relatively snug while you're moving. You can rope up using either a half or single dynamic rope (but not a twin rope). However, for convenience's sake, especially for self-rescue hauling systems, a single rope is preferable—its larger diameter allows friction hitches to grab more easily. In addition, ropes lose up to 30% of their static strength and 70% of their dynamic strength when wet or frozen.

Each team member should carry a crevasse-rescue kit:

- 3 locking carabiners.
- 2 non-locking carabiners.
- 2 x 5 metre sections of 6 or 7 mm accessory cord (at least 2 mm thinner than the diameter of the main rope), or 2 rope clamps.
  - These may be pre-tied into Purcell prusiks.
- 2 ice screws (19 cm+).
- 120 cm sewn webbing sling.
- 1 progress-capture pulley.
- 1 snow fluke or picket (depending on conditions).

Depending on snowpack conditions, each rope team should consider carrying an avalanche probe.

Travel techniques

PRINCIPLES

When travelling on dry (snow-free) glaciers, the crevasses are plainly visible. A rope may be necessary to protect technical climbing moves through crevasses. When travelling on snow covered glaciers, the rope may be needed to protect from unexpected falls into crevasses. The most challenging travel conditions occur in late September after the first significant snowfall. The crevasses are hidden by snow, but the bridges are not strong enough to support body weight. Conversely, in early Spring the glaciers have their maximum snow cover. An avalanche probe is a useful tool to determine both snowpack depth and hardness.

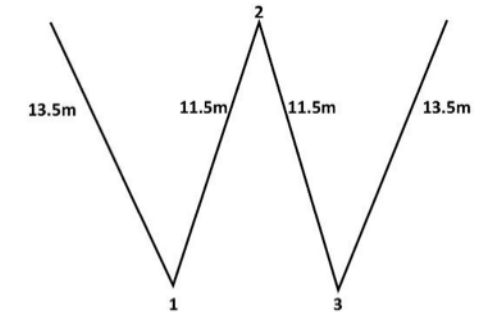
The rope provides maximum security when the rope team is travelling at 90 degrees to the direction of the crevasses. Knowledge of where crevasses are likely to form and an assessment of the amount and quality of the snow sitting on the glacier will help a Summer Mountaineering Leader determine whether the team needs to rope up.

ROPING UP

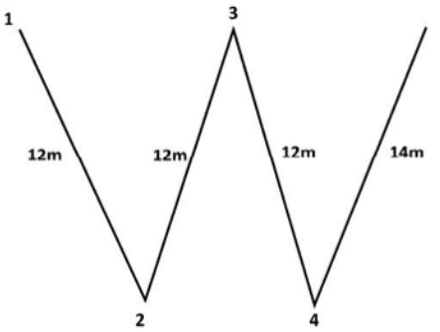
The rope length between climbers will depend on the nature of the glacier and the size of the anticipated crevasses. Climbers may want to increase the distance between them in bigger terrain when the crevasses may be larger. The rope length between climbers on a glacier must be long enough so that only one climber is exposed to a crevasse at a time. A simple principle that works for rope teams of three, four and five, is to divide the rope in quarters. In addition, take an extra two to three metres in on each unoccupied end before dividing the rope into four. The extra two metres will facilitate setting up a mechanical advantage hauling system.

The rope team members can clip in with a figure-eight on a bight to the belay loop with a triple action locking carabiner or two double action locking carabiners, attach a prusik to the rope and daisy chain the prusik to the harness belay loops. The spare rope at each end is coiled or stuffed into the pack and ready for deployment. Climbers in a middle position should attach a prusik both in front and behind.

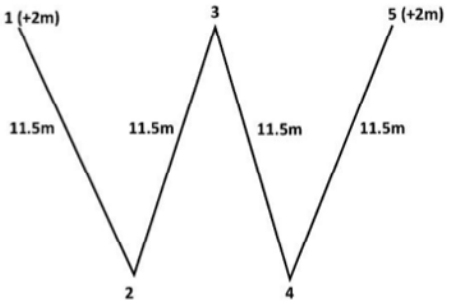
Maintain at least 8-10 meters of rope between each climber. Both ends of the team should carry spare rope (kept in backpacks for aid in ascending the rope or to construct a rescue hauling system. Ideally, keep at least an equal amount of spare rope on either end as the distance between climbers.



Rope team of three (50 m rope)



Rope team of four (50 m rope)



Rope team of five (50 m rope)

Travelling as a team of two

Crevasse rescue is considerably more difficult for a single person. The person on the surface must be able to arrest the fall, hold the weight of the fallen partner, construct an anchor and transfer the load to the anchor. This is typically a difficult scenario that must be practiced. Both members of the rope team must be skilled at this task as either climber could fall into a crevasse. If one of the team members is less experienced and can only hold the fall, but not construct an anchor and transfer the load, the fallen climber must be able to self-extricate.

Rope teams of only two should consider adding a series of knots tied in the rope between them about every two meters (leaving the central section of the rope span clear of knots). This technique has advantages and disadvantages.

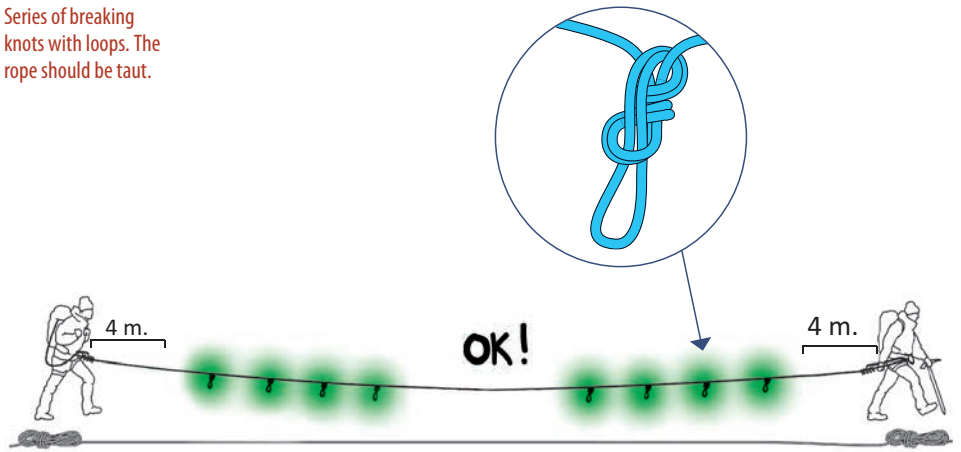
Advantages

The knots have a braking action on crevasse lips. This technique makes it easier to arrest a fall in certain cases, especially for a team with a significant weight difference between the climbers. If the fallen climber is conscious and has stopped just below the crevasse lip, the loops can help him or her climb out.

Disadvantages

The knots make hauling very difficult and require that you carry another rope, or a large amount of spare rope.

Series of breaking knots with loops. The rope should be taut.

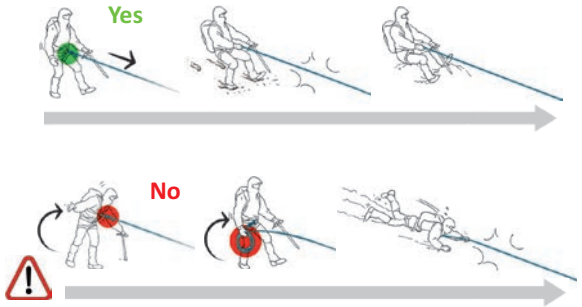


Crevasse rescue

Crevasse fall avoidance strategies involve careful route selection. However, the ability to both extricate a fallen partner or oneself is essential. Every team member should know how to build a hauling system and ascend the rope, in case of a crevasse fall. When a second rope team is available, the simplest hauling system uses no mechanical advantage. The first team holds the fall. The second team moves in, grabs the first team's rope and all team members haul. Be careful as this can be very powerful. Slow down and carefully assist the fallen climber in the transition up onto the surface. Be careful not to jam the climber into the lip of the crevasse.

STOPPING A FALL

How to arrest a crevasse fall



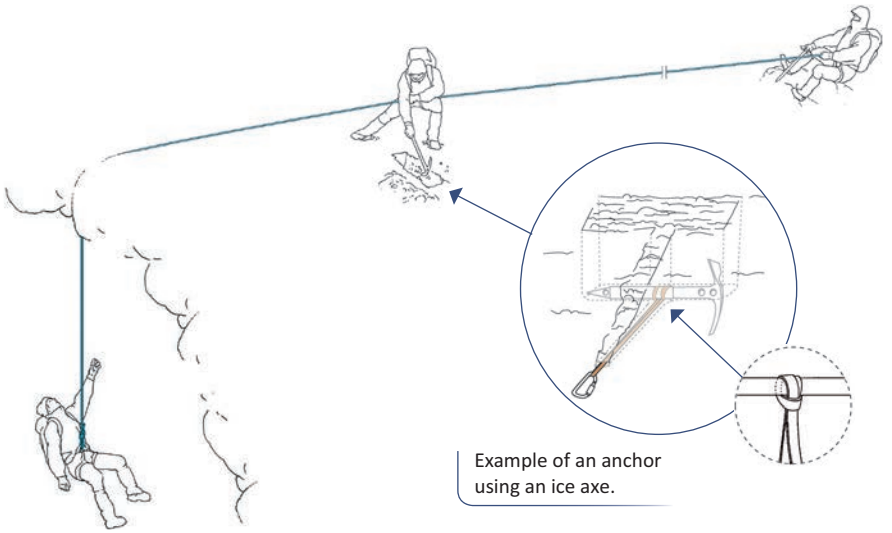
- If your legs punch through a snow bridge, you may be able to arrest your fall by spreading your arms (with your backpack hip belt well tightened), in the hopes of staying on the surface and not dropping fully into the crevasse.
- Be aware that a fall's impact comes directly onto your unanchored partner(s), which makes arresting the fall difficult if your partner is unprepared.
- When a teammate falls, their partner(s) immediately adopt(s) a self-arrest position (opposite the direction of pull), planting their ice axe(s) firmly in the snow.
- Once the fall has been arrested, you'll need to build a bomber anchor. This may be a snow anchor or ice anchor, depending on the snow depth. Ice anchors are preferred as they are quicker to set up and likely stronger. Keep all required equipment handy: ice axe, ice screws, 120 cm sling, 2 regular carabiners and 1 locking carabiner.
- If the fallen climber can reach the crevasse wall, he should quickly place a screw in the ice and clip into it. This relieves the load on the rescuer up top. It reduces the likelihood of further slippage and makes it easier for the rescuer to build an anchor.

HOW TO BUILD AN ANCHOR

Once the fall has been arrested, the first step is to communicate with the fallen climber and establish a plan. The climber may be able to walk out the bottom of the crevasse or climb out. If necessary, the next step is to build a bomber anchor and transfer the load. With a rope team of two, this will be very difficult. Crevasse rescue is much simpler with a rope team of three or more climbers. Ascertain whether the fallen climber is able to perform a self-rescue or if you'll need to build a hauling system. Self-rescue is often much simpler than hauling, especially with a rope team of two.

Note: Chapter 12 - Snow and Ice Climbing Skills has detailed descriptions of snow and ice anchors.

Never disconnect from the rope. Remain tied in or clipped into a prusik during the entire operation, as additional crevasses may be hidden under the snow. Approaching the lip to establish communication requires caution. The lip may be undercut. Approach under rope tension and probe to find the edge of the ice. An unroped fall or a fall with large amounts of slack in the system will make the rescue far more complex.



Example of an anchor using an ice axe.

Depending on the conditions, use a long ice screw, a snow fluke or a deadman (in deep snow) as an anchor.

GETTING OUT OF THE CREVASSE

This is how to extricate yourself from a crevasse if you cannot climb out.

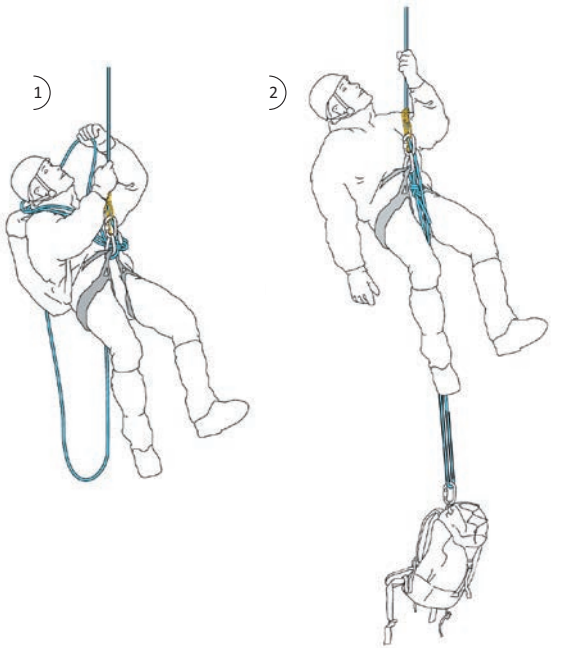
If the fallen climber isn't injured and knows how to ascend a rope, crevasse self-rescue will be the quickest escape. Make sure the climbers up on the surface have braced themselves properly. Wait until they've installed an anchor before you ascend the rope.

Required equipment

- Two ascending devices
  - It's much easier to use mechanical ascenders than friction (prusik) hitches.
- Spare rope reserved in the backpack.

THE STEPS

1. Clip the friction hitch that is already attached to the rope to your belay loop with a locking carabiner. (Alternatively, attach an ascending device to the rope). Undo your shoulder coils. The load is now borne by the ascender/hitch at hip level.
2. Remove your backpack and clip it to the rope: the added weight will aid in your ascent by keeping the rope taut.
3. Place a second ascending device or friction hitch on the rope, below the ascending device/hitch already clipped to your harness. Clip a sling to this lower ascender, to use as a foot loop. During the ascent, ensure that both ascending devices are connected to your belay loop.
4. To ascend, first move up the foot-loop ascender as close as possible to the harness ascender, and then stand in the foot loop while moving the harness ascender up.



HOW TO TRANSFER THE LOAD TO AN ANCHOR

If the victim is incapacitated or lacks the skills to climb out of the crevasse, you'll need to build a raising system. The first step is to transfer the fallen climber's weight to an anchor. Always keep the following equipment handy on your harness or pack when traveling on a glacier: progress-capture pulley or friction hitch, pulley, cordelette or spare rope, sling (60 cm or longer), locking carabiners.

Your objective is to transfer the victim's weight onto the friction hitch or progress-capture pulley. Mastering this procedure requires proper instruction. (At a glance: lying in the snow, you build an anchor while supporting the fallen climber's weight on your harness.)

Connect the friction hitch which is already on the weighted rope, and is supporting the fallen climber to the anchor sling. Slide the friction hitch or pulley down the taut rope to load the sling. Now you can slowly and smoothly transfer the fallen climber's weight onto the anchor.

Once the weight is transferred, undo your shoulder coils to construct a hauling system.

Warning! Always remain tied in or attached to the rope with a friction hitch.

DETERMINE A COURSE OF ACTION

Once the load has been transferred to the anchor, the rescuer(s) can take a deep breath and decide upon the next action. This will require additional information.

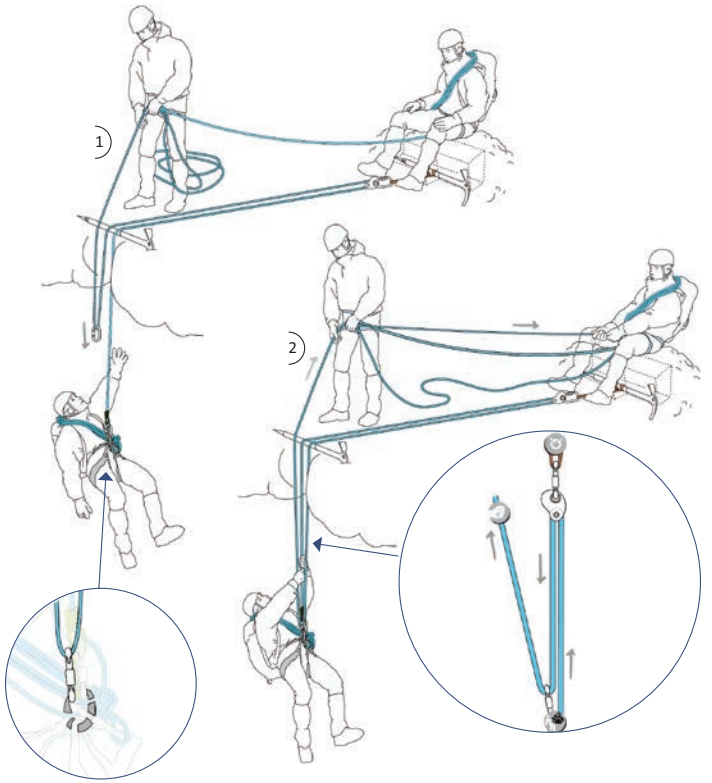
- Communicate with the climber.
  - Approach the lip to establish communication.
  - Is the climber hurt?
- Is first aid needed?
- If so, someone may need to rappel in to render first aid.
- What are the possible methods of extraction?
  - What is the simplest method of extraction?
- Can the climber be lowered down and walk out the other side?
- Can the climber climb the crevasse wall with a belay?
  - Is a second team available?
- If the climber is hanging over a bottomless abyss, a hauling system will be needed.

HOW TO HAUL AN ABLE-BODIED CLIMBER

The basic principle of hauling systems is to use the simplest system that will accomplish the goal of extricating the fallen climber. With three climbers total, one of whom is in the crevasse, your best bet is to set up a 'dropped loop' hauling system.

Climbers on the surface should remain connected to the rope throughout the entire rescue.

- Dig the lip back to solid snow (preferably close to the edge of the underlying ice).
- Place an ice axe, ski/trekking pole or a pack at the crevasse lip to keep the haul line from cutting into the snow.
- Lower a loop of rope with a locking carabiner. The fallen climber then clips this to his belay loop.



- This rope allows the victim to assist the climbers on the surface with the hauling.
- Clip the UP strand of the dropped loop to the anchor through a progress capture device at the anchor or anchor extension.
- Attach a short prusik or rope clamp to the UP strand of the dropped loop (not the strand attached to the anchor).
  - Note: this may be sufficient mechanical advantage with a large hauling team.
- Take the rope coming from the progress capture device back out to the short prusik and clip it through a carabiner or preferably a pulley.
- This creates a 6:1 mechanical advantage.
- If a single pulley is available, use it on the short prusik attached to the UP strand. This will be closest to the hauling climber(s) and create the greatest efficiency.

HOW TO HAUL AN INJURED CLIMBER OUT OF A CREVASSE

An injured climber may need immediate first aid. In this case, one of the climbers will need to rappel into the crevasse to render first aid. This rescuer can also bring down a dropped loop and attach it to the injured climber. The rescuer then ascends the rope and sets up the 6:1 dropped loop hauling system.

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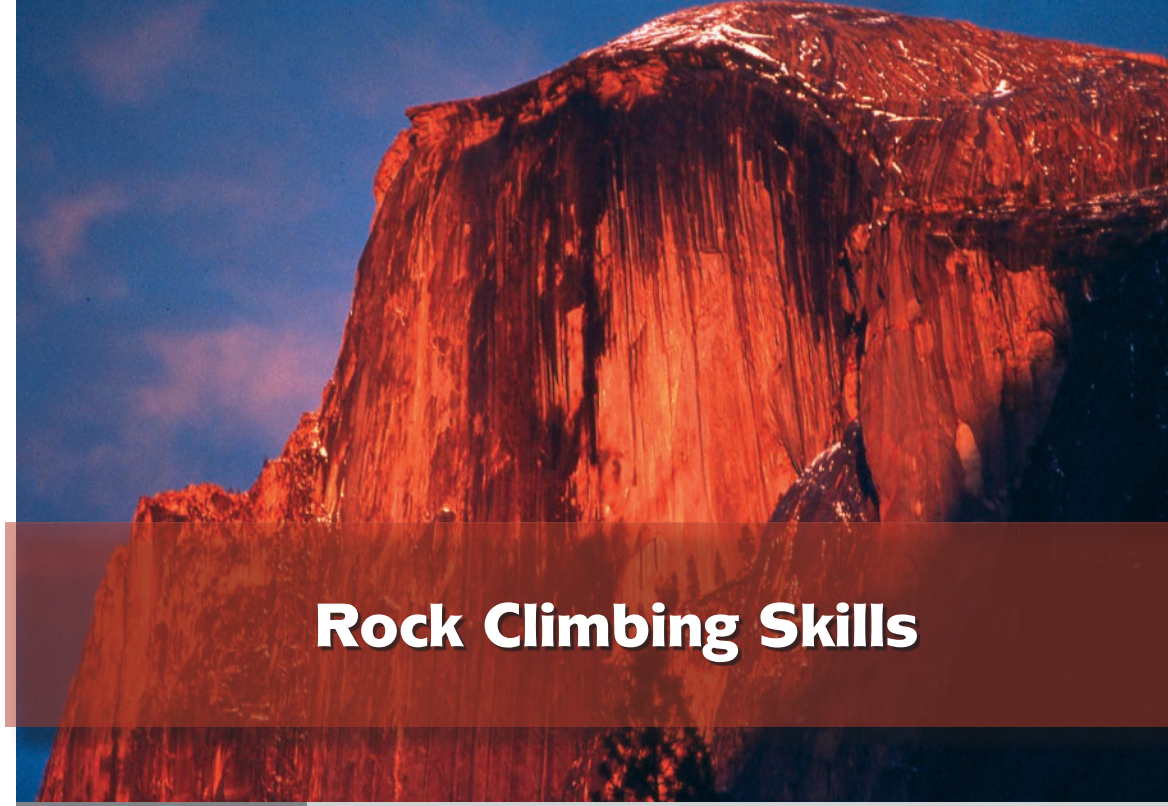


Rock Climbing Skills

The ability to apply rock climbing movement techniques on a variety of rock types, enables the Summer Mountaineering Leader to perform a range of necessary tasks. Proficiency in movement ensures they can efficiently lead mountain routes in addition to providing participants with movement modelling, instruction, and coaching. In this chapter we will highlight climbing movement techniques that can be applied when face climbing, crack climbing, and slab climbing.

Rock movement

FACE CLIMBING

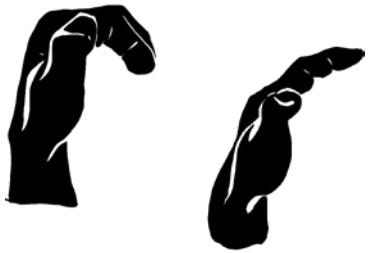
Face climbing activities are typically completed in terrain that is featured with a variety of edges, pockets, incut, and sloping holds. Limestone, sandstone, gneiss, quartzite, and conglomerate rock types often present face climbing opportunities.

Hand position

Three grip positions are commonly used while face climbing. These positions can be used in a variety of orientations depending on the alignment of the hold's most positive aspect.

Open hand position:

The open hand position is the most relaxed and ergonomic grip. It is often used for sloping holds, pockets, and large incut holds. This hand position requires the climber to create a 'C' shape with all five fingers of the hand prior to placing it on the hold.



Crimp position:

The crimp position enables the climber to grasp small edges by creating a closed finger position with the thumb wrapped over top of the index finger. This position is extremely powerful and enables the climber to grasp small holds that an open hand position could not.

Pinch position:

The pinch position allows the climber to grasp holds from two sides by opposing the thumb to the fingers. Unlike the open and crimp grip, it also enables the climber to articulate their body around the hold without adjusting the orientation of their grip.

Foot position

In addition to the smear position that is discussed in slab climbing techniques, the inside edge position, outside edge position, and front-point position are commonly used foot placements when face climbing.

Inside edge position:

The inside edge position enables the climber to use the most powerful aspect of the foot and climbing shoe. This foot position involves aligning the foot parallel to the positive aspect of the hold, with the big toe positioned on the hold and the heel turned outward slightly. This position is typically used on edges and incut holds that possess a positive aspect and is the most commonly used foot position while face climbing.

Outside edge position:

The outside edge position can be applied on small edges as well as larger holds and is best suited to use in steep terrain or when the climber is moving laterally. Contrary to common belief, the outside edge uses the big, second, third, and fourth toes, and not the pinky toe. The outside edge position involves aligning the foot parallel to the positive aspect of the hold with the outside edge of the climbing shoe or boot and angling the heel out from the rock roughly 60 degrees due to the asymmetric shape of most climbing shoes. This foot position is less intuitive than the inside edge position but enables maximum hip and shoulder rotation and therefore greater reach when moving laterally or moving through overhanging terrain.

Front-point position:

The front-point position works well with mountain boots and is commonly used in pockets, cracks, and seams that are poorly suited to the inside and outside edge position. This position involves using the point of the climbing boot where the inside and outside edges meet and placing it in or on the most positive aspect of the hold. With the front-point

Rock climbing well in stiff mountaineering boots is a skill well worth developing, and requires slightly different techniques than with technical rock shoes. An emphasis on edging as opposed to smearing is one key difference.

position, the heel is typically positioned perpendicular to the aspect of the hold the foot is being placed on, in order to maximize the contact between the climbing boot and the hold. It is important maintain a low heel and to not extend upwards. This may cause the toecap of the boot to lever the boot off a small hold.

Body position

The optimal body position for face climbing will vary greatly depending on the orientation and placement of the hand and foot holds. Whenever possible it is ideal to orient the body so that the hand holds are being used in alignment with their optimal direction of pull. However, it is also important that the centre of gravity remain over the feet whenever possible. At times it may be preferable for the climber to position themselves so that they are balanced over their feet at the expense of using a hand hold in a less than optimal position. The general sequence for face climbing involves initiating upward momentum by pushing with the legs and feet before reaching up for a higher hand hold. Once a higher handhold, or set of handholds, has been reached; the centre of gravity should then be repositioned to enable the movement of the feet to higher footholds. Once the feet have been positioned on the higher foot hold or holds, and the next set of hand holds spotted, the centre of gravity can be repositioned so that it is squarely over the pressured foothold. This will allow the leg to generate upward momentum.

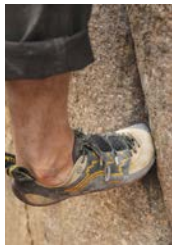
CRACK CLIMBING

Often cracks alone provide opportunity for upward progression. Crack climbing is a unique skill that requires significant practice to gain proficiency. Granite, basalt, quartzite, and occasionally gneiss, often present long continuous crack systems that require crack climbing techniques to successfully complete.

Hand position

The optimal hand position for crack climbing will vary greatly depending on the size of the climber's hands relative to the size of the crack. That said, regardless the width of the crack, the general concept is consistent. The climber must create a space-filler with the fingers, hand, fist, or body that matches the size of the crack, thus creating outward force between the opposing sides of the crack, or an obstruction that will jam above a constriction. Thin finger cracks are most like face climbing so sport climbers seem to adjust more quickly to learning how to finger jam. Hand and fist sized cracks tend to be harder to learn on because although they often offer solid jams and positive foot placement opportunities, these skills are different and must be learned. Off-width cracks and chimneys are typically far less secure and more challenging to climb as the jams are more difficult to create, and often the crack is too wide to accommodate positive foot placements.

Foot position



The optimal foot position for crack climbing depends on the width of the crack being climbed. Very thin cracks that will not accommodate foot jamming require a combination of smearing and front-pointing to climb efficiently. Moderate size cracks typically allow foot jamming techniques to be applied. Foot jamming involves rotating the foot into the crack to wedge the toe of the shoe between the crack walls or above a constriction. Large cracks may require the foot to be turned perpendicular to the crack walls and jammed sideways rather than straight in. Regardless of the size of crack being climbed, good footwork is still critical in ensuring efficient upward progress.

Body position

The body position for crack climbing differs from the positions used for face climbing, slab climbing, and corner climbing, as cracks generally force the climber to position their hands and feet in-line with one another. This body position is less stable laterally and therefore the climber needs to be acutely cognisant of their centre of gravity and ensure that it remains well balanced over the feet or beneath the hands at all times. Similar to slab climbing, shorter deliberate moves tend to be more effective when crack climbing than large dynamic ones.

CORNER AND CHIMNEY CLIMBING

Prominent corner and chimney systems in certain rock types such as granite, basalt, limestone, gneiss, and sandstone, often allow a climber to ascend steep terrain with minimal, if any, significant holds. Corner and chimney climbing requires good balance, confident foot positioning, creative body positioning, and effective pushing and pressing between opposing rock features.

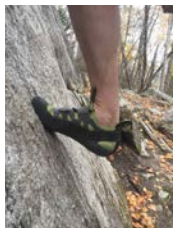
SLAB CLIMBING

Slab climbing activities occur in terrain that is less than vertical and devoid of prominent holds. In this terrain, friction between the climbers' climbing shoes, the climbers' palms, and the rock, enable upward progress. Limestone, granite, and occasionally sandstone as well as some conglomerate rock types often present slab climbing opportunities

Hand position

Occasionally while slab climbing, small crimp grip position hand holds may present themselves, however, the typical hand position for slab climbing involves palming the rock with relatively flat hands. This hand position is rarely intuitive, novice participants may have the tendency to grasp onto features in the rock, rather than using their palms. The palming position does not allow for the rock to be grasped, instead it generates friction between the palm of the hand and the rock surface. This enables the climber to remain balanced and adjust their centre of gravity and reposition their feet. The palming hand position typically involves orienting the fingers in an upward manner, but occasionally a reverse palm position with the fingers pointed downwards, may be preferable.

Foot position



The commonly used foot position for slab climbing is referred to as the smear position. The technique involves pressing the sole of the climbing shoe under the ball of the foot against the texture of the rock or against any small convex or concave features in the rock. Unlike edging and front-pointing, which require the foot to be placed parallel to the positive aspect of a hold, smearing involves flexing the foot below the toes, and dropping the heel down slightly to maximize

surface contact between the sole of the shoe and the rock surface. The heel should be positioned perpendicular to the surface that is being smeared against, and the centre of gravity adjusted to ensure the climber's weight is being directed to the foot placement and adequate friction created to maintain the smear. Smearing is more difficult to achieve when wearing mountain boots. With minimal flex, the typical mountain boot edges rather than smears. Look for minor ripples and changes in angle for foot placements.

Body position

As slab climbing occurs in terrain that is less than vertical, the body position differs from that which is typically used for steeper forms of climbing. The general body position for slab climbing involves slightly shifting the hips and centre of gravity away from the rock surface to ensure the climber's weight is positioned directly over the feet. Slab climbing movement is often slow and balanced, with smaller static moves being preferable and more stable than large dynamic ones.

Routefinding

Routefinding is a dynamic process that requires constant re-evaluation. "Does this make sense?" Routefinding is based on intuitive decisions anchored by developed expertise in similar terrain. The type and nature of the rock will contribute to the complexity of the routefinding. Splitter granite cracks that soar from the base to the summit up an obvious corner system may pose few problems. Whereas on limestone faces with multiple options, it may be much harder to "follow the obvious line to the summit, moving left and right as needed". It is all too easy to make the written words of a route description fit with the reality of the terrain.

PLANNING STRATEGIES

Extensive preparation will simplify the routefinding.

- Read the guidebook.
- Look at pictures.
- Check online forums.
  - Beware of potentially bad beta.
- Talk to people who have climbed the route.
- Write the approach and descent information into your fieldbook.
- Bring a paper topo.
- Take pictures of the guidebook with your phone.
- Develop a mental map of the macro features.

On the approach:

- Landmark key features.
- Start at the right point.

On the route:

- How hard should it be?
  - If the route is 5.7 and you are pulling 5.10 moves – you are off route.
- What makes sense?
- Explore – look around the corner, get to a high point.
- When belaying the second up, look at the route above, plan where you want to climb.

Route following:

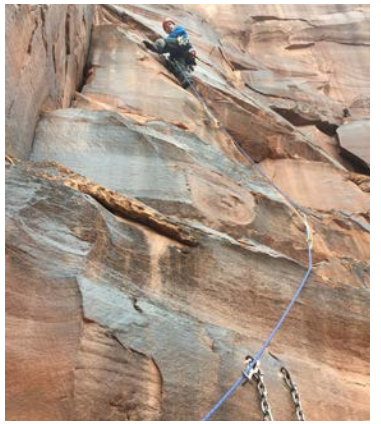
Look for evidence of previous passage:

- Chalked holds, fixed protection, boot rubber, polished holds, cairns.

Or lack of evidence of passage:

- Lichen-covered rock, many loose holds, off-route retreat anchors.

The approach



On route

Chalked Boardwalk

Multi-pitch climbing

LOGISTICS

An integral part of the route planning strategy is selecting appropriate equipment. This will include: length and number of ropes, size and number of protection pieces and number of quickdraws and alpine draws. It also includes the method of descent. Is it a walk off or a rappel? Can you return to the base to retrieve equipment, or does everything need to go up and over?

Make a list in your fieldbook

- Approach route
- Climbing route
- Descent route
- Anticipated crux
- Escape route
- Start time
- Turnaround time
- Return time
- Vehicle (make/model/ plate #)
- Location parked
- Alternate plans (2nd choice route)
- Equipment taken
- Number and length of ropes
- Rack taken

EQUIPMENT SELECTION

Rope

A 60 metre single rope is fairly standard for multi-pitch rock routes. A bi-colour rope is preferred, but a good mid mark will suffice.

Rack

A guidebook may give an idea of the size and number of protection pieces needed. Routes that wander will need more alpine draws to reduce rope drag. If you are going adventuring and there is no guidebook or other source of route information, you will need to strike balance between too much equipment (which slows you down), and insufficient equipment (which forces you to either retreat or run it out).

A fairly typical light alpine rock rack might include:

- Six cams from size 0.3" to 2",
- Six to ten wired nuts,
- Six alpine draws,
- Two 120 cm sewn slings,
- A selection of locking and non-locking carabiners, and
- Three to five metres of webbing.

Pack

Decide how many packs you will take up the climb. It is recommended to keep the pack(s) as small as possible in practice. Climbing with a big pack requires more effort and becomes awkward in chimneys.

The method of descent will influence the size of pack needed. A walk off necessitates bringing a larger pack as shoes will be needed for the descent. Approach shoes are preferred as they take up less space than hiking boots. There also needs to be room for the emergency gear, first aid kit, guide's tarp, water, food and clothing.

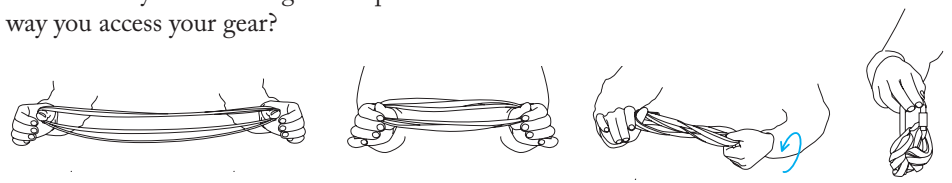
Check the weather forecast to determine your clothing needs; sunny and hot, or cold, wet and windy? Consider the value of extra clothing as insurance in the event of a sudden unforeseen change in weather, longer than planned outing, or an emergency. Don't forget the sunscreen. Put it on before the approach and wash your hands with soap and water.

Retreat options

Be prepared for the retreat options. If it is a walk off, are you bringing a second rope? What is the likelihood of needing to rappel off at some point? Are there fixed anchors, or will you be leaving gear behind?

CARRYING THE GEAR

The basic principle is that the gear needs to be accessible. There are a number of ways to rack your trad gear, from racking it all on your harness to carrying it all on a gear sling. Develop a system that works for you. If you are swapping leads with a partner, the system will need to work for both of you. How will you carry your quickdraws and alpine draws? Will you be leading with a pack? How will this influence the way you access your gear?



Harness racking

Advantages

- The gear is tight to your body and does not swing around.

Disadvantages

- May be difficult to access – chimneys and corners.
- The harness becomes very heavy, may slide down.
- If swapping leads, every unused piece must be transferred individually.

Sling racking

Advantages

- If swapping leads, all the unused pieces are transferred on the sling.
- The sling can be worn on either side – better in chimneys.

Disadvantages

- On lower angle pitches the gear can swing down in front of you.

CLIMBING PHYSICS

Climbing physics plays a much more significant role in the multi-pitch environment, as the forces exerted by leader falls on a single pitch are limited to the reality of impact with the ground. On a multi-pitch route, longer falls and consequently higher forces can be generated as the leader can fall past the belayer. The ability to evaluate the forces placed on the climbing systems is an essential skill.

Fall factors

The severity of a leader fall can be calculated through a simple ratio (the Fall Factor); the distance the climber falls divided by the amount of rope that absorbs the fall. This force estimate assumes a clean fall with no impact with the wall. Longer falls generate more energy. The rope absorbs energy. The rope stretches as it holds the fall. This dynamic elongation ranges from 25-33%. Skinnier ropes stretch more that fat ropes. The implication for the lead climber is that every time a piece of protection is placed and clipped to the rope, the fall factor changes. A lead fall with no protection and caught directly by the belayer is the most severe fall.

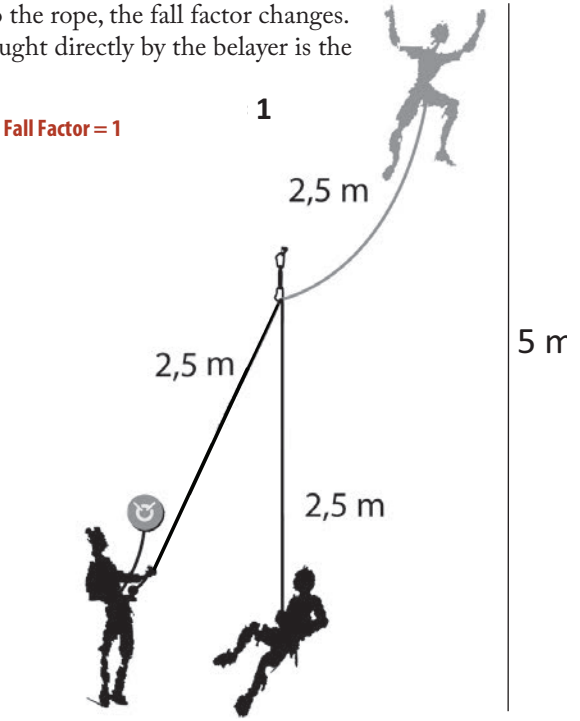
Example fall factor 1

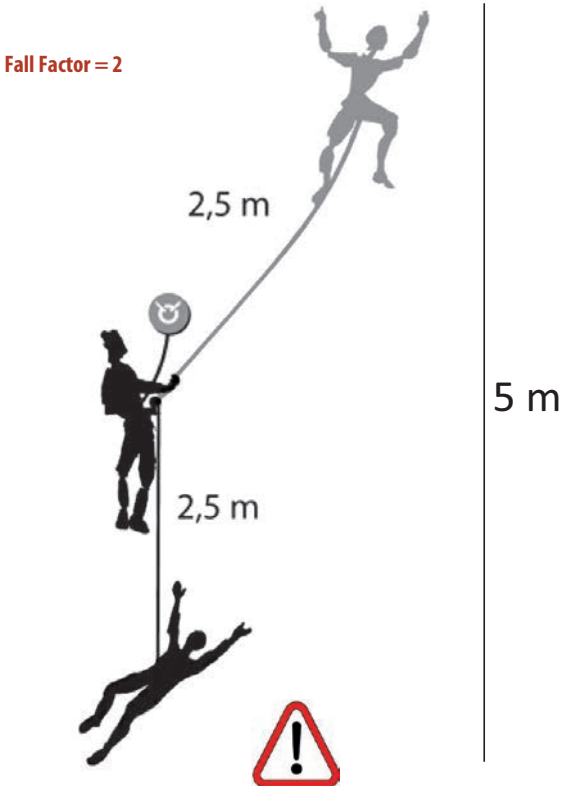
The leader climbs up 2.5 metres and places a piece of protection, climbs another 2.5 metres and then falls off. The fall distance is 5 metres and the amount of rope catching the fall is 5 metres.

Example fall factor 2

The leader climbs up 2.5 metres and falls off before placing a piece of protection. The fall distance is 5 metres and the amount of rope catching the fall is 2.5 metres.

The scenario for the most severe falls occurs in multi-pitch climbing as the climber moves off from the belay. This is when a Fall Factor 2 fall can occur.





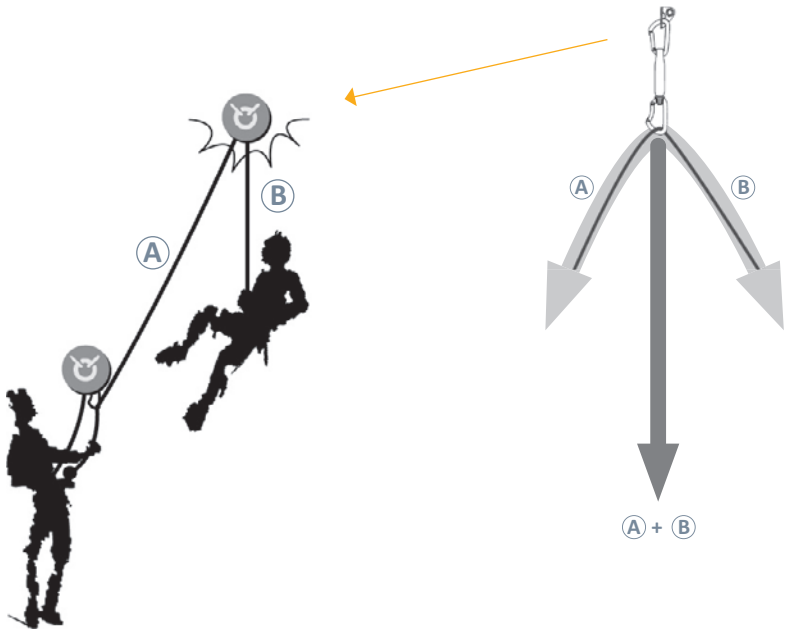
Dynamic climbing ropes are designed to absorb energy and limit the force placed on the system. The standard test for climbing rope is set by the UIAA. The test for single ropes and twin ropes uses an 80 kg weight for the climber, and a Fall Factor (FF) of 1.7 (4.8 metre fall held by 2.8 metres of rope). The test for double ropes uses the same fall factor, but a 55 kg weight. The hang tag on a new rope will list the maximum impact force generated on the first fall, and the number of UIAA standard falls (1.7 FF) the rope can hold based on an 80 kg climber.

There are a number of factors that will influence the force exerted on the system: weight of climber, impact with the wall on the way down, history of the rope (age, number and type of falls held), weight of belayer, type of belay device, and friction in the system.

Rope drag will significantly increase the Fall Factor as friction reduces the effective rope length. Only the rope closest to the falling leader will absorb energy. The belayer may feel minimal force.

Note: The piece of gear that holds the fall will experience roughly 1.66 times the force exerted by the falling climber (downward force exerted by climber PLUS counterbalancing force held by the belayer MINUS friction from carabiners and rock).

Pulley effect on protection = Force A + Force B



A = Force generated by the belayer
B = Force generated by the climber

Forces within the system

A person that weighs 100 kg exerts a force due to gravity of 1 kN. In a 1.7 Fall Factor fall the rope will limit the force on the system to roughly 8 kN. The body can withstand a 12 kN force before things begin to break. However, with the piece of protection that holds the fall subjected to 1.66 times the force, smaller pieces will break or pull out.

Strength of equipment

Cams	*Nuts*
[0.1] 5 kN	[size 1-2] 2 kN
[0.2] 6 kN	[size 3] 5 kN
[0.3] 8 kN	[size 4-5] 6 kN
[0.4] 10 kN	[size 6-12] 10 kN
[0.5] 12 kN	Carabiners and Quickdraws –
[0.75-6] 14 kN	20-25 kN

Fall factor 2

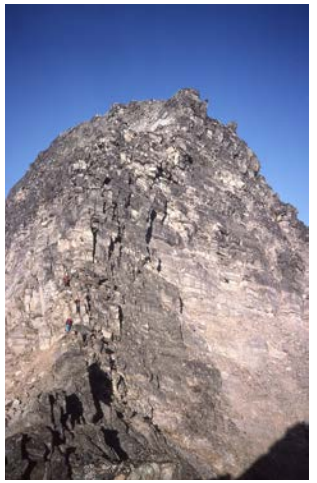
It will be difficult to hold a four-metre fall with two metres of rope on a manual braking device without allowing some rope to slip through the device. The reality of this is that the climber's feet are at the level of the highest piece in the anchor. A slip from this point will result in a four metre (fall factor 2) fall. The rope will likely begin to slide through the belay device. Without gloves, the belayer may lose control. This scenario is avoided by clipping the anchor. If the top piece is unquestionably strong (such as a large cam, large nut, or bolt, etc.), it can be clipped. Redirect through the shelf if the top piece is a medium to small nut.

PRINCIPLES OF PROTECTION PLACEMENT

Placing protection wisely is an essential insurance policy. You hope not to need it, but it must work. Failure is not an option. Placing quality protection takes skill. A greater percentage of the climber's attention and energy is demanded as the climbing becomes more difficult, leaving less for protection placement. At some point, the quality and frequency of placements will drop, however it is at this point that the climber is most likely to fall. There is no point in placing bad gear. Take the time to do it right.

Protection assessment

A novice lead climber has a limited frame of reference to assess protection. Intuitively, a big, fat shiny bolt may seem 'better' than a big, fat rusty bolt, but there is more to it.



Left to right: Quartzite, Granite, Limstone

Rock quality

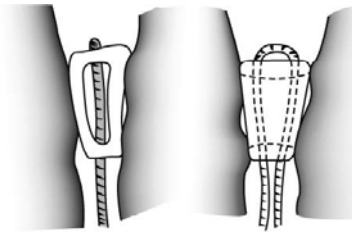
Rock quality is the number one assessment criterion. Is the rock solid? Is it part of the mountain? Will it move, or break if you pull, or push on it?

Rock types have defining characteristics that influence protection quality. For example, splitter granite cracks are thought of as offering a multitude of opportunities for quality protection, but sometimes a hollow or expanding flake will be found. Assess the rock quality. Tap on it with a nut tool or hammer. How does it sound? Does it crumble? Look at the stone. Is it well supported, or just a shattered mass of flakes?

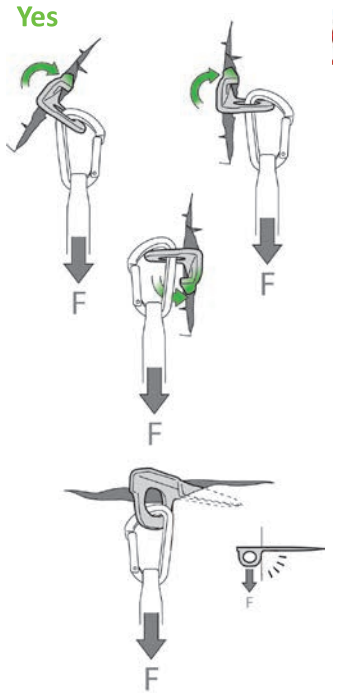
Type of gear

There are a variety of types of gear.

- Active camming units have springs that will help to hold the unit in place. Active cams work well in parallel cracks, but may walk up and out of constrictions that widen above.
- Passive camming units work well in pockets but are more difficult to place than active cams.
- Wedges (nuts, chocks, stoppers) work well in constrictions, but may have only minimal edge contact with the rock in parallel sided cracks.



Nut placements.



Good Placements: when weighted, the piton's eye twists in the direction of pull.

Example of cam and nut placements in a crack.

- Pitons work well in narrow cracks and pockets but damage the rock. Pitons require a hammer for placement, testing and removal. If you do not have a hammer, it is difficult to assess the quality of a fixed piton.
- Bolts are a permanent fixture. However, bolts are difficult to assess. The person who placed the bolt may or may not have done a good job in the first place. Bolts degrade over time. Stainless steel and titanium bolts are more weather resistant. Environmental factors play a role in bolt degradation. High humidity, exposure to salt, and regular freeze-thaw cycles will accelerate degradation.

The leader may have a choice of protection types for a given placement.

Example 1 – A 10 mm crack. Either a size 6 stopper or a 00 cam will fit. If they are both placed perfectly, the stopper will break at 10 kN and the cam will break at 6 kN. If the crack is parallel sided, the cam will provide close to its maximum breaking strength, while the stopper will only provide a fraction of its maximum.

Example 2 - Cams will not fit in a crack that is 3-7 mm. This leaves a nut or a piton. A size 1 Black Diamond stopper is rated at 2 kN. A knifeblade piton will fit in the same size crack but provide far superior holding power.

Fit

The key to assessing fit is to look at surface contact. Does a nut have full contact on both sides of the crack? Do all the cam lobes make contact with the sides of the crack?

Size

Size matters. Bigger pieces are stronger. A bigger piece has more surface contact with the rock. The smallest nut breaks at 2 kN, while the largest breaks at 10 kN. The smallest cam breaks at 4 kN, while the biggest breaks at 14 kN.

Direction of pull

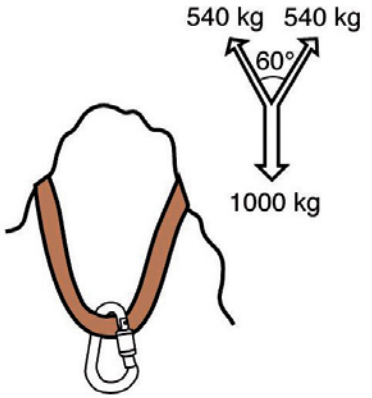
Bolts and pitons are for the most part able to hold loads in multiple directions. Cams and nuts are typically better at holding loads in a single direction, but there are exceptions. A cam in a horizontal crack or under a flake will hold both upward and downward forces.

Is the piece placed so that it can hold the anticipated direction of pull? What happens if a sideways or outward pull is exerted on the piece (such as rope drag)? Will it stay in place?

Natural protection

A variety of natural protection may also be available.

- Horns provide quick and easy protection; however, they are unidirectional and rope drag can often easily lift them off. Make sure the sling is long enough so that the angle formed by the sling is less than 60º.
- Chockstones are a natural form of the commercial wedges. Rocks wedged in cracks can be tied off with sling or cord.
- Threads are hole in the rock where a cord or sling can be passed through and connected.
- Trees come in all shapes and sizes. Large trees can be used a single point anchors, whereas shrubs and bushes provide minimal protection.



Examples of natural protection: a slung chockstone and a natural thread.

PROTECTION PLACEMENT STRATEGIES

Use the following principles to guide your leading strategy

- Don't run out of gear.
  - Look ahead to anticipate your needs. If you think that you will need a particular size of piece to protect a crux high on the pitch, do not use it low on the pitch if you have other options.
- Protect the anchor.
  - Factor 2 falls are to be avoided.
  - Clip the highest big piece in the anchor as your first piece.
- Protect early.
  - First piece must be multidirectional.
- Use quickdraws and alpine draws.
  - Reduce friction early in the pitch.
- Avoid overcamming and deep placements (make it easy to clean).
- Use a nut tool to clean cracks.
- Protect hard moves.
- Protect the second.
- Protect from long runouts.
- Protect from hitting ledges.
- Back clean if you are running out of a size.
- Ease of cleaning.
  - Make sure the second has a nut tool.
  - Do not place awkward, devious, hard to extract pieces.

CLEANING

The second climber should use technique rather than force to remove the gear. This will save wear and tear on the gear and reduce the likelihood of pieces getting stuck.

- Assess how the piece was placed.
- Use the nut tool rather than just ripping the nut out.
- Leave the rope clipped in until the piece is out.
- Rack on a sling ASAP.
- Keep it organized.
- On traverses, remove the gear after the move, then reach back.

BELAY STATION CONSTRUCTION

The anchor must be unquestionably strong enough to support the forces exerted on it. The forces will be considerably higher in a vertical environment compared to lower angled mountaineering terrain. A multi-pitch anchor must also be able to withstand both upward and downward forces. Typically, this means three pieces for downward pull and one piece for upward pull. However, two large cams for downward pull may be sufficient whereas four small nuts may not.

Strategy

- Assess the location – are there good options?
  - Assess the rock quality.
  - What are the options for size of pieces?
  - Assess the placements.
  - How far apart are the placements?
  - How will you connect them together?
- Create a focal point with a shelf.
  - Use a direct anchor belay.
- Anticipate the changeover.
  - Plan the rope stack.

Methods of connection

Pieces in an anchor can be linked in parallel or in series. Sometimes a combination of series and parallel works well.

Left: Parallel construction
Right: Series construction

Parallel

A parallel configuration will have a bight or strand of cord/webbing running from each piece to a focal point. This works well when pieces are separated horizontally.

Series

A series configuration will have a bight or strand of cord/webbing clipped to the top piece and then clove hitched to the next piece. This works well in a vertical crack system and with multiple pieces. It uses less cord than the parallel configuration.

Angles

When connecting two or more pieces together, consideration must be given to the potential increase in force applied to each piece. If the pieces are connected in series, one directly above the other, the angle between them will be 0º. If the pieces are separated horizontally, each piece will have to hold its share of the downward force, plus a horizontal vector force.

For example: At 120º, two equally loaded pieces will each hold 50% of the vertical load, plus an additional 50% as the pieces pull horizontally against each other. Above 120º, each piece will have to hold more than the load.

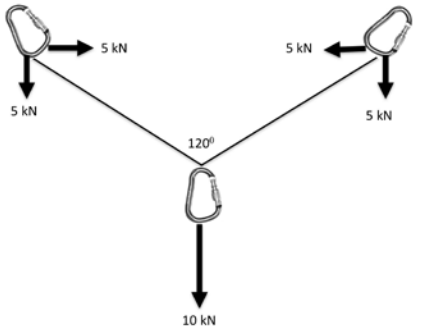
Angles between pieces within a multi-point anchor should be kept below 90º to reduce force multiplication on the pieces.

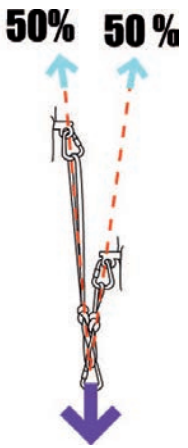
Belay station assessment

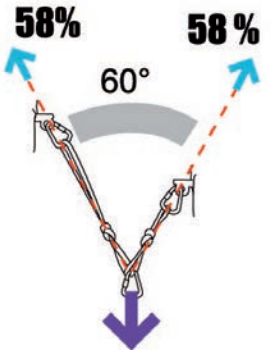
- Redundancy – Are there any elements in the anchor that are not redundant? Do they need to be? Redundancy is good, but not always necessary.
- Shared load – Is the load shared equally amongst all the pieces in the anchor? Does it need to be shared? Should the strongest piece carry the greatest load?
- Direction of forces – Is the anchor oriented to optimize its ability to hold a load?
- Force multiplication – Are the angles low enough to avoid force multiplication through additional horizontal vectors? Are all the angles below 90º?
- Simple – How long did it take to construct?
- Final top to bottom check – Are the gates done up, knots snug?

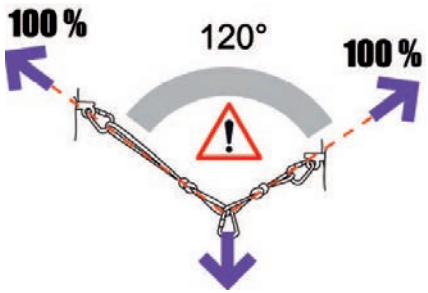
Station Management

- Secure yourself to the first piece if necessary.
- Build the anchor.
- Secure yourself to the focal point or the shelf with the rope.
- Yell “Secure”.









- Clip your direct anchor belay device to the focal point or the shelf.
- Clip a draw to the highest piece.
  - Redirect the rope through the draw.
    - Pull up the extra rope between you and the second.
- Clip the rope to the belay device.
- Yell "On belay".
  - Belay the second up.
- When the second gets to the belay.
  - If you are continuing to lead,
    - Clip the second to the focal point with a clove hitch.
    - Remove the belay device.
    - Flip the lap coiled rope off your tie-in onto the belayer's tie-in.
    - Have the second clip each piece of gear to your rope between your tie-in and the anchor.
    - Re-rack your gear.
    - The belayer puts the leader on belay.
    - Redirect the lead rope through the top piece of the anchor.
    - The leader unclips from the focal point.
  - If you are swapping leads,
    - The second leans back and weights the autoblock belay device.
      - Tie an overhand on a bight on the brake strand as a back-up.
    - If not using an autoblock device, clip the second to the focal point with a clove hitch.
    - Transfer any remaining gear over to the new leader's rope between the belay device and the harness tie-in.
    - The belayer takes the new leader's belay device and puts the leader on belay.
    - Redirect the lead rope through the top piece of the anchor.
    - The leader unclips from the focal point.
      - Take the belay device and untied the back-up knot.
- Climb.
  - Place a piece as soon as possible to reduce the fall factor.

When multi-pitch climbing, use the climbing rope to attach yourself and your partner(s) to the anchor. It is simple, dynamic, easily adjustable and full strength. Do not use a Personal Anchoring System (PAS). The PAS gets in the way when you are climbing. It is a static lanyard. If you clip into a piece, or an anchor, climb above it and then fall, you will place tremendous forces on the anchor.

You will need to convert to a PAS, Purcell prusik, or lanyard for multi-pitch rappels as you will no longer be tied into the rope. The Purcell prusik is perhaps the best option, as it provides a dynamic connection and is readily adjustable.

Rock rescue

IMPROVISED RESCUE

Through the diligent management of risk, and careful assessment of participant competency, the need for rescue can often be avoided or prevented. That said, when dealing with the natural environment occasionally factors outside of one's control may lead to accidents. In a mountaineering context, improvised rescue can be relatively complex due to the scale of the terrain.

RESCUE FROM ABOVE

Rescuing an injured participant from above is a complex skill that requires advanced knowledge and ongoing practice to complete effectively. If a rescue from above is needed, the Summer Mountaineering Leader will need to complete some or all of the following steps depending on the severity of the injuries:

- Tie off the belay;
- Descend to the injured participant via rappel and perform first aid;
- Construct an improvised chest harness;
- Ascend the rope; and/or
- Create a raising system.

RESCUE FROM BELOW (FALLEN LEADER)

Rescuing an injured lead climber is even more complex. If the climber has used less than half the rope, rescue can be as simple as lowering the climber back to the belay. The act of lowering may aggravate existing injuries, but it is the quickest response.

If the climber has used more than half the rope, or the route traverses, the climber cannot be lowered back to the belay. Life becomes complex.

- Tie off the belay device.
- Reinforce the upward pull component of the anchor.
  - It may be necessary to reconfigure one of the downward pull pieces.
- Attach a prusik to the lead rope.
  - Attach the prusik to the anchor with a releasable knot.
  - Transfer the load to the prusik.
- Back up the prusik by tying-off the climbing rope to the anchor with a clove hitch.
- Ascend the climbing rope with prusiks or ascenders.
  - Take some of the protection pieces out from early in the pitch, as you will need to build an anchor.

- When you get to the injured climber:
  - Attend to life threatening injuries.
  - Build an anchor.
  - Transfer the climber to the anchor.
- You will likely need to raise the climber with a block and tackle.
- Remove any upper protection pieces.
- Rappel back down to the lower anchor and remove it.
- Prusik back up to the upper anchor.
- Set up for either a lower or a tandem rappel.

Improvised chest harness:

In instances where injuries or level of consciousness prohibit the injured individual from maintaining a seated position in their harness, an improvised chest harness should be used to prevent them from inverting. An improvised chest harness can be created using a 120 centimetre sewn sling by putting one twist in the sling and passing the injured individual's arms through the two loops created, so that the twist crosses their back. The front of the improvised chest harness can then be connected to the climbing rope the injured individual is tied to, using a short prusik, to keep them in an upright seated position.

RAISING SYSTEMS

If all other options have been exhausted and it is deemed necessary to raise the injured participant to the top of the cliff, then a 3:1 raising system can be used. This system is easily created if an autoblocking belay device has been used.

- Add a short prusik to the loaded rope.
- Tie it off with an overhand bend.
- Clip a carabiner into the prusik.
- Clip the brake rope into the carabiner.
- Haul.

If the belay device is not autoblocking, the Summer Mountaineering Leader will require additional specialized equipment in the form of a rope- grabbing pulley such as a Petzl Micro Traxion. Minimizing friction in a raising system will greatly increase its efficiency. If a sharp edge exists between the anchor and the injured participant, padding it with a pack or other similar material to round the edge, may make the task less laborious.

One procedure for constructing a raising system is as follows:

- Tie a three wrap prusik around the loaded rope with a 5 metre section of 7 millimetre cord.
- Tie an overhand bend in the tails of the cord Immediately behind the prusik knot, to create a small closed loop.
- Tie the tail ends of the cord with a double fisherman's knot creating a closed loop.
- Clip the prusik to the anchor with a locking carabiner.
- Add a rope grabbing pulley to the brake strand behind the tied-off Italian hitch.
  - Connect it to the anchor with a locking carabiner.
- Set the prusik as far down the loaded rope as possible.
- Release the tied-off Italian hitch and lower the load onto the prusik.
- Remove the Italian hitch.
- Remove all slack between the loaded prusik and the rope grabbing pulley by pulling the rope through the pulley.

- Place a carabiner in the small closed loop directly behind the prusik.
  - Redirect the brake strand of the climbing rope through that carabiner.
- Pull firmly on the brake strand ensuring that the rope is moving smoothly through the rope grabbing pulley.
- When the prusik reaches the pulley, reset the system by extending the prusik down the loaded rope as far as possible.

The climber can help in the rescue by pulling up on the rock and climbing as much as possible.

Additional mechanical advantage

If it is too hard to raise the victim with the 3:1 system, more mechanical advantage can be added. To create a 5:1 raising system,

- Remove the haul rope from the haul prusik.
- Tie the two ends of a 7 mm x 5 m prusik together.
  - Clip one end into the anchor.
  - Push the other end through the carabiner on the haul prusik.
  - Clip a carabiner into this loop.
  - Clip the haul rope into the carabiner on the second prusik.
  - Extend the haul prusik as far as the second prusik will allow.
  - Haul.

The assistance of additional participants in completing the physical component of the raise will make the task significantly less challenging for the Summer Mountaineering Leader. However, if significant resistance is met while completing the raise it is important to confirm that the injured participant is not stuck under an overhang or other obstruction.

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Snow and Ice Climbing Skills

The Summer Mountaineering Leader must demonstrate competence in a variety of movement techniques over the full range of snow and ice terrain. Proficiency in movement is the basis for efficiently leading routes and providing instruction and coaching to participants through movement modelling. In this chapter we will highlight the movement techniques that are applied when climbing alpine snow and ice. Summer alpine snow and ice ranges from powder snow to hard black ice. Crampons become necessary once the snow hardens and boots can no longer be kicked into the surface. The consistency of the surface depends on the ambient air temperature and sun exposure. The characteristics of the surface change over the summer season and with temperature changes through the day.

Equipment

BOOTS

Not all mountaineering boots are equal. They are designed for a specific range of mountaineering activity. The best boot for an ascent of the Southwest Ridge of Mount Temple will not do well on the Southwest Face of Mount Everest. Mountaineering boots come in a variety of weights and materials.

Weights and warmth

- The lightest boots will have a moderately stiff sole, waterproof uppers made of leather and nylon and be compatible with crampons.
- A more robust boot that will serve well for longer, colder and technically harder routes will have a stiffer sole, stiffer uppers, increased waterproofness and some insulation. The boot will have welts at both the toe and the heels to accept crampon bails.
- Boots for winter climbing or altitude will have increased amounts of insulation. The warmest boots have an insulating inner boot and an attached outer gaiter. The toe and heel features of the boot must be compatible with the crampon.

Stiffness

The stiffness of the upper will translate into ankle flexion. Stiffer boots are harder to roll over laterally but provide greater support when front pointing. As there are a variety of crampon attachment styles, it is essential to check the fit prior to departure. Boots that flex excessively in the sole run the risk of the crampons falling off. It is more difficult to walk long distances in boots that are completely rigid.

Waterproofness

Although boot manufacturers claim that their boots are 'waterproof', it is relative concept. A boot may be waterproof for an hour-long approach through a wet grassy meadow, but will it still be waterproof on the seventh day of slogging through wet snow? As a waterproof breathable membrane incorporated into many mountaineering boots, Gore-Tex works well when it is new and for short durations (24 hours). As the material fatigues and gets impregnated with dirt and body oil, it loses its ability to repel water and to breath.

Materials

Mountain boots have been made out of leather for over 100 years and it is still the most durable material. Lighter boots use a combination of leather and nylon. But other materials are making their way into the market. For example: the top of the line La Sportiva Spantik has an outer made from "synthetic Benecke CeraCom® PUR leatherette coated with embossed, transparent polyurethane, combined with water-repellent Lorica® coated with Antiacqua™"

CRAMPONS

Crampons can be classified as:

- Lightweight ❶
  - For simple snow ascents and use on spring ski tours.
  - 10-point design.
  - Aluminum and/ or steel.
- General Mountaineering ❷
  - For use on snow and ice.
  - 12-point design.
  - Horizontal front point.
  - Steel.
  - Option for heel and toe bails to provide greater security on harder climbs.
- Technical ❸
  - For hard technical ice and mixed climbing.
  - 12-point design.
  - Vertical front points.
  - Steel.
  - Heel and toe bails.

Crampon fitting

It is essential to ensure that the crampons are compatible with the boots and fitted properly.

- Step 1 – Adjust the length of the rail so that the boot is snug within the crampon without the strap done up. Crampons will fit a range of sizes – usually from size 36 (US Women's 5.5) to size 49 (US Men's 14). Longer bars are available to fit bigger boots.
- Step 2 – Adjust the heel bail if so equipped. The attachment methods for crampons range from straps, to bails, to clamps. To use crampons with bails, the boot must have a welt designed for this.
- Step 3 – Wrap the strap around the boot as per the manufacturer's description.

Anti-snow plates made from plastic or rubber help to prevent snow build up under the crampon and are a necessity for summer mountaineering. They are effective and reduce the risk of an unplanned slip or fall.

Crampon maintenance and repair:

- Inspect your crampons before and after every use. Over time, metal fatigues and straps wear out.
- Sharpen your crampons as needed. If you have been travelling over rocks or mixed climbing, your crampons will need more frequent sharpening. Dull crampons are a hazard. On hard ice the vertical points will skate, and the front points will bounce off.

Catching a crampon on your other leg or on gear hanging off your harness may produce a spectacular fall with potentially negative consequences. Tight fitting gaiters will reduce the likelihood of snagging a point on your other leg. Do not clip dangling items from the back of your harness.

ICE AXE

The length and shape of the ice axe should be selected based on the anticipated need. Travel up a low angle snow covered glacier will need a longer less technical axe, while an ascent of a north face demands a shorter technical tool (or two).

Types of ice axes

- General mountaineering axes are typically 55 cm to 80 cm long with a gently curving pick.
- Alpine axes are shorter, with more radically curved picks.
- Technical ice tools are 45-50 cm long, have interchangeable picks, can be an axe head or a hammer head, and have a pommel at the bottom of the shaft.

Ice axes are rated with a CEN certification. The shafts and the picks are rated either 'B' for basic, or 'T' for technical. Usually they will have the same rating, but not necessarily.

- B rated tools are good to 280 kg.
- T rated tools are good to 400 kg.

Snow movement skills

The movement skills for snow climbing range tremendously. A major transition occurs when the surface becomes hard enough to warrant crampon usage. The transition to and from crampons is a critical decision. Falls are more likely both when the snow is too hard to get a good purchase with the sole of the boot and when the snow softens, and crampons are left on too long. Snow climbing is typically dependent on three points of contact comprised of crampons and ice axe. Climbers must find a balance between security and efficiency.

FOOT MOVEMENT

The principle for step kicking is to build a platform that will support you and your team. Consistency is the key. If you are taller than your travelling companions, make the distance between the steps with shorter people in mind. The step kicking method will depend on the hardness of the snow. In soft snow, plunge your foot down into the snow to pack a platform. In harder snow, use the side of your boot and the serrations on the sole to carve a platform. Every team member needs to work on improving the track by pressing, kicking, or carving a better platform. Steps should angle into the slope.

Pied en canard (Duck walk)

As the slope steepens, open up your stance and splay your feet out. This will allow you to kick and press your feet into the slope.

Pied a plat (Flat foot)

When it is no longer possible to proceed with a duck walk, transition to a rising diagonal line. The box is an efficient method of progression.

- Gain elevation with the uphill foot.
  - This creates a balanced position.
- Move forward with the downhill foot.
  - This creates a less balanced position.
- On lower angle terrain, it may be possible to cross the downhill foot over the uphill foot, thereby gaining both horizontal and vertical distance.

In softer snow, it may also be possible to kick your toes straight in straight into the slope.

USE OF THE AXE

The ice axe becomes a third point of contact or a self-belay. If one foot slips, the other foot and the axe will provide stability. This necessitates a change in the natural rhythm of walking as it is a three-step process. (foot, foot, axe, foot, foot, axe…).

Holding the axe

When walking or climbing with an ice axe, it is important to know where the pointy parts are facing as an inadvertent movement or swing of the arm may place the tool into your flesh or somebody else's. If the axe is not needed it should be stowed on the pack. For short sections where the axe will not be needed, it can be slid under a shoulder strap and slid around to the back.

To avoid losing your axe, remember to remove the axe before removing your pack.

Piolet Canne on a steep slope.

Piolet Canne

When walking on a flat glacier the axe should be held with the pick facing backward in anticipation of self-arresting to hold a crevasse fall. As the slope steepens, the axe becomes more important for self-belay. Hold the axe in your uphill hand. Rotate the pick around so that the adze is under the palm of your hand. This makes it much more comfortable when plunging the shaft into the snow. There may be a decision point where the angle has steepened, and the footing is less secure that it makes sense to rotate the pick back into the self-arrest position. It is less comfortable when pushing the shaft into the snow but makes for a quicker transition into self-arrest if needed.

Piolet manche

The axe shaft is held just under the head of the axe. The pick is pushed into the snow. This works well in harder snow, typically matched with front pointing on crampons.

Piolet appui

This is a transition from the piolet canne position with the pick pointing forward. Instead of plunging the shaft into the snow, push the pick in.

Piolet poignard

Grab the pick like a dagger with the thumb under the adze and thrust it into the snow at shoulder height or above.

Wrist loop

Wrist loops tend to get in the way when using the above-mentioned ice axe techniques and are not recommended.

Turning with the axe

It is necessary to turn at some point when making a rising diagonal track. The climber is more vulnerable to falling while making the transition. Take the time to make a good platform. Kick your toes in if possible. Grab the axe with both hands at the moment of transition. Complete the turn and resume the three step.

Piolet manche

Piolet appui

Piolet poignard

Cutting steps

There may be times when the snow hardens briefly or there is a short patch of ice and your boots will no longer get sufficient purchase. Cut a few steps instead of putting crampons on. In ice, use the pick to score the bottom of the step first, then remove the top. In softer ice or hard snow, use the adze to remove material. Start closest to you and work away so that you are cutting into the space that you have just created. It is likely more efficient to put on crampons instead of engaging in a long session of step cutting.

Descending

Descending snow can be fun, but also carries greater risks. In softer snow the plunge step can be very effective. Face out and plunge your heel into the snow dynamically. This works best when each climber makes their own track. Stay out of the up track and make your own track, as you will destroy the uptrack. It may be useful to yourself or others on subsequent days. As a last resort, it may be necessary to face into the slope if the snow is hard and the slope steep.

GLISSADING

Glissading is the act of sliding down the slope. It can be done either standing, crouching, or sitting. The standing glissade is also known as boot skiing. The edges of the boots are pressured to produce turns similar to downhill skiing. However, the Vibram sole of the boot is not a smooth surface so great attention must be given to rate of descent. The sitting glissade, or bum slide, is easier to control as the ice axe is used as a steering and speed control. The crouching glissade combines the angulation and pressuring of the boots with the steering and braking control of the ice ace.

SELF-ARREST

Self-arrest is an essential skill that must be practiced. It is a skill that will save your life, but you may only have one shot, one opportunity to get it right. The climber must be equally competent with either hand on the head of the ice axe and from any body configuration (feet first, head first, stomach and back)

Hand positions (applies to all body configurations)

- One hand on axe head, thumb under adze, fingers curled over the top.
- Other hand grasping the bottom of the shaft.

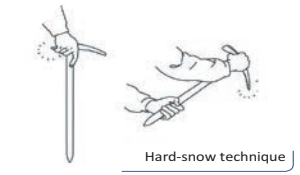
Body Configurations

On your back or sitting – feet first

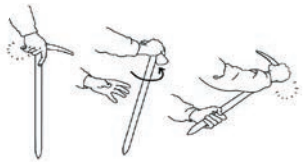
- Grab the axe with both hands diagonally across your body.
  - The hand with the axe head is held at your shoulder with a fully bent arm.
  - The lower hand is held out to the side, away from your stomach.
- Roll towards axe head side of the body.
- Press the pick into the snow.
  - Be prepared for the pick to catch suddenly in hard snow.
- Pressure your toes and spread your feet wide.
- Pull your hips up off the snow while pulling up on your lower hand.
- This will form a triangle of pressure points (the pick and two feet).

On your face – feet first

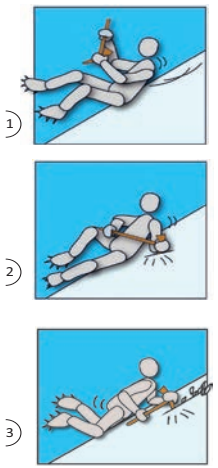
- Get both hands in position.
- You may be able to pull into the arrest position.
  - Arch up onto your toes and pressure the axe head with your shoulder.
  - If not – roll onto your back and initiate as per sitting – feet first.



Hard-snow technique



Soft-snow technique



On your back – head first

- Hold the axe with both hands horizontally across your body at mid belly height.
- Shove pick into the snow, close to your body.
  - This will cause your feet to rotate around to the downhill position.
- Complete the arrest as per Sitting – Feet first.

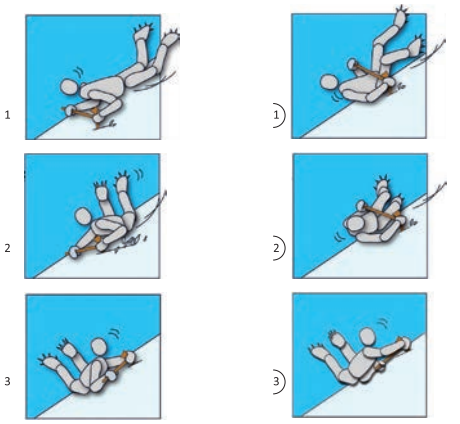
On your face – head first

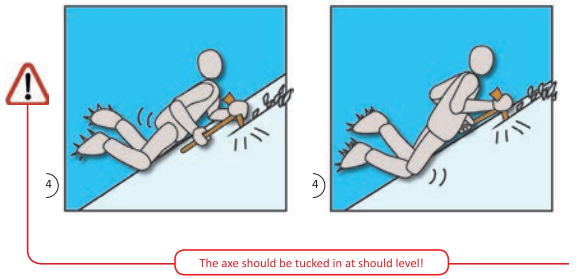
- Get both hands in position.
- Plant the axe out to the side to initiate a spin.
- You will now be on your face – feet first.
- You may be able to pull into the arrest position.
- If not – roll onto your back and initiate as per sitting – feet first.

If you drop your axe, you can still initiate a body position that may slow you down.

- Roll onto your stomach.
- Arch up onto your toes.
- Make a double fist and push it into the snow.

It becomes much trickier if you are wearing crampons. If you slip because your crampons have balled up with snow, you can self-arrest using your front points. Recognize that this may produce a sudden stop and cause a lower leg injury, particularly if you have picked up any speed. A safer option is to keep your feet up and apply pressure with your knees.





Site selection for a practice area

The ideal site is a gradually steepening bowl with a safe, flat runout and no overhead hazard. The snow surface should be free of rock debris.

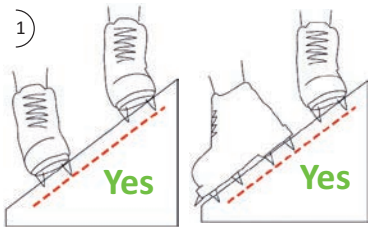
Ice movement skills

Ice (and hard snow) movement skills with crampons are an extension of the skills learned on softer snow. The major difference is that the crampon is pushed straight down into the ice, rather than sliding forward as is done on snow.

Pied a plat or flatfooting takes on added significance. The essential principle in flatfooting is to maintain contact between all the vertically oriented crampon points and the surface of the ice. The difference from flatfooting on snow is that the crampon is not being kicked into the ice. Instead the ankle is rolled to maintain contact with the outer crampon points. The stiffness of the boot upper will determine the extent of ankle roll. If you have stiff boots, you can loosen the top eyelets on your boot.

Pied en canard is essentially the same as when snow climbing.

Flatfooting in a rising diagonal makes use of a modified box step. On lower angle ice it is possible to cross over and gain both horizontally and vertically with every step. As the terrain steepens, it becomes increasingly difficult to keep the outside crampon points of the inside foot in contact with the ice. The tendency is to roll this foot up and lose full contact. The danger is that the edging that occurs will cause the crampon to pop.



TURNING CORNERS

As with snow climbing turning a corner requires attention as the ice axe needs to change hands. Look for small changes in angle where it is a little less steep.

- Plant the axe.
- Stomp the outside foot across the fall line.
- Stomp the inside foot across the fall line at the same level as the outside foot, but pointing in the opposite direction.
  - Your heels should be almost touching.
  - This is an unbalanced position.
- Take what was the outside foot and stomp it into the ice above the other foot and now pointing in the same direction.
- Move the axe.
- Resume climbing.

Pied troisième (Alpine position)

The most comfortable and efficient position for classic 40 to 50 degree alpine ice is the third position or alpine position. It is a blend of flatfooting and front pointing, combining the best of both worlds. One foot is flat, and one is front pointing. It has the upward efficiency of front pointing and the energy efficiency of flatfooting.

- Step up on the front point foot.
- Place the flatfoot above the front point foot and stand up.
- Fully straighten the flatfoot leg to a lock position.
- Move your axe.
- Repeat for twenty to thirty steps then switch feet.

Front-pointing

Once the ice becomes too steep for pied troisième, it is time to front point. The most common efficiency mistake that beginner climbers make is to break into front pointing too soon. Climbing alpine ice is all about efficiency. Front pointing 800 metres up a 40 degree alpine face will build calves of steel.

- The front points of the crampon are kicked into the ice.
- Keep your heels low, knees and hips into the ice, shoulders back.
- Use the first two vertical points to provide additional support.
- Three or four small steps are preferred if the ice is soft.
- Use two larger steps if the ice is brittle and takes more than one kick to get a secure purchase.
- Move as high as possible on your axe.
- Get your feet into a balanced position then remove your axe and plant it higher.
- Avoid planting at your full extension. If you do not get a good placement it may be difficult to remove the axe for a second swing.
- Repeat.

ICE AXE POSITIONS

As hard snow turns to ice, increased levels of support and balance are needed from the ice axe.

At some point, one axe will be insufficient. However, the same technique is not necessarily used for both tools.

Piolet canne

As per snow climbing. Used with flat footing as described on page 258.

Piolet ramasse (ascending)

- Used with flatfooting.
- The axe head is grasped in one hand (thumb under adze, pick back).
- The other hand is mid shaft.
- The spike of the axe is jammed into the ice.
- The axe is used for balance.

Piolet ancre

Used with the alpine position or front pointing.

- Grasp the axe with one hand at the bottom of the shaft.
- Swing it overhead, striking the pick into the ice.
- The other hand can then grasp the head of the axe.
- The axe is mostly used just for balance.
- Move up.
- Repeat.

Piolet traction

Is used with front pointing and once the ice is over 60 degrees. Usually two axes are used.

- Plant one axe overhead less than shoulder width.
- Take two steps up.
- Plant the other axe overhead less than shoulder width.
- Take two steps up.
- Plant the other axe overhead.
- Repeat.

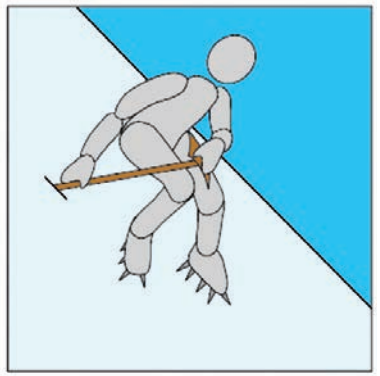
Note – if the climbing becomes harder, the sequence can be modified.

- Step up so that both feet are at the same level.
- Plant both axes at the same level, shoulder width apart.
- Watch for dinner plating between the axes.

Piolet ramasse (descending)

Flatfoot descending is easier than flat foot ascending due to the body angles needed.

- Point your toes downhill (can be straight downhill or at an angle).
- Stomp your foot straight down into the ice.
- Repeat with the other foot.
- Take small steps.
- Stay balanced on your crampons. The tendency is to fall forward over the front points.
- Lean back slightly. It is a good quad workout.



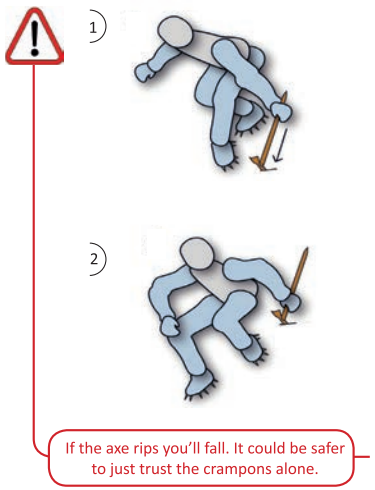
Piolet ramasse

Piolet rampe

The ice axe can be used to create a hand rail.

- Hold the axe at the bottom of the shaft.
- Swing the pick into the ice below you.
- Pull up on the shaft to engage the teeth on the pick.
- Walk downhill, sliding your hand along the shaft.
- Once your hand is at the head, remove the axe and replant it lower.

Frontpoint descending is simply a reverse of ascending. The only difference is that it is harder to swing the axe in piolet ancre position.



It may be necessary to plant the axe at an angle a little wider than shoulder width and then rotate the axe as you climb lower. Alternately, if using technical tools, choking up on the tool shaft or using another means of gripping the tool higher can facilitate swinging the tools lower for descending, especially on ice tools with steeply-angled picks. Be careful not to climb too low before removing your axe, as it can be difficult at full extension to get the teeth to disengage.

Multi-pitch climbing

LOW ANGLE SNOW AND ICE

Low angle terrain presents a dilemma for the mountain leader. Twenty to twenty-five degree hard snow or ice provides a tremendous sliding surface. An uncontrolled slip can quickly turn into a catastrophic fall. A competent climber will comfortably solo at this angle. A competent guide can short-rope two people at this angle. However, a mountain leader with a larger group may need to resort to pitched climbing. Staying roped in, moving together and relying on the 'team' self-arrest is not an option as a sliding climber is likely to pull the whole team off.

HIGH ANGLE SNOW – PITCHED CLIMBING

In the most extreme cases, high angle snow climbing can become an exercise in maximum effort and body contortion to construct a passage with minimal protection. In more reasonable terrain, it requires the leader to climb from belay anchor to belay anchor, typically without needing to place snow protection on the way. Placing protection when leading on snow can be challenging, particularly when considering that the effort to place protection may far exceed the likelihood of a lead fall. In narrow couloirs it may be possible to get rock protection.

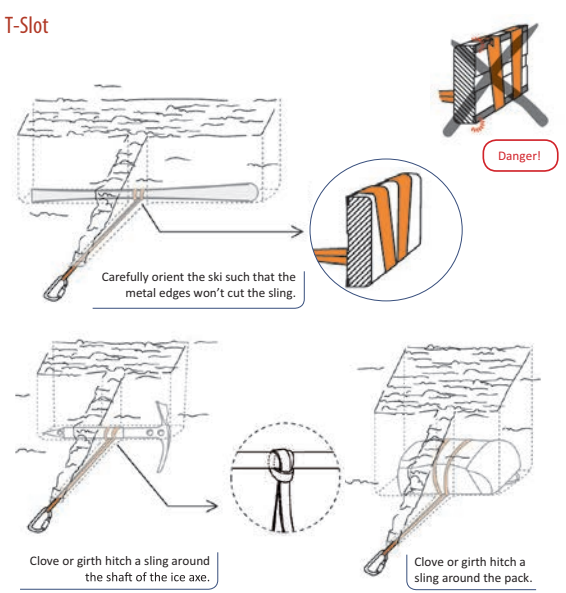
BELAY STATION CONSTRUCTION – SNOW

An additional dilemma to pitch snow climbing is anchor construction. A picket or ice axe placed in a t-slot anchor has been the 'go to' bomber anchor, however it is time consuming to construct. It can take longer to construct a t-slot than to climb a 60 metre pitch. Upright pickets with a mid-length clip-in point have been found to be just as strong, if not stronger than a t-slot anchor.

The question then becomes "how strong does the anchor need to be"? A lead fall on a 45° slope will generate 4-8 kN. The leader must assess the anticipated maximum force applied. This will depend on the likelihood of a lead fall, the number of people on the rope, the angle of the slope, and the hardness of the snow. The strength of the anchor will depend on the strength of the snow, the strength of the anchor material and the direction of pull on the anchor. The strength of the snow will depend on the layering properties: moisture content, temperature, and resistance (particularly ice layers and weak layers). This will affect both the compressive strength and the shear strength. In weak snow (fist to four finger resistance) compression failure is more likely. Shear failure is more likely in hard snow, when the load is applied over the length of the anchor. It is important to recognize that snow strength varies tremendously over both time and location. In hard snow most snow anchor types fail at about 7 kN.

Types of snow anchors

- T-slot – The strength of a t-slot anchor will depend on the quality of the snow and the item buried. An ice axe, picket or ice hammer is buried in a horizontal trench at 90 degrees to the anticipated direction of pull. The strength is based on the force required to pull the object through or out of the snow. Larger objects or harder snow provide more resistance. Failure can occur in either compression or shear.

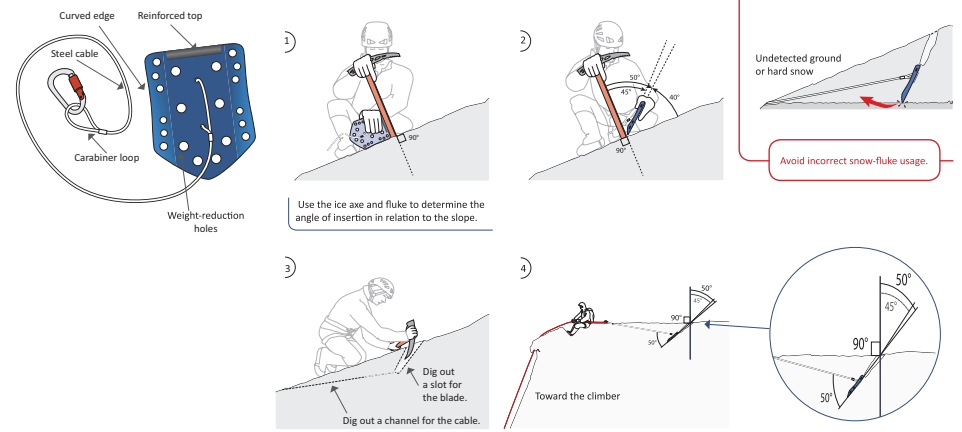


If the snow is soft, a larger object will be needed, and the snow can be hardened through packing. In hard snow the trench should be at least 30 cm deep, while in softer snow the trench will need to be over 50 cm deep.

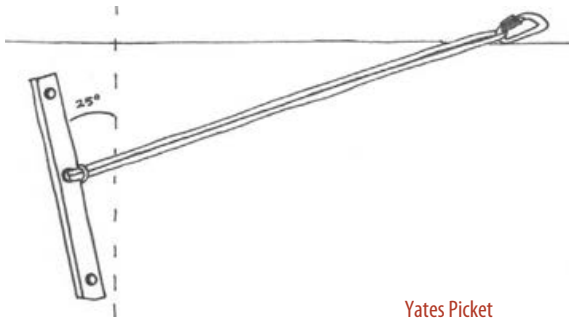
- Cut the trench with a slightly overhanging front face.
- Once the top of the T has been constructed, cut a narrow slot at 90 degrees (the direction of the pull) with the pick of the ice axe.
  - Pickets should be clipped with a locking carabiner mid-shaft.
  - Ice axes should be T-rated.
    - Clove hitch a sling around the shaft at the balance point (not mid-shaft).
    - (Depth, clove hitch, downward pull).
  - Other objects can be used.
  - (Pack, skis, stuff sack, rock)

- Fluke (deadman)
  - Flukes can be very challenging to place well and can behave unpredictably when loaded in variable snow conditions.
  - Probe for ice layers.
  - Angle 40 degrees up from the slope.
  - Chop a shallow trench with your adze.
  - As with the T-slot, cut a narrow groove in the direction of pull for the wire.

Snow Fluke



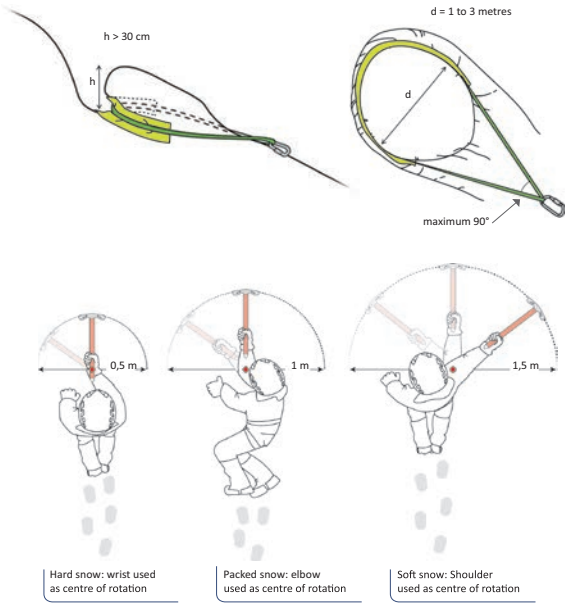
- Vertical picket (mid-shaft attachment)
  - The Yates style picket with a mid-shaft attachment is one of the strongest and most versatile snow anchors. The cable is rated to 10 kN. In real world tests the snow did not fail; the cable finally broke at 12 kN.
  - Insert the picket at 25º back from perpendicular to the snow surface.
  - Yank hard on the cable to cut through the snow and ensure it is pulling straight. Not doing so can result in the picket popping out under load in harder snow.
  - If the picket cannot be fully inserted in shallow snow, a horizontal t-slot will be stronger.



Yates Picket

- Bollard
  - Size equals strength
    - The bollard should be at least 30 cm tall and one to two metres across.
    - In softer snow the back will need to be padded (ice axe, pack, clothing).
  - Construction
    - Use the adze to form a teardrop shaped groove.
    - Make sure the uphill end has a lip to keep the rope from flipping off.
    - Enhance natural features to speed construction.
    - Lip of a moat or ridge feature.
  - Failure mode
    - Shear failure of a weak layer.
    - Rope cutting through the snow (pad the back).
  - Can be a good rappel anchor as nothing is left behind.

Bollard



HIGH ANGLE ICE – PITCHED CLIMBING

High angle alpine ice pitched climbing shares many of the same characteristics as waterfall ice climbing such as the need for protection and high-quality anchors while leading, and fall factor issues. The belay anchors must be unquestionably strong and sufficient to hold the force exerted by a factor two fall.

Efficiency

Speed equates to safety on long alpine ice faces. So, efficiency is important. Beyond just leading pitches faster, there are a number of strategies that will improve your efficiency.

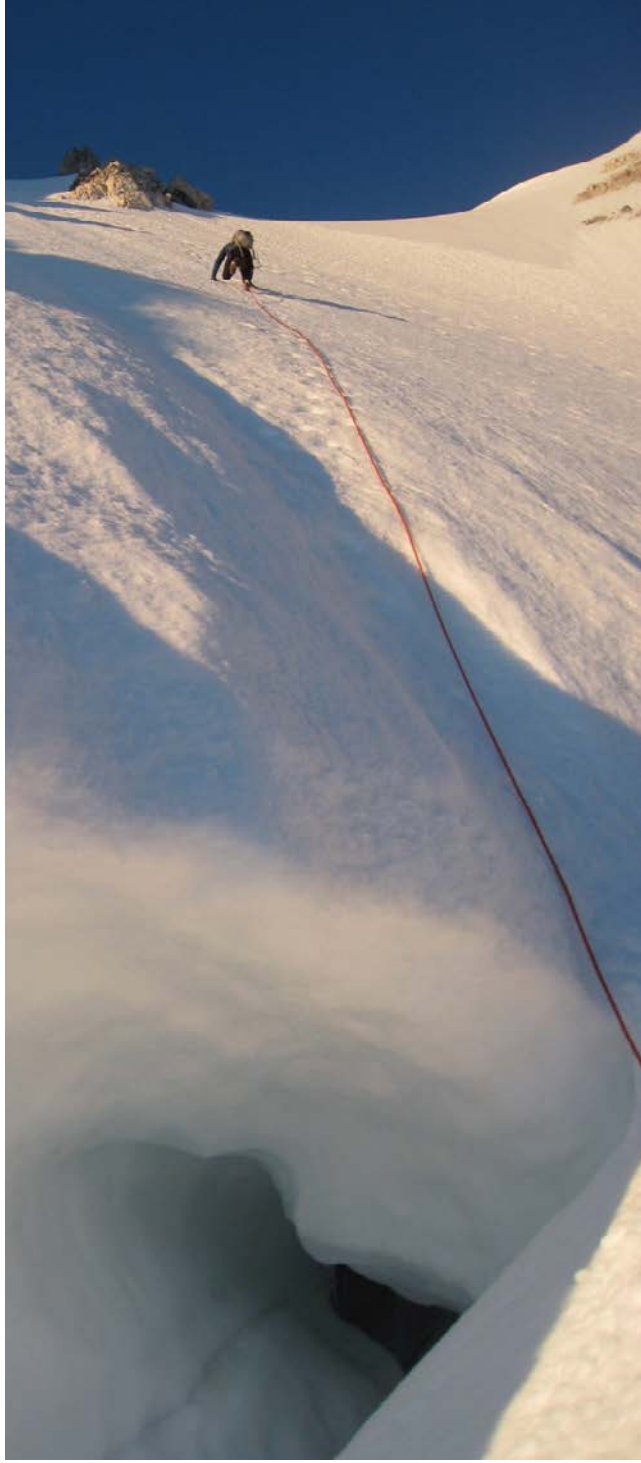
- Use a long rope and run your pitches right to the end. A 700 metre ice face will be 14 pitches with a 50 metre rope, but only 10 pitches with a 70 metre rope.
- If the climbing is easy for you – push yourself to climb faster, but not carelessly.
  - Place a protection screw right off the belay, then climbing carefully, run it out to the anchor.
- Have the second only use one tool and use it just for balance.
  - The second must be kept on a snug belay with absolutely no slack. The second is at risk of a substantial drop if they slip with most of the rope out.
- As soon as the leader gets the first anchor screw in and gets clipped in - yell "secure".
- As soon as the second hears "secure", take out one of the bottom anchor screws.
- Lead in blocks as the leader gets a rest while the second climbs.
  - It is easier to push hard for one rope length at a time, rather than two in a row.

Ice screw placement - leading

- Look for a spot that has darker coloured ice (blue, or black).
  - Use a planar, or concave feature.
- Create a stance by cutting a step with your axe or kicking a step with your crampon.
  - It should be big enough to get your full foot on sideways.
  - Step up into the stance and stand with a straight leg.
- Select a spot for the screw that is between shoulder and hip height.
  - Dig down to find better quality ice.
- Chip a little starter hole.
- Rotate the screw into the ice all the way to the hanger.
  - Chip away more ice if necessary so that the hanger is oriented toward the direction of load.
    - The hanger should not be under tension.
- The placement angle for the screw should be perpendicular to the ice or slightly angled toward the direction of load.
  - In shaded, solid, hard ice,
    - Angle the screw toward the direction of pull by up to 15º.
  - In soft, or sun exposed ice,
    - Place the screw perpendicular to the direction of load.
- Attach the rope to the screw with an alpine draw.
- Cover the screw with snow if the air temperature is above zero or the placement is in the sun.

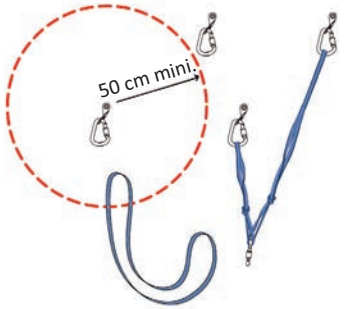
Ice screw cleaning – seconding

- Clean the screw as soon as you take it out.

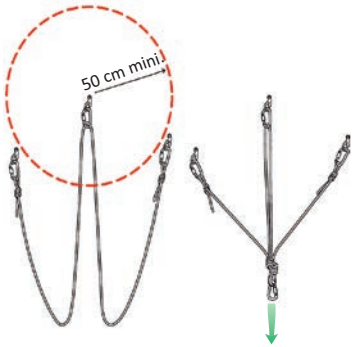


BELAY STATION CONSTRUCTION – ICE

The standard belay anchor configuration is two 16-22 cm ice screws. They should be placed one above the other and connected with a 120 cm sewn sling.



Belay station with two ice screws



Belay station with three ice screws

An alternate configuration is to place them at the same height about 30 cm apart and connect them with two 60 cm sewn slings.

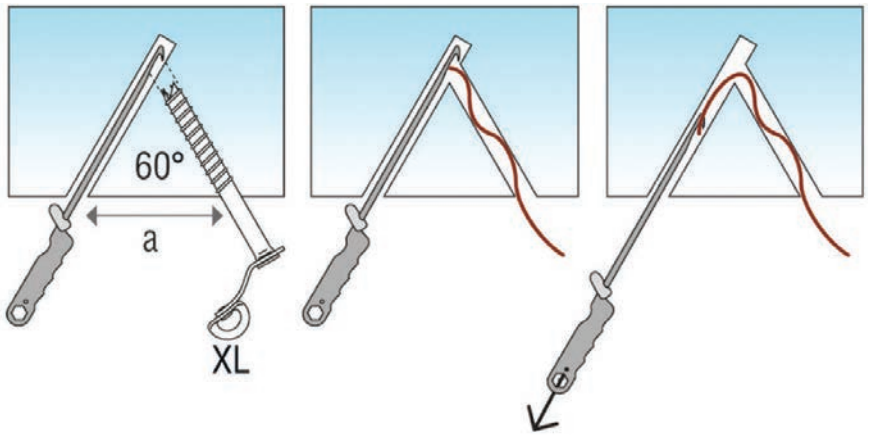
The holding power of an ice screw is based on the size of the threads, the length of the screw, the angle of placement and above all the quality of the ice. Alpine ice varies considerably in quality from a snow/ice combination (snice) to hard black ice. The long-term quality of screw placement is also dependent on the ambient air temperature and exposure to sun. On a hot, sun exposed face, an ice screw can become questionable in the time it takes to lead a pitch.

Ice screw anchor construction

- Climb until you run out of rope.
- Make a small ledge for one foot.
  - Stand on the ledge with a flat foot.
- Place your first screw at shoulder height.
  - Clip the rope in with an alpine draw.
- Step down and place a second screw directly below the first screw.
- Connect them together with a 120 cm sewn sling.
  - Tie the sling off with a sliding X or an overhand knot.
  - Clip in with a clove hitch on a locking carabiner to the focal point of the sling.
- Step down and carve a ledge to stand on.
- Set up a direct anchor belay.
  - Clip your tools into the anchor so that you do not lose them.
  - Lap coil the rope onto the tools as you bring up your partner(s).

Other types of ice anchors

- V-thread
  - V-thread anchors have a number of advantages over ice screws, but they take longer to construct.
    - V-threads are preferred if the anchor will be used for a period of time such as when top-roping.
  - Vertical v-threads test at about 12% stronger than horizontal v-threads.
  - Clean the ice surface.
  - Place a 22 cm screw at 60 degrees to the ice surface.
    - Back the screw out partway to make it easier to sight the second screw.
  - Place a second 22 cm screw.
    - Pointing at the first screw.
    - 22 cm away, at 60 degrees to the ice surface.
  - The two holes need to line up at the apex of the equilateral triangle.
  - Thread 8 mm cord or 1 inch webbing into the hole.
  - Fish the end out from the other hole with a hooker.
  - Tie the cord/webbing together.
    - Single fisherman's for the cord or an overhand ring bend for the webbing.
    - A double fisherman's knot is acceptable for rappel anchors.
  - If the ice quality is suspect, consider building a second v-thread and linking them together.



- Bollards can also be cut into the ice. Use the same principle as for snow anchors. They do not need to be as big as a snow bollard (20-30 cm will typically suffice). It is usually faster and stronger to construct a V-thread.
  - Select a section of ice that is not fractured.
    - Avoid planar ice layers with weak layers underneath.
  - Chip delicately and deliberately, as a hard hit toward the centre of the bollard may cause a dinner plate fracture across the entire bollard.

Routefinding

COULOIRS

Couloirs provide a natural line of descent for falling debris, so careful route selection, timing and routefinding are essential. Under optimal conditions (below freezing, no wind and no precipitation) couloirs are generally free of naturally falling cornice chunks, rocks, snow and ice. However, changes in temperature, precipitation or wind can change that rapidly. If the couloir runs straight up and down, the centre will have the greatest frequency of debris fall. In a narrow couloir, belays should be situated as close to one of the sides as possible. This may also provide the possibility of constructing rock anchors and sheltering under rock overhangs or prominences. It may also be possible to climb up the moat between the snow and ice in the couloir and the rock beside it. There may be a route description or topo that includes information on specific pitches. Timing is essential when climbing a couloir as rising daytime temperatures may climb above freezing. That is when rocks will loosen, and snow softens. Be up the couloir before the sun hits the top and the temperature climbs.

RIDGES

Routefinding on a ridge may be complicated by cornices and short steep sections of rock. Ridges may be less exposed to rockfall and avalanches but are more exposed to weather events such as wind. The prevailing wind will produce cornices on the leeward side. If a cornice is large and unsupported, a route must be found around on the windward side. The challenge then becomes to determine how high on the cornice it is safe to climb. Once established on an extensively cornice ridge, the routefinding challenge is to stay off any overhanging portions. The presence of rocks is a good indicator of safer ground. Be aware that connecting a straight line between two visible rocks may put the climber on a cornice over the top of a couloir.

FACES

Large snow and ice faces provide fairly straightforward routefinding challenges. Typically, the first challenge is to get through the bergschrund at the base of the face. Once established on the face above the bergschrund, climb in a rising diagonal so that any climber generated snow or ice does not hit the belay. Use the same strategy on subsequent pitches. If there is overhead hazard, aim for an area that is less exposed.

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Notes:

Notes:

Short-roping Skills

Short-roping is dangerous when done poorly and slightly less dangerous when done well. The information in this chapter must be used with hands on practical coaching and instruction.

Short-roping two seconds should only be done by leaders with extensive short-roping expertise.

Terrain rating

The North American terrain rating scale runs from Class 1 (Hiking) to Class 6 (Aid Climbing). Short-roping and short pitching is a guiding rope management technique that is used for Class 3 and Class 4 terrain.

Third class terrain is defined as scrambling. Hands may be used, but more for balance than pulling up. The terrain is broken and often exposed. A fall can have consequences.

Fourth class terrain is differentiated by the need for handholds. Strong climbers will move with confidence through this terrain and not need a belay. Novice and intermediate climbers should be belayed. Exposure is an issue and a fall potentially fatal.

When considering whether to short-rope the Summer Mountaineering Leader should factor in:

- Personal competency in short-roping.
  - How much short-roping have I done?
  - Have I short-roped in this type of terrain (rock type)?
  - When did I last short-rope someone?
- The second's movement skills and competency in being short-roped.
  - How well do they move in third class terrain?
  - When were they last in terrain of this nature?
- Nature of the terrain.
  - Is it stepped, benched or slabby?
  - Is it low angled snow or ice?
  - Exposure?
- Anticipated loads
  - Relatively low (body weight or less).
  - Consequence of a fall (slip).
    - Minimal (not catastrophic).
    - Where pitching it out would be slow and/or inefficient.
    - Bottom line – Can I prevent a slip from becoming a fall and ripping us both off the mountain?

Principles of short-roping

A rope team with a range of personal climbing abilities will be challenged to move through third and fourth-class terrain safely and efficiently. Easier ground might involve simple walking, and harder terrain would involve technical belayed climbing. But what about the terrain where a team of two competent climbers would move independently, without a rope? The Summer Mountaineering Leader has the skills to move through this terrain safely, but the rope team member(s) do not. On a long route with considerable amounts of third and fourth-class terrain, pitched out climbing is not a viable option due to time constraints. Soloing is also not an option, as the team members' movement skills are not strong enough.

The Summer Mountaineering Leader must undertake a risk – benefit analysis; balancing probability with consequence. Soloing might have a high likelihood of success and low likelihood of a fall occurring, however the negative consequence might be fatal. Pitched out climbing might be at the other end of the scale, with minimal likelihood of a fatal fall, but also minimal likelihood of a successful summit.

If the leader chooses to short-rope the team, the probability of success goes up. The likelihood of a fatal fall is based on the leader's competency in applying short-roping skills correctly. However, the consequence goes up, as a fatal fall will include the entire rope team.

Short-roping is based on a number of principles.

- Speed is safety (speed is not always a priority, but safety is).
  - Be efficient.
- The leader must not fall.
- Balance and tension.
  - Security in movement comes from climbing in balance.
  - The leader should not pull the second up the climb.
- Too much tension is counterproductive.
- The leader cannot catch a fall. The leader can only prevent a slip from becoming a fall.
- The leader must be ready to catch a slip at all times.
  - If the leader is unable or unready to catch a slip, the second must not be moving.

COMMUNICATION

Inherent within short-roping is that the leader and the second are close together. This allows the leader to utilize a powerful tool in the form of verbal communication. The value in the leader's coaching is the ability to provide a verbal virtual rope. It is difficult to be short-roped. Constant and careful communication will make it easier. This can help to ease any feelings of uncertainty due to exposure and loose rock. The constant communication runs in sync with physical modelling of movement. "Put your foot here." "Do not use this block. It is loose." "There is a good hand hold here."

RATIOS

Short-roping depends on the simple physics of 'the immovable object (the leader) meets the irresistible force (the second)'. When the leader and the second are of similar size, the leader uses the terrain to keep the team safe. On a smooth rock slab, hard snow or ice slope the only thing keeping the team safe is the leader's strong stance and the purchase of his feet; rubber friction on rock, boot lugs on snow, or crampons into ice. If the body core tension of the stance or the purchase of the feet fails, the rope team will fall.

A Summer Mountaineering Leader who has built and demonstrated competency short-roping a single partner can consider short-roping two or even three partners. It is essential to recognize that if both partners fall off, a 70 kg leader will not be able to hold a 140 kg rope team without the benefit of terrain. Not only is it essential to prevent the second's slip from becoming a fall, but also preventing the second's slip from knocking off the third. The implications are that the leader will need to only short-rope in simpler, low consequence terrain and transition to short pitching sooner.

A Continuum of techniques

CONFIDENCE ROPING

A hesitant climber, unsure of his footing, or scared by exposure typically feels a tremendous boost in confidence with the addition of the rope. This translates into more confident movement and hence less likelihood of falling. The varying tension in the rope also acts as a conduit for feedback on the second's movement skills to the leader.

SHORT-ROPING

Rock

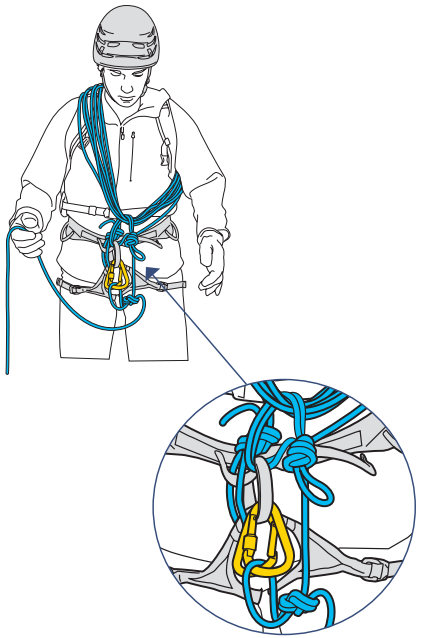
Roping up

Assess the terrain. Is it mostly third and fourth-class terrain with short technical steps that are 15-20 metres high? If a full 60 metre rope has been brought for elsewhere on the climb, the rope needs to be shortened considerably.

Tie-in for a team of two on rock.

- Tie into the end of the rope with a figure-eight follow through.
- Coil up 40 metres of rope and stuff it in your pack.
- Coil 10-15 metres of rope in loops over your shoulder.
- Tie off the coils with a slippery overhand knot around the coils and through the belay loop.
- Butterfly coil the remaining 5-10 metres and hold in your hand.
- Tie the second into the end of the rope with a figure-eight follow through.

This provides a variable rope amount.



Tie-in for a team of three on rock.

- Tie the third into the end of the rope with a figure-eight follow through.

- Tie a large overhand on a bight.
  - The distance up the rope from the second will depend on the nature and steepness of the rock.
  - More rope will be needed for harder climbing or steeper climbing.
  - The loop should be 0.75 metres.
- Tie a figure 8 on a bight in the loop.
  - Clip the second into the figure-eight with a triple action locking carabiner.

The distance between the second and the third can be adjusted by tying another figure-eight on a bight and clipping it into the thirds belay loop with a locking carabiner.

If the short-roping section will transition into a more technical section that will be end-roped, the tie-in for the second should be changed to a single fisherman's on a doubled line. The tie-in for the third remains the same.

Technique

The rope to the second is held in the downhill hand, thumb up toward yourself. The uphill hand holds the coils. There should be a small amount of tension on the rope. Enough to feel how the climber is moving, but not so much as to pull the climber out of balance. Minor variations in speed between the leader and the second are sensed through rope tension. Correct tension is maintained through arm flexion/extension. Do not allow the control arm to become fully extended as this reduces the ability to react to a slip. If necessary, allow the rope to slide down through the control hand, or up by pulling with the hand holding the coils.

On ridges, the second may be able to travel on the opposite side from the third. Stationary, one climber on each side provides an instant belay anchor.

Snow

Roping up

Tie-in for a team of two on snow and ice.

Snow slopes are fairly uniform, so the rope can be shortened to a fixed amount.

- Tie the second into the end of the rope with a figure-eight follow through.
- Tie a hand loop one to two metres from the tied-in second.
- Tie the rope off around the coils as per rock short-roping.
- The ice axe is held in the uphill hand as a self-belay.
- The rope is held in the downhill hand by the hand loop.
- When the arm is fully extended, the rope should come tight on the harness tie-in.
- The arm holding the rope is held in a bent position.
  - This acts a shock absorber.
- The hand loop can also be used at transitions as a temporary anchor point.
  - Put the shaft of the ice axe through the loop and push the shaft into the snow.

Tie-in for a team of three on snow and ice.

- Tie the third into the end of the rope with a figure-eight follow through.
- Tie a large overhand on a bight 2.5 metres up the rope.
  - The loop should be 0.75 metres.
- Tie a figure-eight on a bight in the loop.
  - Clip the second into the figure 8 with a triple action locking carabiner.

Technique

On snow the rope to the second is again held in the downhill hand. The uphill hand holds the ice axe. The rope hand is held high near the chest with a bent arm. Quality step kicking will enhance both efficiency and safety.

Ice

Roping up

Short-roping can be useful on low angle (less than 25 degree) ice or on crevassed sections of dry glaciers. A technique similar to that used on snow will work on uniform, low angle ice. Tie a hand loop about two metres from the second. Recognize that a fall on 25 degree hard ice is not much different from a free fall.

When moving through broken up sections of crevasse fields the leader may need to continuously vary the amount of rope used; similar to the techniques used on rock. The leader will need to have both hands available to manage the rope, so the axe is stored between his back and the pack for easy access.

Technique

Use a similar technique as on snow. On hard snow or ice, a tractor pull method using two ice tools can be an efficient method of dealing with short steep sections. Keep the rope snug and use four points of contact to provide security. The second can use either one axe or two. Two axes will provide more safety, but less speed.

SHORT PITCHING

Once it becomes no longer feasible to move together, the next step is to climb short pitches and belay from anchors that are just strong enough. In fourth and perhaps easy fifth class terrain, the leader climbs short (5-20 metre) pitches then belays the second up. Terrain repeats itself. Assess the nature of the terrain. Features tend to repeat themselves. How high are the rock steps? The belay anchor can range from a horn to a sitting belay to one or more pieces of gear. When in doubt, anchor and pitch it out.

Protection

If the climbing is harder than the leader is willing to solo, or conditions have deteriorated (rain, wind, snow), the leader can choose to be belayed and to place protection.

Anchors

- The quickest anchor is to throw the rope over a horn, as long as the rock quality and direction of pull is good.
- Also quick and simple is an unanchored waist belay.
- If it is not possible to incorporate a piece of terrain, the next best solution is a single piece of gear plus a body brace.
- Finally, if the consequence of a second slipping or falling off is full body weight hanging on the rope, a two-piece (or more) anchor may be needed.

Limitations

When moving together, it is essential to recognize that the leader is NOT an anchor. Preventing a slip from becoming a fall is based on careful terrain selection and the application of the correct rope handling technique for that terrain. On the way up the leader must sense the movement of the second, by listening and the feel of the rope. Whereas on the way down, the leader has better visual clues of the second's movement skills; the second goes first and the leader follows. If the leader holds the rope up to their chest with a bent arm it is possible to hold 1.5 times the amount of force the average person generates in a slip. If the second falls 20 centimeters before the rope comes tight, he will generate more energy than the average leader can hold, even from an optimal stance.

Size matters

Size difference between the leader and the second also plays a role. An 80 kg leader with a 40 kg second can safely short rope through terrain that a 50 kg leader with a 70 kg second cannot.

Routefinding

PACING

Short-roping allows the leader to maintain an appropriate pace for the second. Set a steady, measured, un-rushed pace that can be maintained for a long period. The pace should be slow enough to allow adequate time to maintain a high level of situational awareness in addition to ensuring precise hand and foot placements. Proper pacing is determined by several factors, which include distance, terrain, group fitness, and weather. The proper pace has everyone moving at a comfortable level of exertion, which allows the pace to increase temporarily if hazards exist or develop (i.e. traversing rockfall or avalanche paths or a storm) and/or to continue for a longer duration than initially planned. A proper pace greatly reduces the risks of fatigue related injuries.

On snow and ice, it is easier than on rock to maintain a consistent stride length and cadence. If the length of rope between the leader and the second is too long, the second will tend to bunch up against the leader. This will also happen between the second and third. This is a dangerous situation for the rope team as the slack in the system will make it difficult for the leader to arrest a slip before it becomes a fall. In this scenario, the only way for the leader to maintain proper spacing is to accelerate and push the pace (which is not usually desirable).

DESCENDING

The challenge now becomes micro route finding, as the leader must coach the second on where to go. More accidents happen on the way down, as the leader is one step removed from route selection decisions. The second can inadvertently take a step into steeper, more consequential terrain, forcing the leader to catch the slip before it becomes a fall. Take note of key landmarks on the way up. Once above a key landmark, stop and point it out to the team. Let them know that they will be expected to find it on the way down.

When down climbing short steep steps, coach the first person down while using a belay from above. Have the first person coach and spot the rest of the group down.

Belays

A variety of belay methods are used when short-roping and short pitching.

- Hand – the simplest belay.
  - From a strong stance, slight tension is placed on the rope.
  - This only works if less than body weight is anticipated.
- Waist
  - Standing position
    - Can hold body weight.
    - Legs braced against the direction of pull.
    - Rope around the waist.
    - Single wrap around the forearm.
  - Sitting position (stronger than standing)
    - Can hold more than body weight.
    - Legs braced against the direction of pull.
    - Rope around the waist.
    - Single wrap around the forearm.
- Shoulder
  - Braced for a downward pull.
  - Angle of pull is critical.
    - Must be a downward pull.
    - Not good for an outward pull.

Waist belay.

Hand belay.

Shoulder belay.

- Possible to pull the second up.
- Terrain
  - Horns
    - Check for rock quality.
    - Angle of pull.
      - Make sure that the rope will not slide off or roll up.
  - Ridges
    - Keep a piece of terrain between the team members.
    - If the second falls off, the leader needs to be prepared to get to the other side of the ridge.
      - Jumping off might not be a great option.
    - The leader and the second may be able to climb on opposite sides.
    - Cornices create additional complexities.
    - Often necessary to traverse around.
      - A short-belayed pitch may be a solution.

Transitions

Efficient and safe transitions are very important as poor transitions will lengthen the days. The Summer Mountaineering Leader must be able to transition the team from short-roping to glacier mode and back to short-roping; and from short-roping to pitched climbing and back to short-roping. The transition from glacier mode to pitched climbing is covered in the Snow and Ice Climbing chapter. The other transitions to master are going from rock-to-snow, snow-to-ice, and rock-to-ice.

SHORT ROPE TO GLACIER TRAVEL

This fairly common transition can be prepared as you rope up at the toe of the glacier. In mid-summer the toe of the glacier is bare ice. At some point there will be a transition to glacier travel.

- Prepare the rope for glacier travel as per Chapter 10, with rope carried in the pack and prusiks on the rope.
- Shorten the rope by adding coils over your shoulder.
  - The leader and/or the second can take up coils.
- Tie off the coils with an overhand slip knot.
  - Clip the loop back to your harness.
- Tie a hand loop.

When you get to the firn line and the crevasses are no longer obvious, transition to glacier mode.

- Make the transition before you get onto the snow.
- Remove the coils.
- If there is still the potential for the second to fall off.
  - Put in an ice screw and anchor to it during the transition.
- Extend the rope.
- When the rope comes tight to the second, he can remove the ice screw and follow the leader.

GLACIER TRAVEL TO SHORT ROPE

As the glacier steepens, it may be necessary to transition to short-roping. If the short-roping will transition to pitched climbing a full change is needed. Make the rope transition in the lower angle terrain rather than in a potentially more exposed position when preparing for pitched climbing.

- Probe a safe transition stop.
- Use a prusik to belay the second in if required.
- With a three-person team,
  - Take coils between second and third to shorten the rope.
  - Or change position of second by clipping close to the third with a carabiner.

GLACIER TO SHORT ROPE (and prepared for pitched)

- As above but retie the second into the end of the rope.
- The second can take up some coils, but not too many as they can become awkward.
- Stuff half the rope into the pack.
  - If the rope is stuffed rather than coiled, it can be pulled out without removing your pack when you are ready to transition to pitched climbing.
- Take up coils around your shoulder.
- Tie off as per standard short rope tie off for snow, ice or rock.

SHORT ROPE TO PITCHED

It may be necessary to establish an anchor.

- If the transition point is a large ledge there may be no need to secure the climbers.
- If the transition point is more tenuous, then create an anchor.
- If the leader will not be belayed, a single point anchor may be sufficient.
- If the leader will be placing protection, then a full two or three-piece anchor is needed.

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Water Crossings in Summer

Water crossings are often a necessary requirement of summer mountaineering travel. All water crossings should be considered dangerous and be evaluated carefully. An understanding of basic principles of water crossing, as well as how to assess and manage associated hazards, can make this undertaking much safer. Understanding appropriate water crossing techniques and when to use them is important.

Principles of water crossing

Water crossing is dangerous and must be evaluated carefully. Moving water is powerful, relentless, but also somewhat predictable. If a creek or river must be crossed, the ideal site has slow and shallow water. The three key factors to be evaluated are water temperature, flow rate and distance to cross. In western Canada creeks and rivers are generally influenced by snow melt so they are cold. Cold water will quickly reduce sensation in feet and legs and decrease physical performance. Full immersion may cause hypothermia. Be wary of water temperatures below 20 degrees C.

Water volume is measured in cubic metres per second (cms) and gives an indicator of the amount of water passing a given point. Water speed is driven by gravity. The river gradient influences the speed. Both the volume of water flowing, and the speed determine the force that the river exerts. A slow-moving river may have the same force as a fast-moving creek with less water.

Flow may change over the period of a day due to the diurnal cycle. The weather is directly related to streamflow. The rate of snow melt will maximize in the afternoon due to daytime temperatures. Hot sunny days will produce more snow melt and consequently higher water volume. Flow will be lowest early in the morning. This may make for an easy crossing in the morning on the way to a climb, but an impassable creek in the afternoon on the way home. Thunderstorms with intense rain events may produce flash floods.

Hazard management

DECISION MAKING AND COMMUNICATION

Stream crossings seem to bring out the independent thinking process as everyone comes up with their own idea of the best place to cross. It is easy to lose people as they investigate options. Take a firm stance and form a group action plan. River noise makes it hard to communicate from one side to the other. So, make sure everyone is clear on the plan before it is enacted.

Take some time to scout the riverbank both upstream and downstream before selecting a site.

HAZARD ASSESSMENT

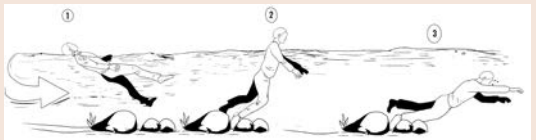
- Look downstream for hazards. This includes: obstructions, constrictions, bends, holes, waterfalls, logs, sweepers, strainers.
  - Do not cross above hazards.
- Assess the bed surface condition. Is it large boulders, sharp rocks or smooth sand? Is there potential for a foot entrapment?
  - Avoid crossing when foot entrapments are possible.
  - Look for smooth surfaces to walk on.
- Assess the stream width. Is the river braided with many smaller channels? Does all the water flow through a tight gap?
  - Cross where the stream is braided.
- Assess the direction of the flow. Is the river straight or does it follow a series of bends?
  - Avoid bends as a swimmer will be flushed to the faster water on the outside of the bend.
- Asses the bank height.
  - Will it be easy to get out on the other side?
- Look for any debris floating down.
  - Are there any large logs?

Once the best crossing choice has been made, assess the residual risk compared to the alternatives.

- Can you change the route?
- Can you walk to a bridge?
- Should you just wait for the water level to drop?

Foot entrapments

If you get swept away keep your feet up to avoid a foot entrapment. Only stand up if you are in shallow water (less than 60 cm) or out of the current. Use a defensive swimming position. Lie on your back with your head upstream and your feet up. Use a backstroke to head for the shore.



Water crossing techniques

LOG CROSSING

There are two forms of log crossings: constructed and naturally occurring. Constructed crossings may have hand rails, ropes or wires for additional balance. Naturally occurring crossings can have hand lines added.

Assess the hazard

- How high is the log above the water?
  - A log that is in or near the water can be wet and slippery (or even frozen).
- What is the downstream consequence?

Strategies

- Tighten packs.
- Add downstream safety.
- Add a rope as a hand line.
- Balance with a pole or ski poles.
- Put your crampons on.
- Sit down.
- Ferry the pack over for the weaker member(s).
  Ensure that everyone in the group is capable of making the crossing.

HIGHLINE (TYROLEAN TRAVERSE)

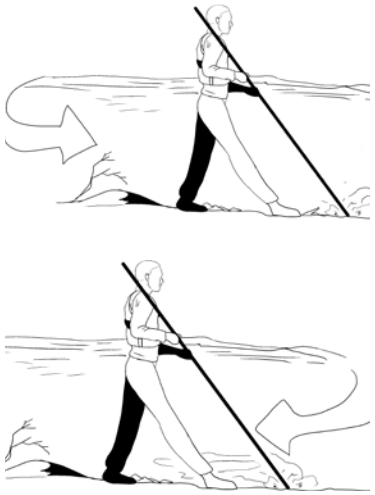
Another solution is to build a highline that keeps everyone above the water. If you will be returning the same way, bring an extra static rope and leave it set up. The challenge can be to get the first person across. One person can cross without a pack and get wet. Once somebody is on the other side unquestionably strong anchors must be selected.

- Throw a rock or stick tied to parachute cord to get the line across. Attach the climbing rope to the parachute cord and pull it across.
- Set up a doubled rope like a rappel so that it is retrievable. Decide which side you want to retrieve it from.
- Tension the ropes with prusiks and a 3:1 pulley system.
- Build a tram system using a locking carabiner and the mid-point on another rope. This guide line will be used to ferry the packs across and provides extra security to help pull people across.
- Guideline is managed at each end with an Italian hitch.

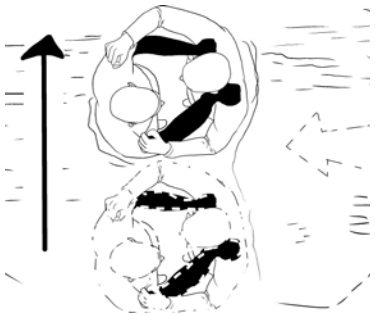
BOULDER HOPPING

Boulder hopping is often selected as a primary choice as it offers the option of maintaining dry feet. However, it is not without hazard as river rocks are often covered in slippery lichen and moss. Large steps and jumps require agility and balance. Ensure that everyone in the group is capable of making the crossing.

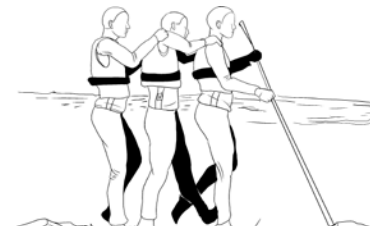
- Spot the wider gaps.
- Pass packs across.
- Ski poles are of great benefit and should be fully extended.
- Set up downstream safety.
- Tighten pack straps for better balance.



Solo crossing technique



Two person crossing technique



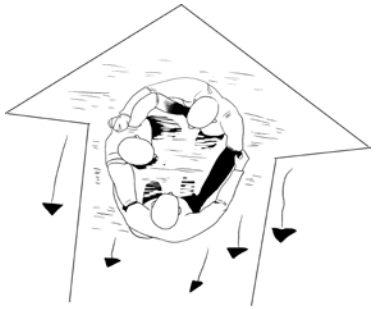
Group crossing techniques

IN THE WATER

Once you have made the decision to enter the water use the following techniques.

- Packs
  - Loosen shoulder straps, hip belts undone.
- Footwear
  - No bare feet.
  - Plan ahead – running shoes.
  - Use your boots.
- Solo crossing
  - Use ski poles or a stick.
  - Face upstream, bracing with poles upstream and move sideways.
  - Face downstream, bracing with poles downstream and move sideways.
  - Face the direction of travel, braced with a pole either upstream or downstream.
- Group crossings provide mutual support but need coordinated movement.
  - Two people.
    - Face each other, arms braced on each other's shoulders.
    - One person is upstream of the other.
    - Walk sideways.
  - Line abreast
    - Face upstream.
    - The largest person is upstream.
    - The upstream person is supported and provides a buffer for the downstream people.

- Tripod
  - The largest person is upstream, facing downstream.



Three person tripod crossing techniques

USING THE ROPE

Using the climbing rope is a last resort. Beyond the fact that the rope will be wet for the climb, ropes and moving water are a dangerous mix if done poorly. The primary hazard is entanglement. It is essential that if the person in the water is tied into the rope that they have a method of quick release. It is extremely hazardous if you get swept away. Even having a knife handy may not be enough.

Using a rope may make it easier for the middle people to get across, but it can be difficult to get the first and last people across. The simplest method of rigging a rope is to set up a downstream diagonal. The ends are secured with people using waist belays. The rope must be releasable. The far side of the crossing is set up downstream from the near side. The water will help to push people across.

Downstream safety

Have people downstream to help if someone gets flushed down the river. They should be equipped with a throw rope or reaching stick. Two five metre prusiks will work. If in doubt, practice throwing the rope to ensure that it will reach.

References and further reading

Long, S., (2004) Hillwalking – *The Official handbook of the Mountain Leader and Walking Group Leader schemes,* The Mountain Training Trust, Sheffield, UK

Lavalley, J., Stegemann, M., & Segerstrom, J., (2010) *Rescue Canada Swiftwater/Flood Rescue Programs – Student Study Guide,* Rescue Canada

Notes:

Notes:

Manage Groups in Avalanche Terrain

Though often thought of as a 'winter problem', many summer mountaineering objectives can have avalanche risk associated with them outside of the winter months. Many of the avalanche skills familiar to winter backcountry leaders also apply to the summer mountaineering environment. The summer mountaineering leader will also have an understand of the avalanche challenges affecting summer mountaineering terrain.

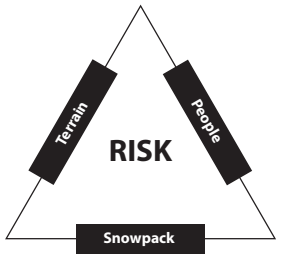
Principles of travelling in avalanche terrain

Mountain terrain that is appealing for climbing is, by its nature, also potentially avalanche terrain. Avalanches become possible when snow sits on steep slopes. Avalanche hazard is based on the likelihood of triggering an avalanche and the destructive size of the avalanche. Avalanche risk is based on exposure to the hazard and the climber's vulnerability to the hazard. Avalanche risk can be described as the interaction between people and snowpack, situated in terrain and modified by weather. Avalanche risk is only present when all four elements come together: people, steep slopes, snow, and weather. The risk will vary based on the climbers' degree of exposure and vulnerability. Many summer alpine objectives are free from avalanche risk. Some routes will have brief exposure on the approach or descent, while on others the climbers will be exposed for the entire time they are on the route. Careful assessment of the proposed route and current weather and snowpack conditions are necessary to determine whether avalanche risk is present.

ARE WE IN AVALANCHE TERRAIN?

A caveat is that climbers are vulnerable to even small avalanches. Summer avalanches in alpine terrain are often unsurvivable due to being pushed over cliffs or into terrain traps such as crevasses. The consequence becomes less an issue of suffocation due to burial and more an issue of trauma due to being pushed over steep terrain. The majority of summer mountaineering avalanche fatalities in western Canada are due to climbers being hit by relatively small avalanches while travelling unroped in steep terrain. The hazards posed by avalanches, rockfall and serac fall are becoming worse due to the destabilization of high mountain areas as a result of global warming.

Avalanche Risk Triangle



TERMINOLOGY

- Avalanche path – a location where avalanches occur. Range in size from 50-3000 m or more.
  - Start zone – the location where the failure occurred, typically over 30°.
  - Track – the slope below, typically 15° to 45°.
  - Run-out zones – area where the snow stops sliding, typically 15° or less.

WEATHER INFLUENCE

The weather creates and influences the development of the snowpack. Every weather event creates change.

Temperature

For the summer mountaineer the temperature is the most important driver of avalanche hazard. A thermometer is an essential tool. Freezing levels are key.

Question

- If the temperature is +5.0° C at 03:00 in the parking lot – how high is the freezing level?

Answer

- The lapse rate is that change in temperature based on altitude.
- The dry air lapse rate is 1° C/100 m. The moist air lapse rate is 0.6° C/100 m.
- So the freezing level will be 500-800 m higher.

Precipitation

Summer precipitation is most often in the form of rain. However, it is not uncommon to get powerful hail storms. Whether the precipitation falls as rain or snow is dependent on temperature. As the temperature typically drops with an increase in altitude; it may be pounding rain at the valley floor, but 1000 m higher snow is accumulating.

Wind

Wind will have an effect on falling precipitation and on the surface of the snowpack. Wind will cause snowflakes to tumble and break up. This will create a stiffer and stronger snow surface. Snow that is removed from one side of a ridge will end up on the other side of a ridge. This action creates cornices and windslabs.

New snow.

Snowpack characteristics

The most reliable indicator of unstable snow is avalanches. Observation and recording of avalanche activity will aid the Summer Mountaineering Leader in assessing the degree of risk.

MAJOR SNOWPACK VARIABLES

The snowpack varies both temporally and spatially.

- Temporal changes will occur on a daily cycle and over the duration of the season.
- Weather will influence the temperature of the snow and the depth of snowpack cover.
  - Cold storms will add load and increase snowpack depth (new snow).
  - Warm storms will add load and decrease snowpack depth (rain).
  - Hot, sunny days will warm/melt the snow, increase snowpack density and decrease snowpack depth.
- Terrain features will influence the snowpack causing variations in depth and temperature.
  - Wind loading will vary based on exposure to the wind and terrain shape.

New snow

Summer storms often leave the high mountains blanketed in new snow. The amount depends on the type of weather front, temperature and wind. It will also vary tremendously with elevation. A heavy downpour in the valley bottom may translate into a metre of fresh snow on the peaks. Once deposited, the new snow will change based on atmospheric conditions.

- If the weather stays cold,
  - Initially cold temperatures will preserve the snow crystals, however prolonged cold may cause the new snow crystals to become faceted. These faceted crystals are weak and do not bond well to each other.
- If the weather warms,
  - Initially the snow will settle and become more firm.
  - On solar aspects, the surface snow will begin to melt.
  - With continued warmth, the snow will start to lose strength.

Wind slab

If the initial storm has wind associated with it, the new snow will be tumbled and broken up when it contacts the ground. This will promote bonding between the snow crystals and will form a slab. The slab will range from soft to hard depending on the duration and intensity of the wind. Higher winds for longer periods build harder slabs.

The key consideration for climbers is the nature of the bond between the slab and whatever is underneath it. Wind slab that sits over cold, dry, faceted, or unsettled snow should be treated with care as there may be the potential for larger areas of the slab to fail.

Wet snow

If the snowpack is subjected to periods of above freezing temperatures, the surface will begin to melt. Prolonged warming will penetrate further into the snowpack. Eventually the entire snowpack will be at zero degrees C. This is called Isothermal snow.

- Snow density – how does the snow feel? Is it solid settled summer snow or just mush? How far does your foot penetrate into the snow? Less than 20 cm is a good indicator. Is it easy boot top step kicking, or thigh high wallowing?
- Water in the snowpack percolates down until it hits an impermeable surface (ice face, rock slab).

MELT FREEZE CYCLE

As spring transitions into summer, the diurnal fluctuation in temperature will bring daytime highs that are above freezing and nighttime lows that are below freezing. This cyclical freezing and melting of the snowpack brings predictability to hazard forecasting. Danger is low when the snow is frozen, and the danger is high when the snow is melting.

- The timing of the cycle is based on how hot it becomes during the day and how cold at night.
- This causes a fluctuation of the likelihood of triggering from almost certain at 14:00 to unlikely at 02:00.
- The extent of overnight recovery is based on how much refreezing happens. How far the refreezing penetrates into the snowpack will depend on the duration and intensity of the below zero air temperatures and degree of radiant heat loss.
  - Colder air temperatures increase the intensity of freezing.
  - A cold night with the temperature dropping below freezing as soon as the sun goes down extends the duration of freezing. A clear night will promote radiant heat loss to the atmosphere.
- The intensity of warming during the day depends on solar effect. A clear hot day will accelerate melting.
- Aspect, incline and slope shape play a huge role in the formation of a melt freeze crust.
  - Steep south aspects will have direct sunlight sooner and longer.
    - Shorter cycle of freezing.
    - Convex bowls will intensify the solar effect.
    - Low angle north aspects will experience a longer freezing cycle and more radiant heat loss.
    - Low angle south aspects will have thicker crusts than steep south aspects.

AVALANCHE PROBLEMS ARE DESCRIBED ACCORDING TO THEIR ATTRIBUTES

- Depth - How deep into the snowpack did the failure occur?
- Character – What was the character of the avalanche?
  - Slab, loose, wet, dry, cornice.
- Size – How much destructive potential did it have?
  - Size 1 – knock a person over, but not bury.
  - Size 2 – Bury and kill a person.
  - Size 3 – Destroy a car.
  - Size 4 – Destroy a semi-truck.
  - Size 5 – Destroy a village.

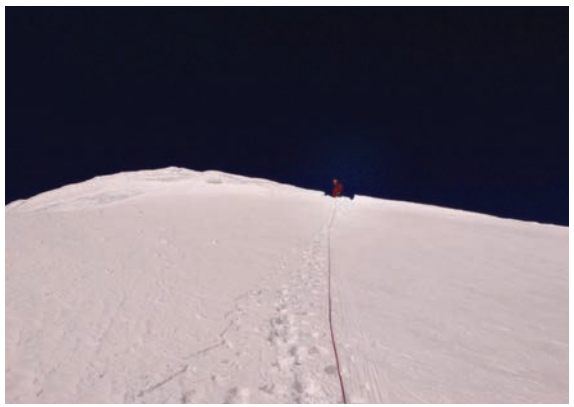
- Sensitivity – How easily was the avalanche triggered?
  - Unreactive?
  - Stubborn?
  - Touchy?
  - Very touchy?
- Spatial distribution – How widespread is the problem?
  - Isolated?
  - Specific terrain features?
  - Widespread?
- Terrain feature – Are there any specific terrain features?
  - Route name?
  - Elevation band?
  - Shape of terrain feature?
  - Aspect?
  - Incline?
  - Exposure to wind?

Overhead hazard

Recognize that overhead hazard may not be obvious. It is possible to be walking on a hiking trail that is threatened by avalanches, cornices, and seracs.

CORNICES

Cornices typically build during the winter months and are at their maximum as the summer climbing season begins. They form on the leeward side of ridges. The prevailing wind picks up snow from the windward side of a ridge and blows it over the ridge. Depending on the air temperature and humidity, some of the snow will stick to the ridge crest and begin to build a cornice out over the leeward side of the ridge. The size and angle of the terrain on the windward side will influence size of the potential cornices. Large low angle areas on the windward side facilitate increased snow movement.



The nature of the hazard posed by cornices is twofold. From below on the leeward slope, it is relatively easy to identify the threat posed by a large unsupported cornice. If the cornice fails, even if it does not trigger an avalanche on the slope below, the relatively heavy snow (300-500 kg/m^3) can cause considerable damage. Cornices are much harder to identify and assess when approaching from the unthreatened windward side. Often appearing as no more than a gradual convex roll, it can be very difficult to assess the size of the cornice.

Poor light adds to the challenge of identifying cornices, making it more difficult to judge where they start and how well supported or anchored they are.

Cornices fail when the strength of the snow or the bond between the snow and the ridge can no longer hold the mass of snow. This can be either a drop in strength or an increase in mass. In the summer, the decrease in strength comes from increased air temperatures. An increase in mass comes from precipitation and wind. The precipitation can be either snow or rain. The fracture line may pull back over the ridge crest.

Cornice management

Hazard management begins with terrain identification as part of the trip planning process. This sets the stage for a field assessment of the magnitude of the problem. How large are the cornices and how can they be safely assessed? This then lays the foundation for careful route selection and track setting. It is recommended to rope up when travelling on a corniced ridge, unless there is exposed rock for the entire distance. An avalanche probe or a ski pole is a useful tool to confirm that the rope team is not travelling on a cornice.

SERACS

Seracs are formed when the glacier flows over a cliff or steep roll. The surface ice is too brittle and cannot bend to follow the roll, so it fractures into many intersecting crevasses. Individual ice blocks or towers are called seracs. On a cliff, the seracs fracture off and fall. The impact of tonnes of ice on the slope below may be sufficient to trigger an avalanche. The ice blocks (and potentially entrained snow) can potentially travel all the way to the valley floor. The timing and likelihood of a serac collapse is dependent on the downslope movement of the glacier due to gravity and is very hard to predict. The tenuous connection between the serac and the rest of the glacier may fail due to downslope movement, melting of the connecting ice, or even the wedging action of water freezing between ice blocks.

A decision must be made as to whether the benefit of travelling below a serac is worth the risk.

- It may be possible to assess the stability of the serac. Is it leaning out over the route with no visible means of attachment, or is it laid back and well attached? This may be difficult to determine from the valley flow.
- How long is the exposure time? Does the route entail a (seems like forever) five-minute scramble across a gully, or is the entire route threatened and will you be exposed to the hazard for many hours?
- What are the options? Is there a longer route that avoids the hazard?

PEOPLE ABOVE

Climbing below other people in alpine terrain is not recommended. Other climbers may trigger avalanches, knock rocks or ice off, or in the worst-case scenario fall off themselves.

GLIDE CRACKS

Glide cracks are often seen in the late spring as water begins to percolate through the snowpack and lubricate the bond between the snowpack and the ground. This is more typically a problem on rock slabs or steep grassy slopes.

SUMMER SEASONAL SNOWPACK

The summer snowpack can be characterized into three distinct periods. The early season summer snowpack is the transition from the end of the winter season. The snow is deep and generally well settled, but melting rapidly, particularly on steep south facing slopes. Late-winter storms can still occur, dumping large amounts of fresh snow. Mountaineering travel is often assisted through the use of skis.

The mid-season snowpack generally provides predictable melt-freeze cycles and good travel conditions. As the season progresses, the firn line moves higher with more exposed rock and ice.

The late season snowpack is often influenced by storms that bring wind and fresh snow. This forms pockets or areas of windslabs. Thin layers of new snow can become faceted and then buried by windslab. This presents a dangerous combination.

Process of daily hazard evaluation

Summer mountaineering leaders may have training and expertise in managing winter avalanche hazards. Much of what has been learned about winter avalanches can be applied in the summer. However, the summer snowpack behaves more predictably. It is not common to have to assess the hazard posed by persistent weak layers. New snowfall events will undergo rapid stabilization due to warmer temperatures. The final bit of good news for climbers is that steeper terrain (50-60^0) is less prone to larger avalanches due to continual sluffing.

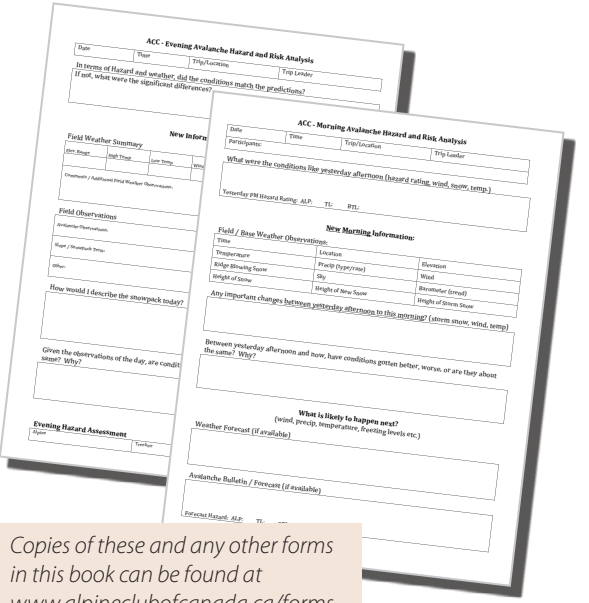
As the avalanche hazard can change rapidly, careful and ongoing assessments are required. They should happen as part of the initial trip planning process, a daily morning meeting, and as the day progresses.

The question to be asked is – Can the route be done safely?

Unlike during the winter season, public safety associations such as Avalanche Canada or Parks Canada do not provide daily avalanche bulletins. The best places to get current conditions are the National and provincial Parks offices and online at www.mountainconditions.com

The hazard evaluation process is more than reading someone else's report. Information from others is one part of the process.

Use the ACC Summer AM/PM Hazard and Risk Assessment Forms.


ACC - Evening Avalanche Hazard and Risk Analysis

Date | Time | Trip/Location | Trip Leader

In terms of Hazard and weather, did the conditions match the predictions?

If not, what were the significant differences?

New Inform

Field Weather Summary

Temp Range | High Temp | Low Temp | Wind

Cloud/Precip / Additional Field Weather Observations:

Field Observations

Aerial/Ice Observations

Slope / Snowpack Tests

Other:

How would I describe the snowpack today?

Given the observations of the day, are conditi... same? Why?

Evening Hazard Assessment

Hazard | Treeline

ACC - Morning Avalanche Hazard and Risk Analysis

Date | Time | Trip/Location | Trip Leader

Participants:

What were the conditions like yesterday afternoon (hazard rating, wind, snow, temp.)

Yesterday PM Hazard Rating: ALP: TL: BTL:

New Morning Information:

Field / Base Weather Observations:

Time | Location

Temperature | Elevation

Ridge Blowing Snow | Precip (type/rate) | Wind

Height of Snow | Sky | Barometer (trend)

Height of New Snow | Height of Storm Snow

Any important changes between yesterday afternoon to this morning? (storm snow, wind, temp)

Between yesterday afternoon and now, have conditions gotten better, worse, or are they about the same? Why?

What is likely to happen next?

(wind, precip, temperature, freezing levels etc.)

Weather Forecast (if available)

Avalanche Bulletin / Forecast (if available)

Forecast Hazard: ALP: TL: BTL:

Copies of these and any other forms in this book can be found at www.alpineclubofcanada.ca/forms

Summer AM and PM Hazard and Risk Assessment Form is different from the winter form. The summer form includes an assessment of all the hazards that a summer leader may encounter and manage including: avalanches, rockfall, seracs, cornices, and severe weather such as thunderstorms.

The AM form is completed prior to departure and on each morning of a longer trip. Access to a Mountain Conditions Report and a detailed weather forecast specific to the area of the climbing route will increase the accuracy of the hazard assessment.

The PM form is completed at the end of each climbing day. It serves two purposes; to summarize the observations that were recorded throughout the day, and as a reflective exercise on decisions that were made. This reflective process is fundamental to building expertise. The forms are more than an exercise in data collection and recording. The forms are a tool to cultivate the establishment of a high level of situational awareness, a good decision-making process and the subsequent development of expertise.

Key observations include: weather conditions (temperature, precipitation, wind), current snowpack conditions, and previous or current avalanches.

An evaluation of consequence is an essential outcome of the process. In the worst-case scenario, how bad could it be? Remember that even a small avalanche may be big enough to knock a climber off. Are there terrain traps below? Will you be pushed into a bergschrund or crevasse and buried?

Terrain assessment

Not all mountain terrain is avalanche terrain. Some terrain such as large rock ridges may be free of avalanche hazard all of the time. Some rock faces may have cornices on the ridge crests that threaten the routes but disappear by mid-June. Snow and ice routes are by their nature avalanche terrain. However, an alpine ice face that is completely free of snow will not have an avalanche hazard.

ROUTE SELECTION

There are a number of strategies that will mitigate exposure.

- Kick steps straight up or down and avoid traverses.
- Hug the edges of snowfields and faces.
- Runnels and grooves often have the best climbing conditions due to frequent sluffs and avalanches that compact the snow. If an avalanche problem exists, stay out of runnels.

Slope tests

It may be possible to test slopes without putting yourself at risk.

- Use a cord to cut a cornice off.
- Throw rocks or snowballs onto the slope.
- Use a hand shear test – cut a small block on all four sides and pull on it.

EQUIPMENT SELECTION

The standard equipment for travel in avalanche terrain is a transceiver, shovel and a probe. Avalanche balloon packs are becoming more popular for skiing activities, but have limited application for climbers. Manufactures are beginning to make lighter equipment that is targeted at mountaineers and ice climbers. The primary usefulness of a transceiver, shovel and probe is in the event that someone in your party is fully buried in an avalanche.

It is essential that climbers recognize the significance of avalanche avoidance in preference to the deployment of avalanche rescue equipment. The impact forces from wet avalanches are huge and the consequence of being pushed off a cliff is often fatal.

Transceivers

Avalanche transceivers perform two tasks; send out a signal or receive a signal.

Technology has improved dramatically over the last 5-10 years. The current standard specifications for a transceiver are: 457 kHz, digital, and three antennas. The digital processor outputs a direction and a distance. The user simply follows the directions.

The ACC Transceiver Policy states,

"Participants on all mountaineering, skiing and ice climbing trips, camps and courses of The Alpine Club of Canada in avalanche terrain are required to use a modern avalanche transceiver, as recommended by Avalanche Canada. Recommended avalanche transceivers are digital, multi-antenna transceivers. Analog and single-antenna transceivers are not acceptable."

The full policy is available here.

www.alpineclubofcanada.ca/forms

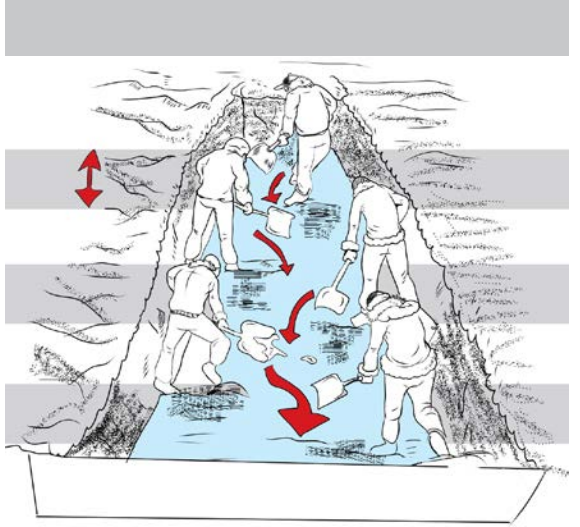
Functions

Avalanche transceivers have two primary functions; transmitting a signal or receiving a signal. The unit must be switched from one function to the other and cannot do both at the same time. The transmitting signal is sent out as a regular set of pulses and originates from the longest of the antennas. It is sent out in three dimensions. The transceiver uses all three antennas in search mode. The two longest antennas provide a direction of travel. The signal strength provides an indicator of distance. The third antenna increases the efficiency of the final fine search.

Interference

Digital transceivers are susceptible to interference from metallic objects: radios, cameras, phones, magnets, metal objects (crampons, ice axe, pitons), etc… Separation between the transceiver and any metallic objects is needed to reduce interference; 20 cm while in transmit mode and 50 cm while in receive mode. Although radios and cell phones are typically an essential part of an avalanche rescue, call should be made away from the immediate search area.

Avalanche rescue cell phone apps have not yet reached the stage of widespread adoption. The search technology is incompatible with traditional digital transceivers.



Shovels

Summer avalanche debris is typically very dense and hard. Most lightweight avalanche shovels do not stand up well to this dense avalanche debris when used improperly. Chop blocks and lift or sweep the blocks downhill. Do not pry. This will break even strong, heavy, steel shovels.

A coordinated team effort is the most effective way to move large amounts of snow. The V-shaped conveyer method is preferred. One person at the front of the line chops blocks. Offset, staggered pairs of shovellers behind the leader sweep the snow down the centre.

Probes

The probe needs to be strong enough not to buckle or break when pushed into firm summer avalanche debris. A 240 cm carbon fibre probe is preferred for summer mountaineering. It is light and strong. Ruler markings make it easier to measure snow depth. Careless use of the probe will easily snap it. A probe is also useful when travelling on a glacier that is thinly covered with snow.

RESCUE

Preparation

- Ensure that the transceiver is turned on and strapped to your body underneath at least one layer.
- Conduct a group check. Is everybody transmitting?
- Shovels and probes should be inside the pack as on the outside they may get ripped off.
- Wear warm clothing.

If you are caught…

- Call out.
- Get to the edge.
- Shelter under a steep feature (rock overhang).
- Kick, swim, fight for the surface.
- Self-arrest, grab trees, or rocks to slow down.
- When the snow begins to slow – try to create an air pocket.
- Push arm to surface.
- Call when rescuers are near.

If your partner is caught…

- Time is critical.
- Watch where he goes.
- Mark the point they were last seen.
- Have a leader.
- Assess for further hazard.
- Switch all transceivers to receive mode.
- Do a head count – how many are missing?

Search procedure

- Be systematic – eliminate terrain and mark it.
  - Visual – scan the debris field for clues.
  - Signal – use the transceiver to check for a signal.
  - Search – use the transceiver to hone in on the buried climber (to within 2 metres).
  - Probe – use the probe to confirm with a physical touch of the body.
  - Shovel – Start digging downhill from the probe strike.
    - At least the same distance downhill as the depth of the probe strike.

Group management

An efficient group search is highly reliant on the cohesive efforts of the entire group. Much of this hinges on group leadership. If you as the Summer Mountaineering Leader are not buried by the avalanche, then you are the most likely candidate for leadership. However, this is not a hard and fast rule, as you may have someone in the group with a greater level of avalanche rescue competence. If you are buried, someone else in the group will need to step up as the rescue leader.

As part of your risk management briefing prior to entering avalanche terrain, it may be prudent to prearrange the accident response procedure.

- Investigate the level of avalanche training of your group members.
  - Determine what skills and abilities they have.
    - Designate a leader (in your absence).

The greatest chance of survival for the victim is based on the skills, equipment and team functioning of the rest of the climbing party. It will likely be too late by the time outside rescuers arrive. However, transceivers make body recovery easier and may reduce the hazard to rescuers.

Accidents

Summer mountaineering avalanche fatalities are infrequent compared to winter outings, but they still happen. The Canadian average annual rate over the last ten years is one per year. Just over half the fatalities happened to unroped climbers, many of whom were hit by relatively small (size 1) avalanches. For the most part, trauma from the fall was the cause of death.

Common errors

- Underestimating the effect of rapid temperature changes.
- Forgetting that snow can lose strength very quickly on sun exposed slopes.
- Underestimating the effect of wind action.
- Not recognizing weak layers in the snowpack.

References and further reading

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The purpose of this field handbook is to support The Alpine Club of Canada's summer mountaineering leader training program, as well as to act as an ongoing resource for summer mountaineering leaders. It is designed to highlight techniques and applications commonly used by summer mountaineering leaders to assist in the delivery of a successful summer mountaineering outing.

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