

Clinic: Two-Person Glacier Travel & Solo Crevasse Rescue

[Krzysztof Ostrowski](#)

last updated on 12/8/2019

Audience: climb leaders and 2nd and higher-year intermediate students

Prerequisites: One of the following badges: Climb Leader, Intermediate Alpine Climbing Course, Intermediate Alpine Climbing Course Student

Duration: 3-4 hours (one evening on a weekday, or preferably, half a day on a weekend)

Location: Mountaineers Program Center (rappel stations at the north wall)

Dates: first session ideally in mid-December, potentially again in January or February if there's interest

Number of students: 4-8 (rope teams of two, students should sign up with a partner)

Number of instructors: 2-4 (ideally one instructor per rope team, minimum one per two rope teams)

Cost: free

Students will learn how to:

- Setup efficiently for glacier travel as a single two-person team: distance between climbers, knots on the rope (when to use, how to space), tie-in, kiwi coil, required gear.
- Arrest a fall and build a SERENE anchor while in arrest position, without relying on external help.
- Rappel into the crevasse, provide first-aid, attach drop loop, and reascend; use runners to extend drop loop if needed.
- Setup a 6:1 mechanical advantage system and haul the fallen climber out of the crevasse while removing slack.

Primary sources/references:

- **Canonical reference:** [The Mountain Guide Manual](#) by Marc Chauvin, Rob Coppolillo
 - When confronted with confusing or contradictory advice, it's safe to rely on this source.
- AMGA videos from Outdoor Research:
 - [How to Rope Up for Glacier Travel](#)
 - [How to Transfer a Fallen Climber's Weight to a Snow Anchor](#)
 - [How to Back Up a Snow Anchor for Crevasse Rescue](#)
 - [How to Prepare a Crevasse Lip for Rescue](#)
 - [How to Rappel Into and Ascend Out of a Crevasse](#)
 - [How to Haul a Climber Out of a Crevasse](#)
- Tacoma Intermediate Climbing instructional materials (consistent with the above):
 - [Drop Loop Crevasse Rescue](#) (video by Gregg Gagliardi)
 - [The 6:1 Drop Loop Crevasse Rescue System](#) (clinic outline by Gregg Gagliardi)
 - [Tacoma 2018 Intermediate Climbing Manual](#) (chapter on rope setup by Gregg Gagliardi)
- [Snow Anchors for Belaying and Rescue](#) by Dan Bogie

Additional sources worth reviewing after the class:

NOTE: Make sure you learn one system well before looking at variations; when in doubt, stick with the AMGA standards, and use The Mountain Guide Manual as the canonical reference.

- [2 person Canadian Drop Loop \(6:1\) Crevasse Rescue](#)
 - Note the alternative way of equalizing the anchor (if cordelette isn't long enough).
- [Drop Loop 6:1 Crevasse Rescue for Guides \(Hard Ice\)](#)
 - Note the way the climber ascends the rope out of the crevasse.
- [Crevasse Falls: do brake knots work?](#)
 - Note how to make the knots bulkier on a thinner rope.
 - Note how efficiency of knots is affected by the composition of the snowpack; with a thin layer of snow over ice, knots won't dig deep enough, and will slide.
- [Kiwi Coil](#)
 - Note the tips on how to size the coil.
- [Traveling on a glacier as a 2-person team with skis and a crevasse rescue with skis scenario](#)
 - Note the use of a ski as a deadman (horizontal mid-clipped) anchor
- [Why you should avoid the Garda hitch \(a.k.a. "alpine clutch"\)](#)
 - Note how this technique, sometimes still taught, can result in a catastrophic failure if it's not executed properly; only consider it as a last resort and understand its failure modes
- [A fall into a crevasse](#)
- [Another fall into a crevasse](#)

Prep work: Review this document, prepare necessary gear, practice setting up the rope beforehand

Scenario:

- A single rope team of 2 traveling on a North Cascades glacier, cannot rely on another team to assist with crevasse rescue.
- Also applicable with 2 teams of 2 as a way to increase the safety margin.

Recommended gear checklist:

- 2 tools
 - NOTE: You will need to dig an anchor while in self-arrest position; doing it with only one tool or axe can be difficult.
- 2 pickets
 - Could also conceivably use 1 tool as a deadman if only carrying 1 picket.
- ATC Guide or equivalent
 - Must be rated for your rope; use ATC Alpine Guide or similar with sub-9mm.
- pulley
 - Can also use a carabiner at the expense of efficiency.
- progress capture

- Can be tibloc or microtraxion, Bachmann (or other carabiner-tended friction hitch), or you can just use ATC in guide mode to keep it simple (at the expense of efficiency).
- 2 hero loops
- 3 single runners (60cm), 2 doubles (120cm), 1 triple (180cm)
- cordelette
- 4-5 lockers, 4 non-lockers
- helmet
- harness
- headlamp
- layers
- rain gear

Agenda:

1. Students form rope teams of two and setup for glacier travel and solo rescue
 - a. Instructors very briefly demo what the correct setup looks like, then students setup on their own. Starting from one climber and moving towards the middle of the rope:
 - Start (as always) with a figure-8 revowen through the hard points on the harness
 - Follow with a correctly tied-off kiwi coil
 - The length of rope in the coil must be enough for the drop loop and 6:1, see the example calculations for 60m rope below
 - Kiwi coil tied through the belay loop, acts as a tie-in point
 - Tug on the rope to test
 - Climber should not be getting squeezed when the rope is pulled
 - Another figure-8 on a bight, clipped with a locker to the climber's belay loop
 - During rescue, this figure-8 will be transferred to the first anchor picket
 - Reference videos:
 - [How to Rope Up for Glacier Travel](#)
 - [Kiwi Coil](#)
 - Optionally, waist prusik can be clipped to the climber's belay loop
 - Prusik is on the rope between the clipped figure-8 and first stopper knot
 - Make it tight, so that during a fall, the prusik takes the load, making it somewhat easier to manipulate the figure-8 on a bight and clip it to the first picket while in self-arrest
 - Traditional pre-tied leg prusik is typically not used in this setup
 - Reference videos:
 - [Drop Loop Crevasse Rescue](#)
 - When using the stopper knots (alpine butterflies):
 - 6 feet of rope from the climber to the first knot (closest to that climber)
 - 3 feet of rope from the first to the second knot
 - 3 feet from the second to the third knot

- Take note of the distance from the third knot to the middle of the rope, as it will help with an efficient setup:
 - e.g., if the desired distance between climbers is 40 feet, this will be 8 feet: $40/2 - (6 + 3 + 3) = 8$
- Factors to take into account when deciding to use stopper knots:
 - Knots are only effective on a wet glacier (snow); they don't work on dry glaciers (hard ice)
 - Must untie knots for belays
 - Must pass knots while prusiking out of a crevasse
- Be sure to choose the right size of a rope to begin with:
 - Enough in-between climbers to arrest crevasse fall (typically 40+ feet)
 - Enough in coils to drop a loop to the fallen climber during rescue
 - Enough for all the tie-in and stopper knots (typically 2+ feet per knot)
 - In North Cascades, in practice ~60m can work for a two-person rope team although a 70m rope would be more comfortable to work with
 - 60m rope = about 195 feet (but measure yours, as it can vary)
 - Subtract from this:
 - 40 feet distance between climbers
 - 12 feet captured in stopper knots (6 knots x 2 feet)
 - 4 feet in figure-8 on a bight (2 knots x 2 feet)
 - 8 feet in revowen figure-8 (2 knots x 4 feet)
 - This leaves ~130 feet for the coils, or about ~65 feet per climber
 - Note this is less than twice the distance between climbers
 - Fallen climber won't fall the full distance (if they were to fall the full distance, both climbers would have fallen)
 - Fall is typically arrested by one of 3 stopper knots on the climber's side (the furthest of which is ~12 feet away)
 - One can always extend the drop loop with a long runner
 - e.g., a triple makes up for ~12 feet of rope
 - Using a shorter rope requires a greater care in tying the knots in the right places
- Considerations for fast-and-light climbing
 - 30m rope is just too short; not recommended for 2-person glacier travel
 - 40m rope might work, but will make this scenario quite challenging, and it may require compromising on the distance between climbers
 - 50m rope can work, but one will likely need to extend the drop loop
 - If using a skinny (sub-9mm) rope, verify that it's rated for use as a single

b. How to setup quickly during the climb:

- Counting coils can work, but it may not be very reliable, as it depends on climber size, layers of clothing worn, pack carried, etc.

d. Rescuer simulates self-arrest and deploys the initial picket, as follows:

- Clip the picket to the rappel anchor, keeping in mind that during the real rescue, when the picket is actually being placed in snow:
 - The type of picket placement will depend on the snow conditions
 - Snow should not be stomped/compressed if it failed the snowball test
- **NOTE: During a real rescue, deploying the initial picket while in self-arrest position will be difficult and energy-consuming; even in hard snow, and with a hamer, it's not easy to pound in the picket with your chest against the snow. Finding the opportunity to practice this on hard snow is highly recommended.**
- Move figure-8 on a bight from the belay loop to the picket clipped to the anchor
 - This is where the waist Prusik can help by taking the load.
 - If there is no waist Prusik, and the figure-8 on a bight is loaded on the belay loop, a second biner can still be used to clip it to the picket (and it can be unclipped from the belay loop once the climber moves back to transfer the load; see the next step).
 - See 1:30 to 1:50 in [this video](#) for details.
- Carefully move back to transfer load to the picket
 - If waist prusik is used, it will go slack and can be removed at this point
 - Be ready to go back into full self-arrest in case the picket fails
 - If the picket were to fail at this point, properly tied-off kiwi coil and waist prusik both serve as (redundant) attachment points (and be ready so the picket doesn't hit you in the face.....just saying)
- Reference videos:
 - [How to Transfer a Fallen Climber's Weight to a Snow Anchor](#)

e. Rescuer reinforces the anchor with the second picket, as follows:

- **NOTE: During a real rescue, one needs to assess the snow conditions, and weigh the benefits of reinforcing the anchor against the risk of the rescue taking longer (climber in the crevasse may be injured and bleeding, or getting hypothermic). In this scenario, we will practice the full redundant anchor setup in order to give participants the chance to practice all elements of it.**
- Attach belay loop with a friction hitch tether to the unloaded strand of the rope between the picket and the rescuer (the "backside")
 - The tether is necessary at this point, because in the following step, we'll be undoing the kiwi coil to gain freedom of movement. If the picket were to fail while dropping the coils, this friction hitch tether acts as an attachment point to the rope and will take the load.
 - See 0:50 in [this video](#) for details.
 - Klemheist is faster; this doesn't have to be bidirectional

- Can use a cordelette and tie with MMO on a biner clipped to belay loop
 - Can also just use the waist prusik and clip to it with the personal anchor, saving the cordelette for other uses (e.g., block and tackle)
 - Untie the kiwi coil, drop a few coils to have space to work, and retie the kiwi coil
 - Place the second picket.
 - Make sure not to place either picket in the other picket's failure cone
 - Make sure to keep the angle between the anchor strands small
 - Too wide of an angle acts as a load multiplier
 - Equalize the second picket to the clip-in point with a block and tackle
 - Cordelette works well
 - Make sure to tie off the block and tackle with a mule-overhand
 - Other alternatives (e.g., trucker's hitch) can also work if the cordelette is not long enough to cover the distance to the anchor
 - Reference videos:
 - [How to Back Up a Snow Anchor for Crevasse Rescue](#)
 - [2 person Canadian Drop Loop \(6:1\) Crevasse Rescue](#)
- f. Rescuer moves to the lip of the crevasse to check on the victim and prepare it for rappel:
- Rescuer drops all the coils (one at a time to avoid the rope getting entangled)
 - Slide the friction hitch to travel towards the victim
 - Put a stopper knot on the rope before approaching the lip
 - Can be a butterfly, overhand, etc. (it's temporary and won't be loaded)
 - Stopper knot should catch if the friction hitch of the tether were to slip in case of a fall
 - Avoid standing directly above the victim (dislodged snow/ice could fall on them)
 - Confirm the victim is unresponsive
 - Pad the lip of the crevasse with a pack (see the video below for an example)
 - Attach the pack to the rope with a friction hitch to prevent it from falling down
 - Take into account the rope stretch once the rope gets loaded during the rappel; slide the friction hitch as high as possible on the rope
 - Reference videos:
 - [How to Prepare a Crevasse Lip for Rescue](#)
- g. Rescuer rappels into the crevasse to render first-aid and attach drop loop to the victim, then reascends out of the crevasse
- Rescuer attaches the belay device on an extension and autoblock on belay loop
 - Make sure to setup rappel above the stopper knot.
 - Setting rappel below the stopper knot risks leaving that knot in place while doing rappel.

- Any knots left on the rope will slide several feet down due to the rope stretch and will have to be passed on ascension while getting over the lip, which can be time-consuming.
- Rescuer removes the tether
 - They are now connected via the rappel setup.
 - Leave stopper knot in until you have weighed/tested the rappel.
- Rescuer tests the rappel and prepares for the rappel, then removes the stopper knot that is still below the rappel device, rappels to the victim, and throws a stopper knot below their rappel, once in position.
- Rescuer provides first aid, then attaches the victim's belay loop to the drop loop with pulley on a locker
 - Will need a runner for extension if drop loop is not long enough to reach
 - Make sure to setup on the correct side, i.e., below the rappel device
 - There is a strand of loaded rope above your rappel device that you are hanging on; if you attach the pulley here, you will not be able to ascend past this pulley.
 - There is a slack bight of rope below your device that goes to your rewoven figure-8 on your hard points; this is where to attach the pulley. As you ascend, the pulley will remain on the drop loop below you.
- Rescuer attaches to the rope a runner they will use as a leg loop for ascension
 - Place above the rappel device with a friction hitch
 - Klemheist recommended, fast to tie and works with a runner, but any friction hitch will work as long as it catches
 - Tie a knot right below the friction hitch on the runner to create an attachment point on it
 - See the "don't forget me at 8:47 [in this video](#)
 - Make sure that you have a backup for the ATC while ascending the rope
 - Can clip the leg loop to the belay loop (e.g., clip to the "don't forget me" knot with a runner)
 - Can also just tie clove hitches, etc.
- Rescuer switches the rappel device into guide mode by attaching it to the belay loop with a locker
 - You will need to raise your body a few inches higher to accomplish this
 - Could climb the crevasse wall if there's something to step on
 - Could also just step into the leg loop if it's vertical
 - Leave extension in place (don't open loaded biner your life depends on)
 - Remove autoblock and stopper knot below it
- Rescuer ascends the rope
 - Pull the breaking strand of the ATC while stepping into the leg loop
 - Pulling is made easier if the breaking strand is redirected via a biner clipped to the "don't forget me" knot to create a 3:1 system

- Keep in mind 3x mechanical advantage means pulling 3x the amount of rope; may need to pull several times
 - May need clove for backup to limit slack if rope slippage is a concern
 - Rescuer attaches themselves with a friction hitch tether back to the rope they were rappelling on
 - Attach back to the strand that goes to the anchor
 - May want a longer leash this time to make it easier to pull, move around to reset pulley, etc., once the rope gets weighted
 - Tie a stopper knot below the friction hitch if slippage might be a concern
 - Can dismantle the rappel system and leg loop at this point
 - Reference videos:
 - [How to Rappel Into and Ascend Out of a Crevasse](#)
 - [Drop Loop 6:1 Crevasse Rescue for Guides \(Hard Ice\)](#)
- h. Rescuer sets up progress capture and the rest of the 6:1 system and hauls the victim up
- Assume a safe position away from the lip of the crevasse (no need to go back to the anchor)
 - Create a remote master point (alpine butterfly) if not at the anchor
 - Can just tie it on the backside of the rope (the strand used for rappel)
 - Can also use one of the stopper knot on the fallen rope, if nearby
 - Attach a progress capture device to the master point
 - Can simply use ATC in guide mode
 - Can also use tibloc or microtraxion if available for higher efficiency
 - Install the pull strand in the progress capture device
 - Finish with a moving pulley on a prusik as in the standard Z-pulley system
 - Haul the fallen climber while removing slack that builds up on the fallen rope
 - Easiest to just tie alpine butterflies every once in a while
 - Can also use other methods (clove hitch, etc.)
 - Pay attention when the victim is at the lip transitioning to moving over the edge, so they don't face plant and lose balance
 - May need to unclip rope from their chest harness if it's clipped
 - Reference videos:
 - [How to Haul a Climber Out of a Crevasse](#)