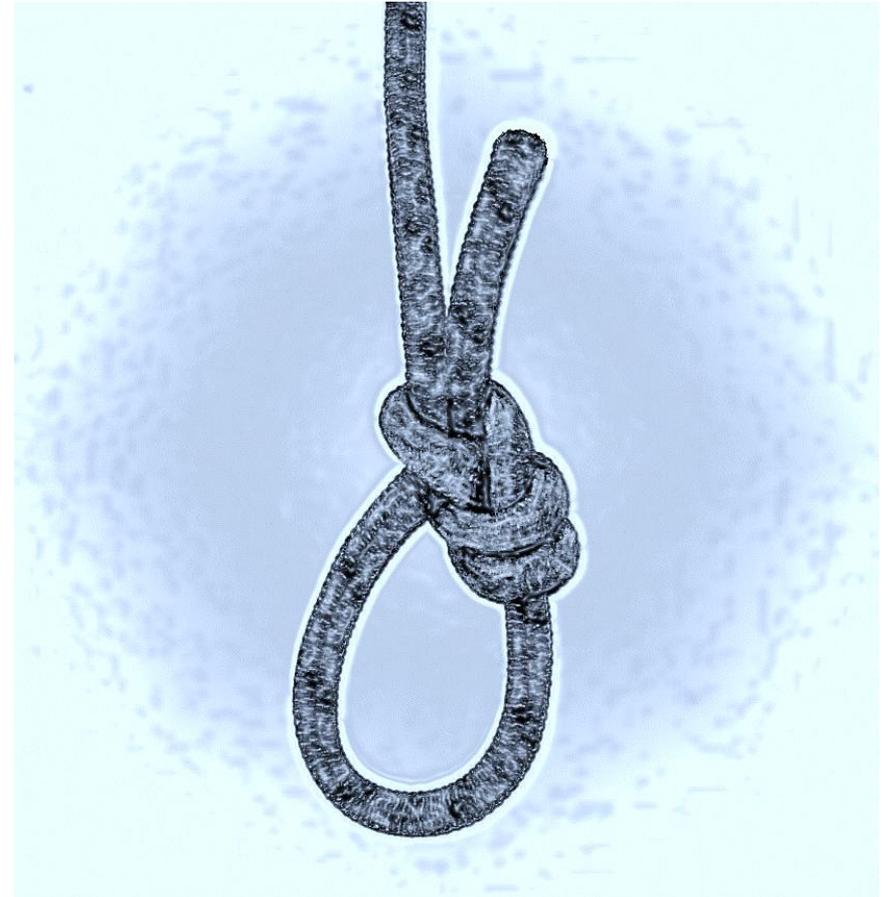


Rope Rescue

Knotcraft



Advanced Knotcraft

Commitment to Muscle Memory

Note:

This module addresses advanced knotcraft that is used in the world of rope rescue. This subject is not intended to be all inclusive. That would be an impossible goal, nonetheless, this module is extensive and demanding.

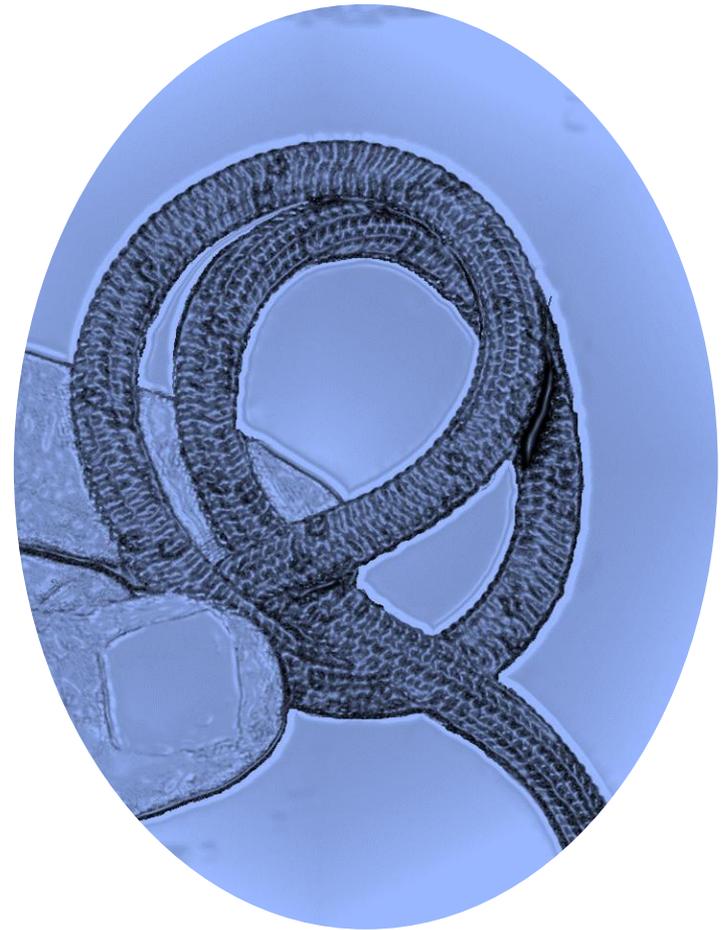


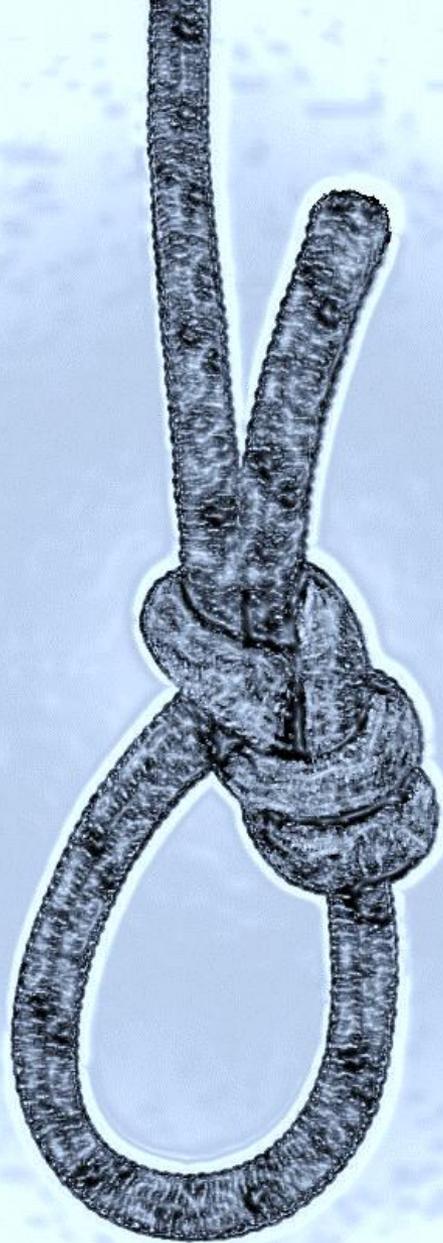
Knot Craft - A Microcosm of Rigging

Knots, Bends, and Hitches

Throughout the evolution of rope rescue there has been much debate over which knot is right for this type or that type of application.

There is quite a collection of rescue knots represented in this chapter. However, please keep in mind we're still only scratching the surface of this topic. Hardly a day passes that we don't learn something new about the language of knots, many of which we have found useful on several occasions. Hopefully, by reading this section you will learn some new knots, and possibly generate some new ways of incorporating them.





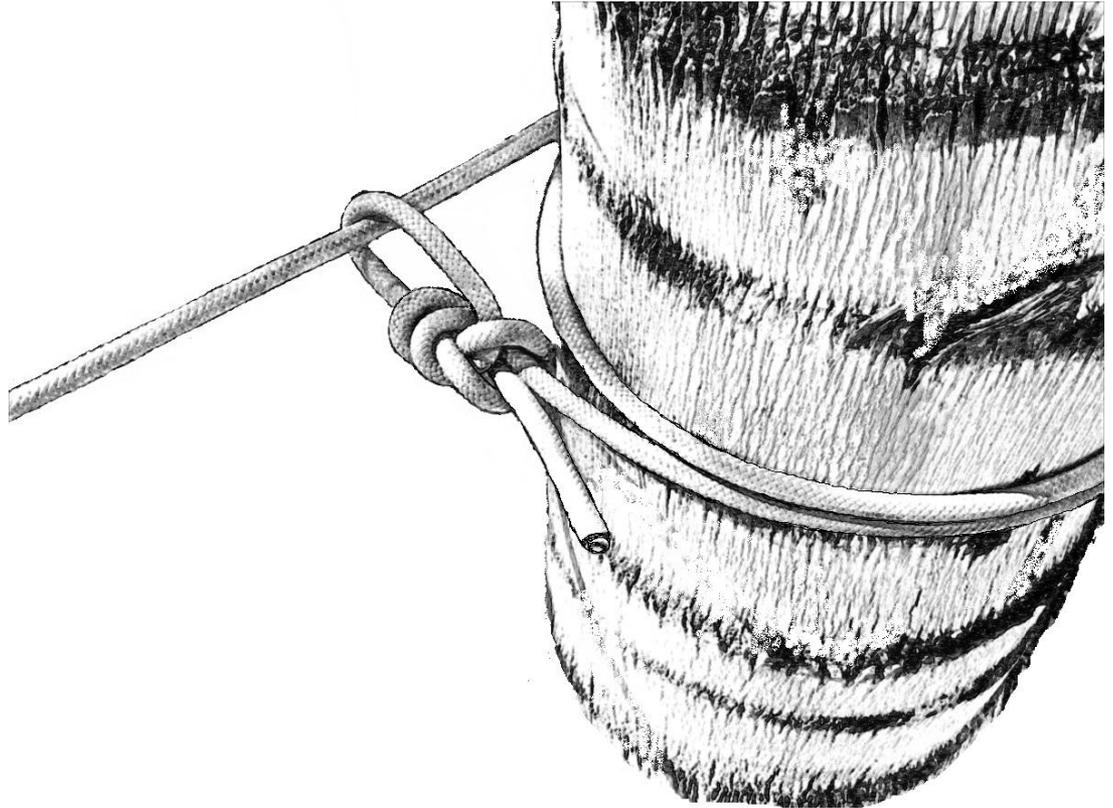
What are Knots, Bends, and Hitches?

There are several definitions of a knot and the interlacing of cordage and such... but what really is a knot in our world of rigging? A knot is an anchor in its most elemental form. A knot is a microcosm of rigging. All the same anchor rigging physics' issues you will be seeing throughout this course about tension, compression, and friction can be found in that elemental first step we take when we construct a rope rescue system. That is most often - tying a simple knot.

- Defining the terms knot, bend, and hitch, a knot is an organized inner weaving of cordage. A bend is the connecting of two ends of cordage, this can be from the same cordage or two different cords. Hitches are generally a type of knot that is dependent on a host object.

- As Clifford Ashley (probably history's greatest authority on knots) stated,

- "A knot . . . is either exactly right or it is hopelessly wrong."





By its very nature, vertical rescue is dependent on rope, and the most fundamental skill in using rope is tying it into a knot. There are no gray areas, no middle ground...knots are elemental to rigging. In tying knots, Mr. Ashley goes on to say, "Make only one change and either an entirely different knot is made or no knot at all may result." What a great lesson in general rigging! Mess up on one step in rigging and it could very well create a chain reaction of one mess up after another. We have seen it time and time again, usually during training. Sometimes resulting in serious injury or even death. Given that this hypothesis is true, the first step of knot management is huge.

- Knots, bends, and hitches are defined by their function. It is the responsibility of the rope rescue technician to use the most appropriate knots for the job at hand.
- As with all systems within a vertical rescue, safety is a team issue. It is important that multiple sets of eyes inspect all knots involved in the rescue operation before anyone can move into the hazard zone.



The Working End

Sometimes the “Working End” is also referred to as the “Running End”. We like the term “Working End” because it explains what that part of the rope is typically doing: Simple put, the working end is the end of the rope we are using to create the knot. However, sometimes we do tie knots somewhere in the middle of the rope by grabbing a section of rope (most often a “Bight” which we’ll talk about in a minute) thus establishing a new working end. So, in summary, we could probably say that the section of rope we are manipulating into a knot is indeed the Working End.

The Standing End

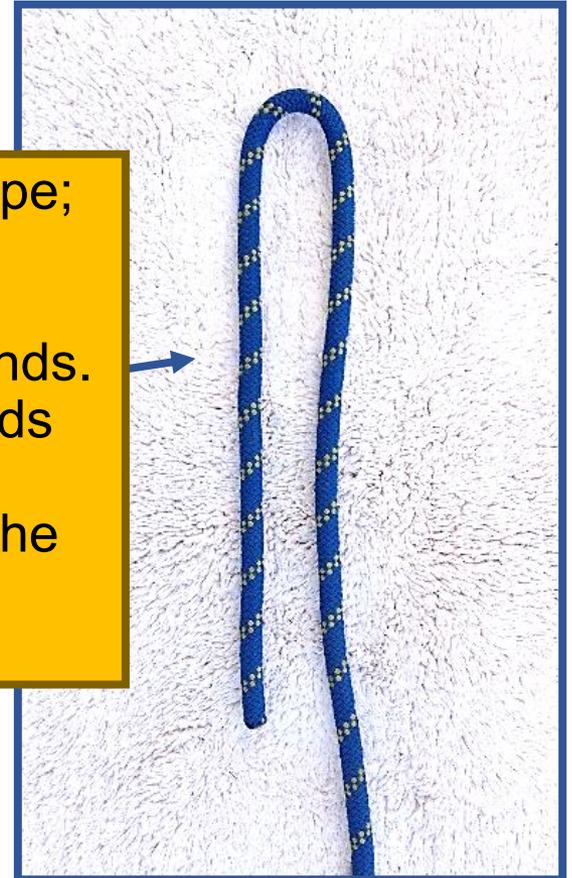
This end of the rope is usually the part that is coming from the rope bag or the coil of rope. The Standing End is typically the bulk of the rope you’re not using while creating the knot.



A Bight

A bight is a bending in the rope that will be crafted into something. *(Note: We are not calling it a “bend”. This could be confused as a type of classification of knots that connect two ends of cordage together, i.e., Becket Bend, Sheet Bend or Figure Eight Follow-through Bend).* As such, there are two strands of rope, one on either side of this “bending”. Also – particularly important – these two strands of rope are parallel to each other – think of railroad tracks. As these “railroad tracks” travel though the knot (Something On-a-Bight) they should never cross. These two strands must stay parallel to each other. Why is this so important? A knot by its very nature is a basic anchor. Something is connected to it, or it’s responsible for supporting something. Like all anchors, they’re not supposed to move. Pay strict attention to these small details. Set all the strands coming in and out of the knot and keep the railroad tracks parallel.

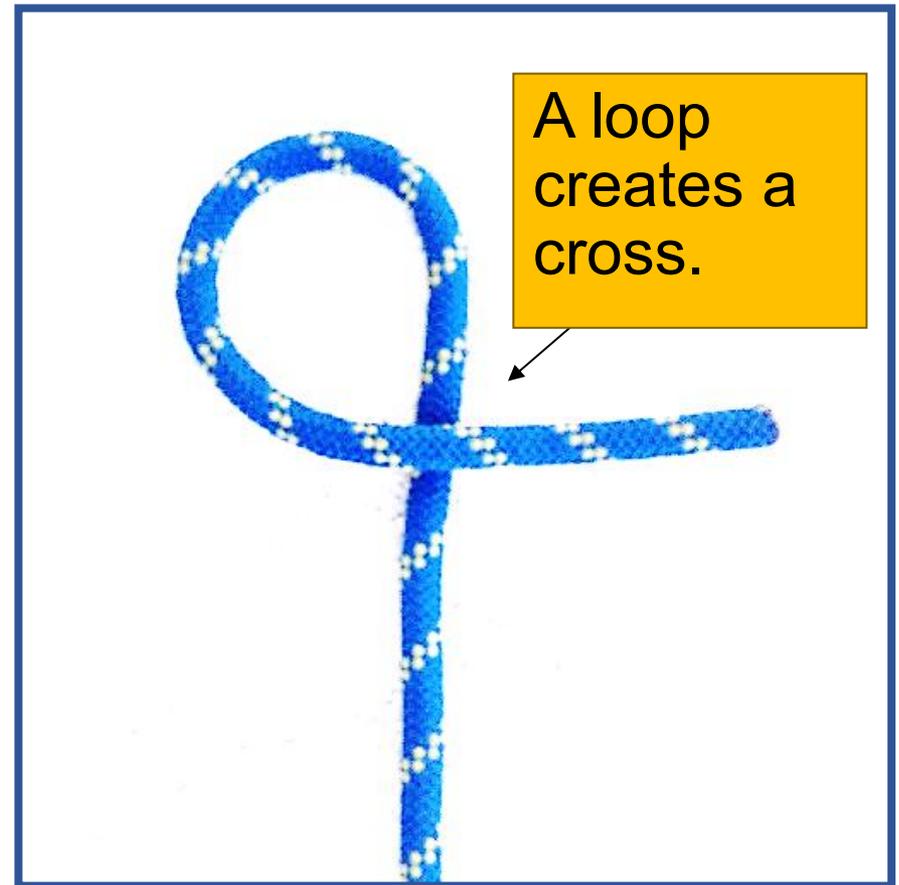
A bight of rope; the bight is made up of parallel strands. These strands stay parallel throughout the knot.



Loops

If the Bight is like railroad tracks running through the knot, the Loop is a cross in the road. Bights are parallel, and Loops are crossed. It could be the working end crossing under the standing part, or the working could be on top of the standing. It all about how the knot picture is being painted.

Here is a curious observation about bights and loops: In general, knots that are completed strictly with just bights (Overhand On-a-Bight, Figure Eight On-a-Bight), or, strictly with just loops (Clove Hitch, Constrictor Hitch) tend to be harder to untie. Whereas knots that combined loops and bights (most of the Bowline family) are typically much easier to release after a hard setting.





Function

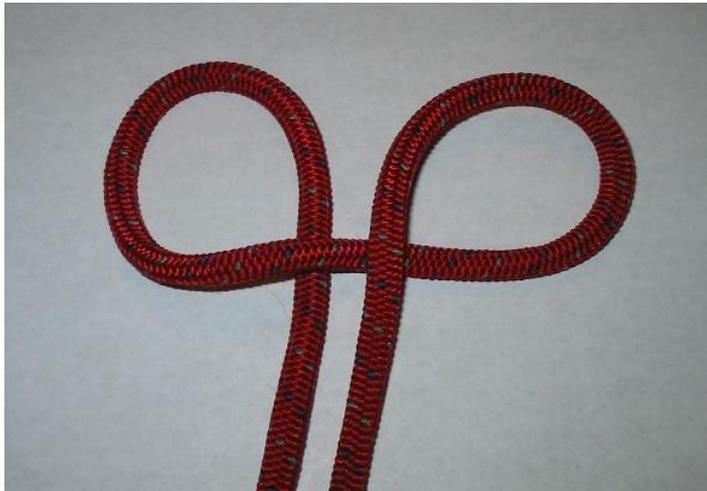
What is the knot going to be used for?
Example: lets address the ease of release qualities of the bowline. When rigging the yoke for a litter basket for a vertical extrication, some aspect of the Bowline (Double-long-tail Bowline, or Inner-Woven Bowline) can accept the extreme weight of a two-person load and still easily release at the end of the operation. Another example – I would tie a Becket-bend, instead of a Double Overhand Bend for temporarily connecting two ropes (because I want to get it un-tied when I'm done). Conversely, when I'm tying prusik loops, I'll never untie those, so the Double Overhand Bend is perfect for welding two ends together.

Gain

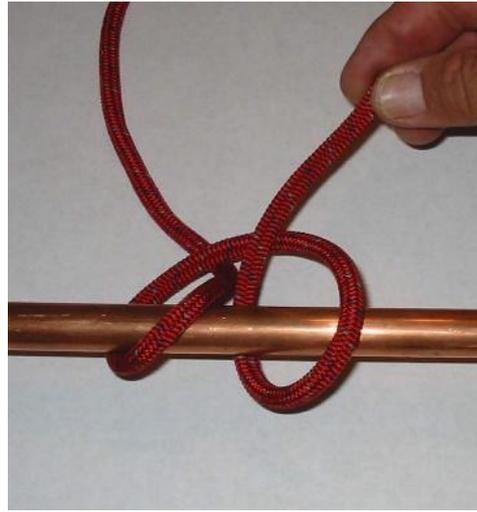
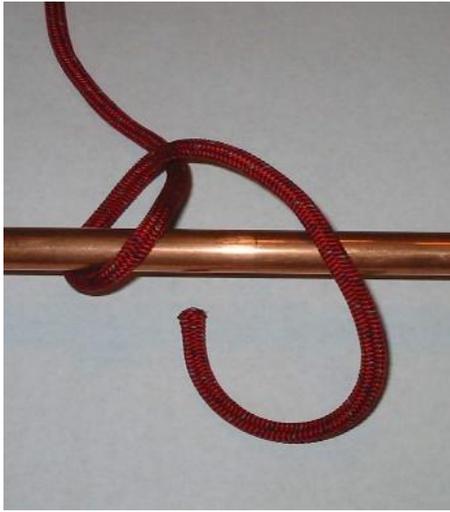
The gain of a knot is its overall size. Or another way to describe this is the amount of usable workspace that is being consumed by overweight and sloppy rigging. Most time, we will reap substantial dividends from rigging systems that are as compact as possible, and of course, this begins with the knot. Nowhere is this more evident than a rope system rigged under a tripod. How many times have we seen systems with enormous gain (frequently in the form of manufactured behemoth 4:1cd haul systems) taking away from the useable precious space needed to extricate the victim from under the tripod at the culmination of the operation?

Clove Hitch

The Clove Hitch nothing more than two single hitches twisted in opposite directions, the two loops then cross the common strand and are slid together.



Clove Hitch Tied Around an Object



Prusiks

The Prusik is used in everything from personal attachment points for ascending, to system uses such as Tandem Prusik Belays, and Haul Prusiks for mechanical advantages. The ability to tie the prusik correctly is a valuable tool in wilderness rigging.



Start by placing the bend on the host rope.



Roll the bend around the host rope three times.



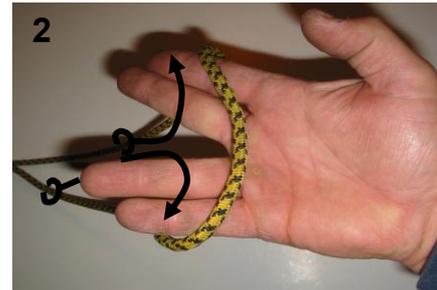
The loop should originate from the middle of the knot.



The bridge should run end to end.

Dress the prusik and offset the bend to one side of the loop.

The 'Purcell' Adjustable Loop Tied with the 3/2 Pursik Hitch



Shown in this example is the factory sewn 6mm loop. Although the sewn version is stronger, the shock absorber loop may also be formed by using a double overhand bend with a 8' to 10' length of 6mm accessory cord for a foot loop. The litter bearer tie-in is much shorter, approximately half the length. All of this is based on the user's size and personal taste.

Start with an open palm (either hand) and spread the middle fingers. Place the large loop over the four fingers. While using the fingers as a guide, bring a bight from each side of the loop up and through the spread of the middle fingers (*fig. 2*).

Continue this process until there is three additional wraps on one set of fingers, and two additional wraps on the other set of fingers (*fig. 3*).



Take the two additional wraps, plus the original wrap from the "two" side and rotate these three sections of cord onto the other two fingers that contain the additional three wraps (*fig. 4, 5, and 6*).



Useful combination for the litter bearer primary attachment to the litter basket.



There should now be five complete wraps around two fingers (*fig. 6*). Pass the opposite end (small sewn loop) through the 5 loops, in the 2 side and out the 3 side (*fig. 7*, and 8).



Dress the 3/2 prusik hitch as shown in *fig. 9*. When the shock absorber is complete, there should be large loops culminating at the 3/2 prusik. The 3 wraps of the 3/2 prusik must be oriented towards the bend or sewn connection. Dress the large loops so there are no unwanted twist.



Method 1

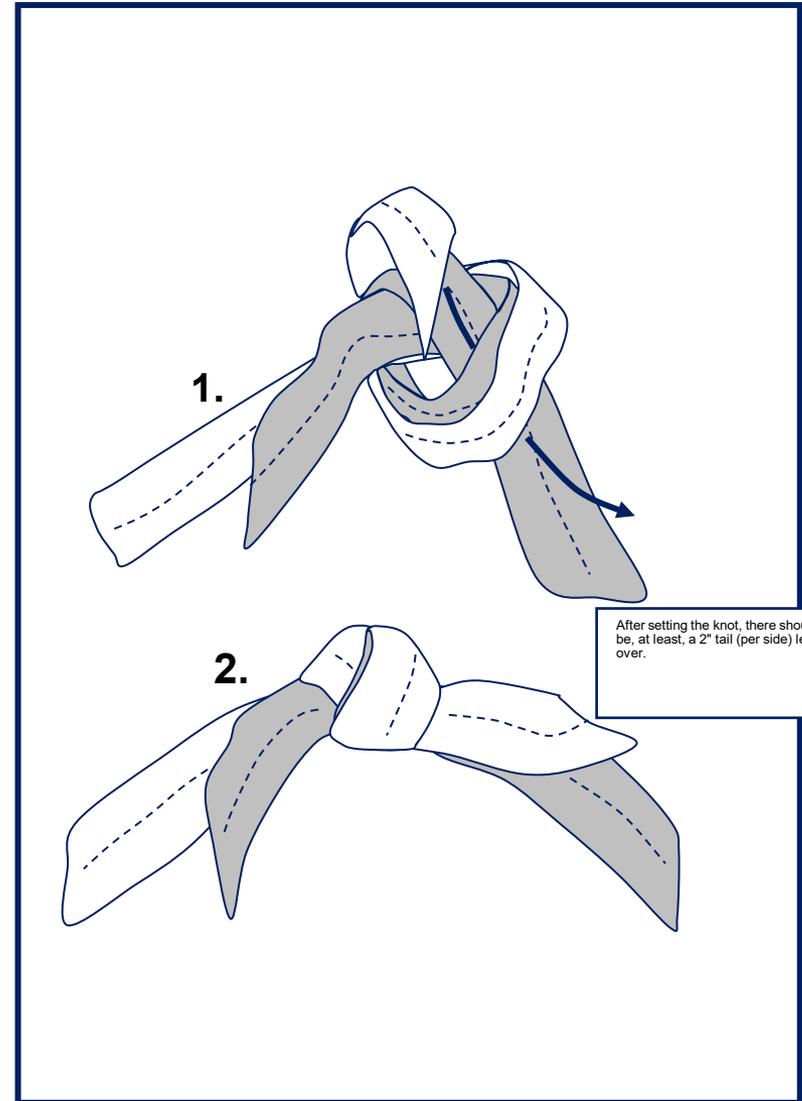


Method 2



Munter Hitch

Overhand Follow Through Bend (Using Webbing)



The Double Overhand Follow-through Bend

This Bend is used to combine two working ends of rope, i.e. extending a line, or for making accessory cord loops. Some teams advocate a triple overhand bend. Three overhands is overkill, two will more than do the job.



After the first Double Overhand is tied, rotate the entire ensemble clockwise and repeat the first three steps.

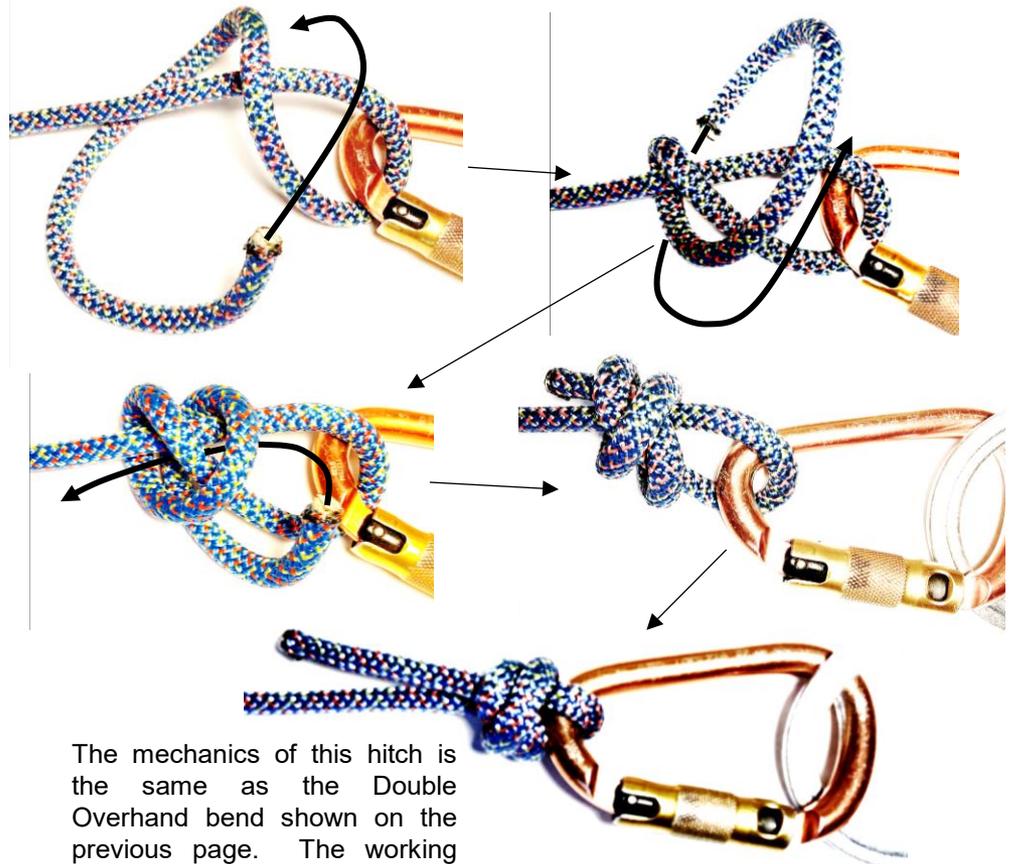


After the two Double Overhands are tied and the tails are pre-tensioned about 1 ½ " long (the tails will tension to about 1" in length when the bend is set), pull on the standing parts so that the two knots slide together as shown below in steps 7 and 8. When this bend is tied correctly, two inter-locking Xs will form on one side (7) and the other side will look parallel.



Double Overhand Noose

The Double Overhand Noose is an incredibly secure knot for non-loaded applications such as the belay line connection. When completed, this hitch will stay tight on the spine of the carabiner and help prevent any side loading of the non-loaded carabiner. This hitch will become extremely tight if loaded. As such, do not use this hitch for mainline connections or any application where high tensioning is planned to take place, unless of course, you do not wish to untie it. The Double Overhand Noose is also wrongly named a Scaffold Hitch by a few uninformed individuals. Once something makes its way to YouTube it sometimes is assumed to be true, when in fact many times that subject is simply someone's misinterpretation. There is a correct historical naming of a knot called a Scaffold Hitch which is a variation of a Clove Hitch and really is used for securing the end of a suspended scaffold board.



The mechanics of this hitch is the same as the Double Overhand bend shown on the previous page. The working end passes over itself twice then finishes through the middle of the two wraps.

Butterfly

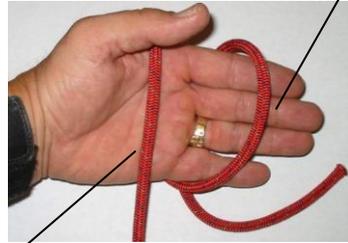
The Butterfly is the most versatile mid-line loop. This knot is very fast to tie, quick to untie, and easily recognized.

In addition to its mid-line qualities, the Butterfly has three distinct loops, when the knot is opened up, can be loaded in three different directions.

Second wrap is closest to the end of the fingers.

Third wrap goes between the first and second.

First wrap is closest to the thumb.



Butterfly Tied from a Bight (Twist Method)

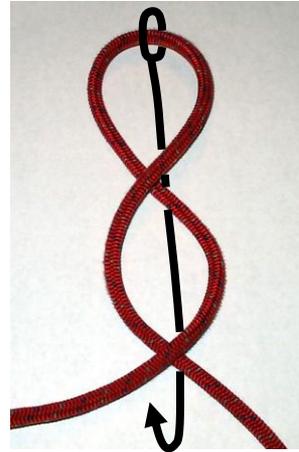


Figure Eight, and the Figure Eight on a Bight

Some notable advantages with the *Figure Eight*, and the *Figure Eight on a Bight* is that they are very recognizable, which makes mistakes in tying these knots obvious. In addition, the *Figure Eight* and the *Figure Eight on a Bight* are easy to learn and remember.

Figure Eight



Figure Eight on a Bight

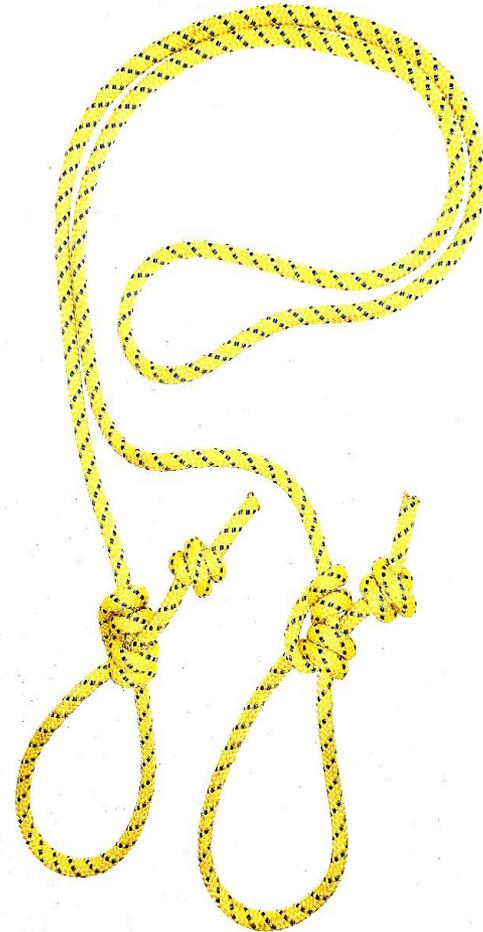


The Blake's Hitch

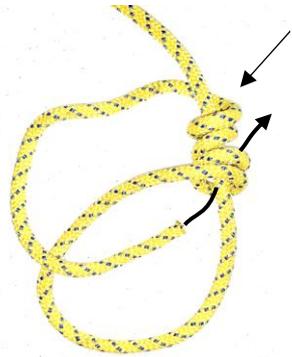
A.P.T. (Ascending/Pickoff Tails)

The Blake's Hitch is a great knot for tying an adjustable knot on the same diameter rope and still maintain excellent holding power when loaded. This is a common knot used in the arborist profession. This knot may be used for adjustable opposition guying systems and rigging an ascending foot loop and counterbalance combination system for solo pickoffs. This system may also be used to rig the legs of a litter bridle system, A.P.T. (Ascending/Pickoff Tails).

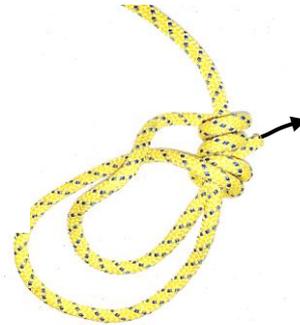
Start with 12' of 8mm, however this is not an absolute rule, with a little longer cordage rigging a 2:1 pickoff system is possible vs. the 1:1 counterbalance.



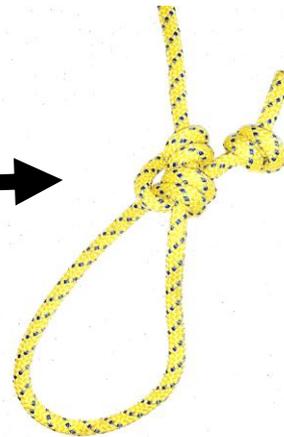
Make four-wraps as pictured.



The working end goes over the top of the loop and up through the middle of the two bottom wraps, then out.



Dress and set the knot and finish the end with a Double Overhand Stopper.



Petzl Ascension with the Ascending/Pickoff Tails (A.P.T.)

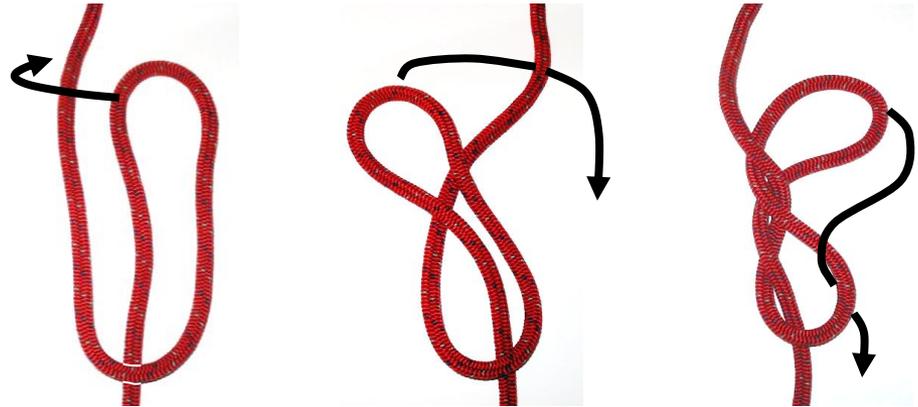
The Petzl Ascension hand ascender combined with the A.P.T. homemade foot loop system is a practitioner-level ascending system for vertical mobility. However, there are several manufacturers that produce hand ascenders and foot loops and any number of them may prove to be preferable to the end user than these examples. The Petzl ascender is a little more efficient in receiving carabiners in the upper hole and when capturing the host rope, i.e. 3:1 pulley system for vertical hauling and ascending.

The A.P.T. system is multi-functional for minimalist rigging, not only can it be used for ascending and pickoffs, but it also easily transforms into a litter bridle. The A.P.T. is showcased in the knotcraft, and Solo pickoff sections.



Directional Eight or Inline Eight

Another knot from the family of eights, the *Directional Eight* is very useful as the first step of an unequal Two Loop Figure Eight Follow Through (next page). This knot has lost some appeal as a midline knot because many practitioners do not feel it is as functional as the *Bowline with a Bight*, the *Butterfly*, and the *Clove Hitch*. Some of the inherit flaws with this knot is that it can be hard to untie after heavy loading, it may capsize if pulled the wrong way, and many people have problems tying it correctly.

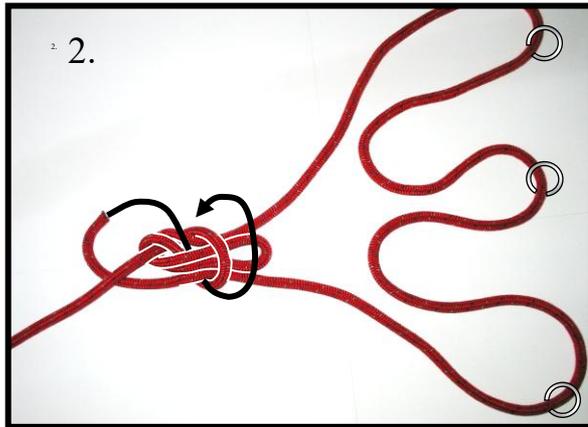


Two-Loop Figure Eight Tied with a Directional Eight Follow-Through

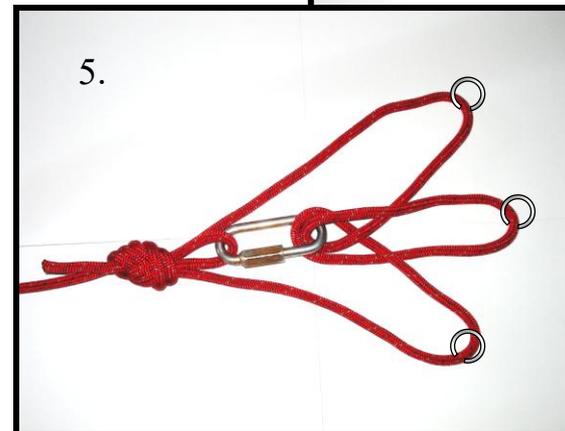
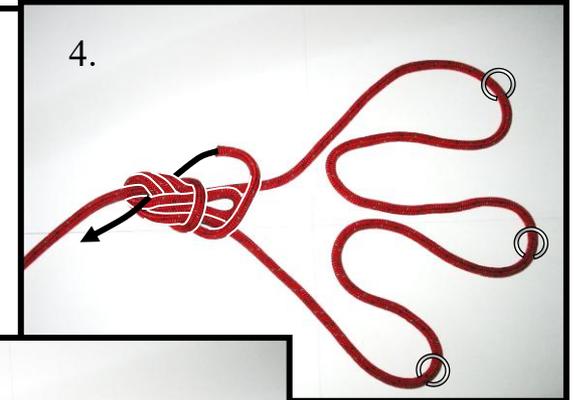
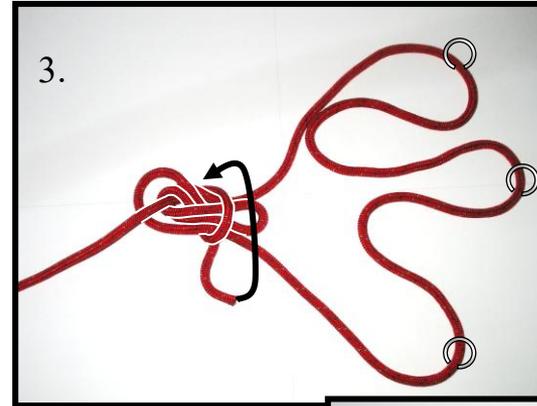
This knot is a great way to construct a fixed multi-point anchor system with the working end of the rope. There are two basic knot skills required in forming this knot; first, correctly tying a *Directional Eight*, and second, correctly performing a follow through (retrace) of the *Directional Eight*.



Start by threading the rope through/around the anchor points. At the appropriate spot tie a *Directional Eight* pointing in the direction of the multipoint anchor or attachments.



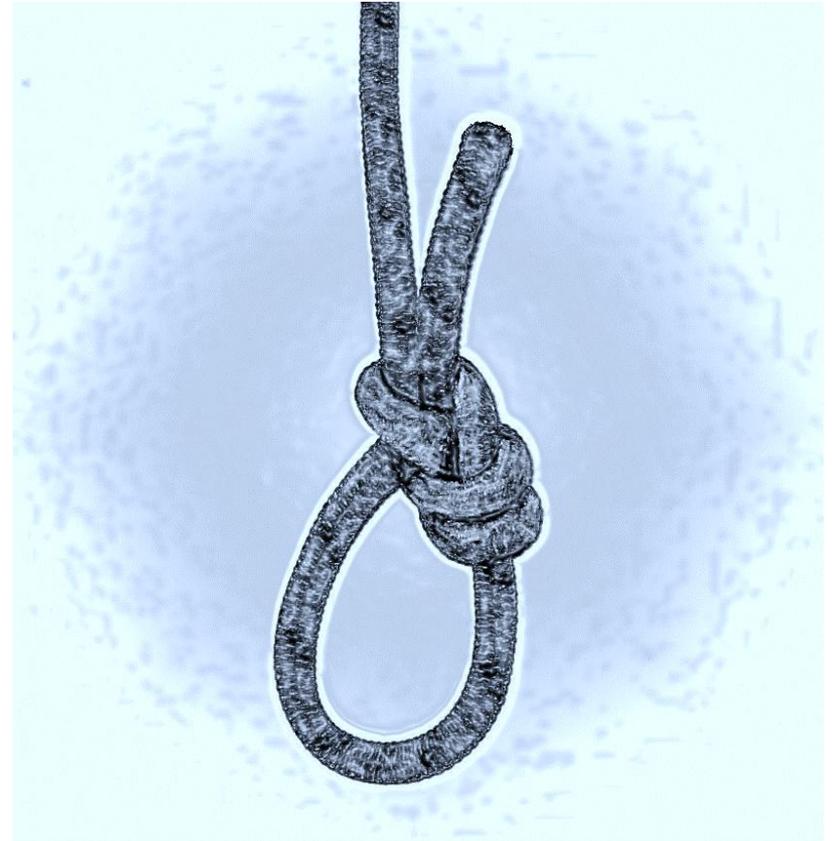
Start and complete a retrace of the *Directional Eight* as shown here and in the next three steps.



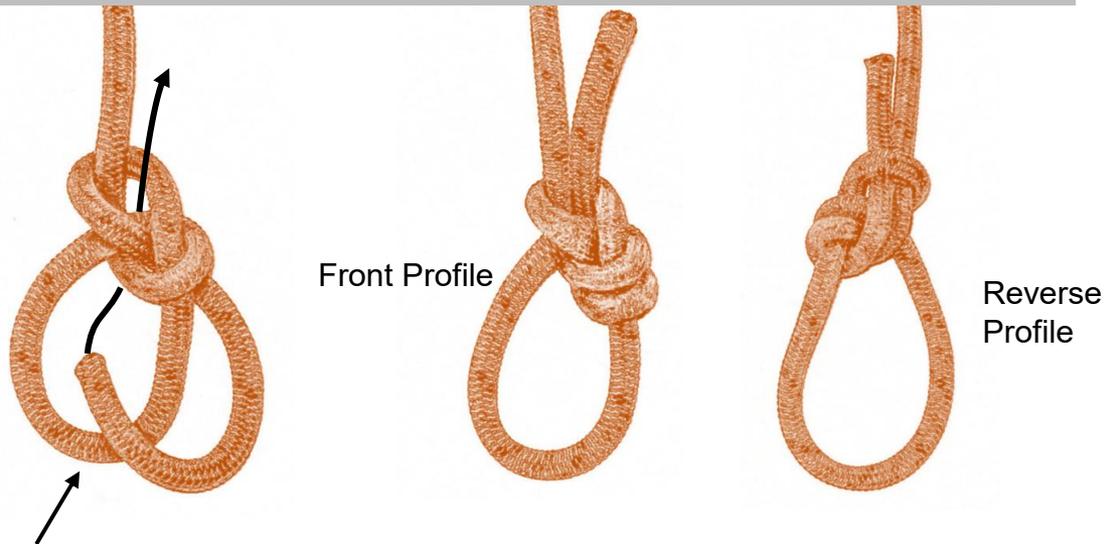
Put a twist at the connecting point of each of the outside loops at the center point. Connect the center points to the small loop as shown.

The Bowline

The variations of the bowline run easily into the hundreds. It is also important to acknowledge the historical importance of the bowline family as it applies to rigging. The name itself is derived from the line use to secure the bow of a ship – the ‘bow line’. There are few knots that can compare to the bowline, that can accept extreme tension and still easily untie after the tension is released.

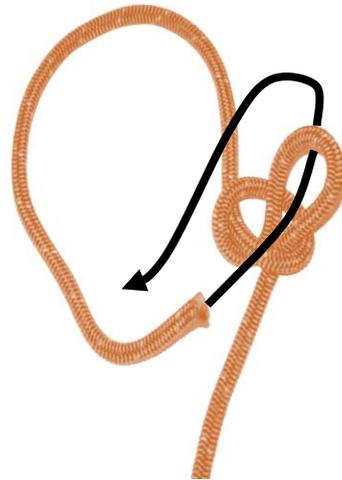


The basic Bowline may be analyzed as having two components. One component is a bight at the working end, and the second component is a half-hitch located at some point mid-line. We use half-hitches all the time to secure items for hauling such a pike-poles and other tools. The use of the half-hitch on the tying of the Bowline is very much the same principal, In the case of the Bowline, the half-hitch is securing the bight as it is weaved around the standing part of the line. Or if you prefer (From your Scouting days as a youth) : The rabbit (working end) comes out of the rabbit hole (the half-hitch), runs around the tree (the standing part), and dives back into the rabbit hole (the half-hitch)...whatever floats your boat, just a long as it comes out correct!

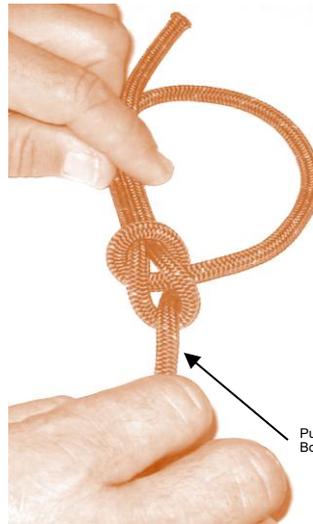


The Yosemite back-up (Yosemite Bowline) is nothing more than taking the working end of the knot and retracing the original half-hitch component (the rabbit hole) of the original Bowline. When completed you will have two parallel half-hitch components.

Snap Bowline/Climber's Bowline



The name *Snap Bowline* is nothing more than a nick name that defines a specific way to tie the knot.

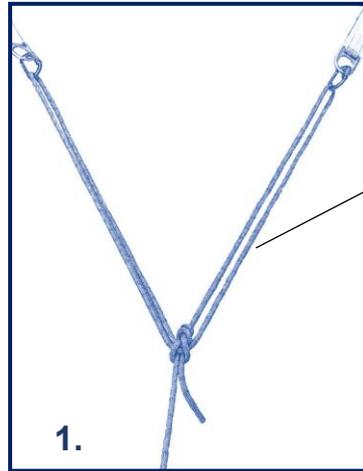


Pull from the standing part to invert the slipped Overhand into a Bowline.

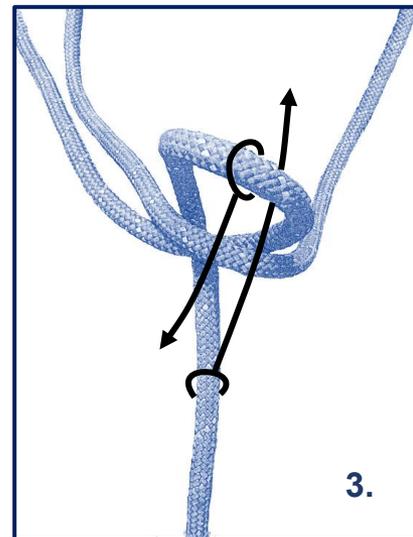
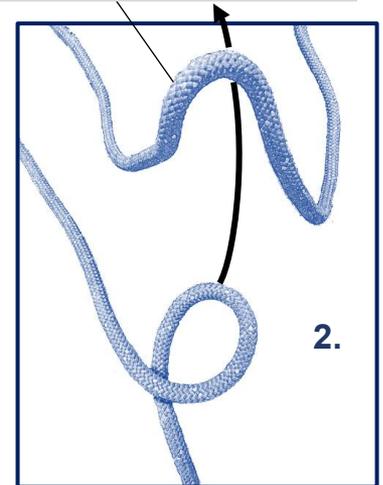
This technique works well when facing an anchor or an object that you must tie the *Bowline* to. It is extremely quick and makes the initial adjustment of the loop very easy.

Portuguese Bowline

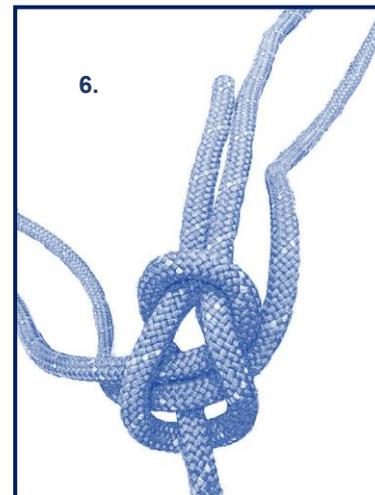
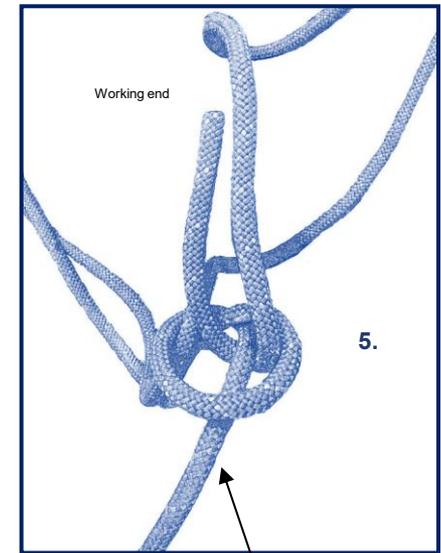
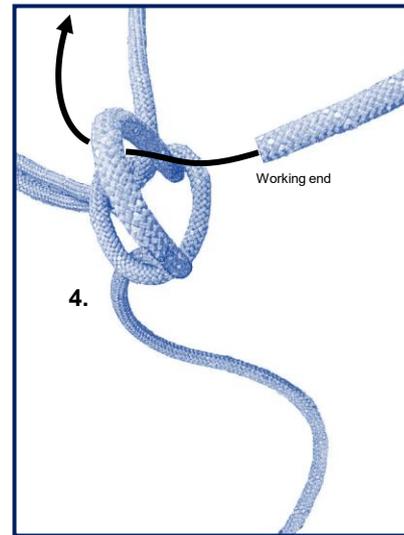
Using this knotcraft methodology, the Portuguese Bowline is tied by employing the “Snap-Bowline technique.



By mindful of the dressing and placement of this adjustable leg which is common between both anchors.

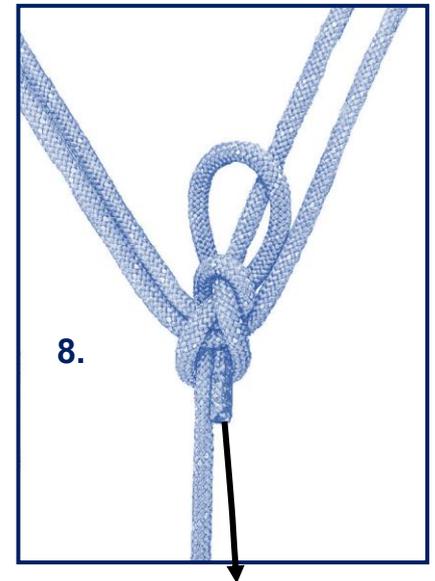
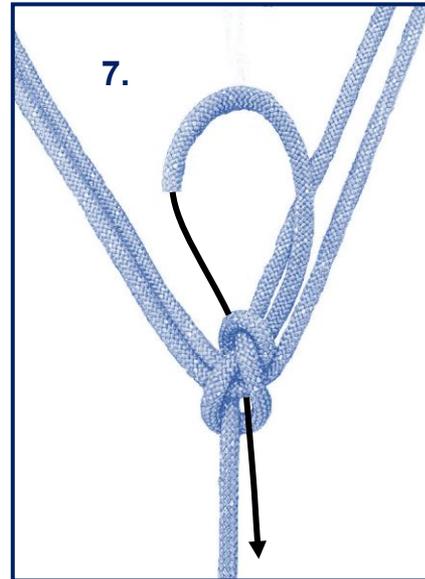


Portuguese Bowline *Continued...*

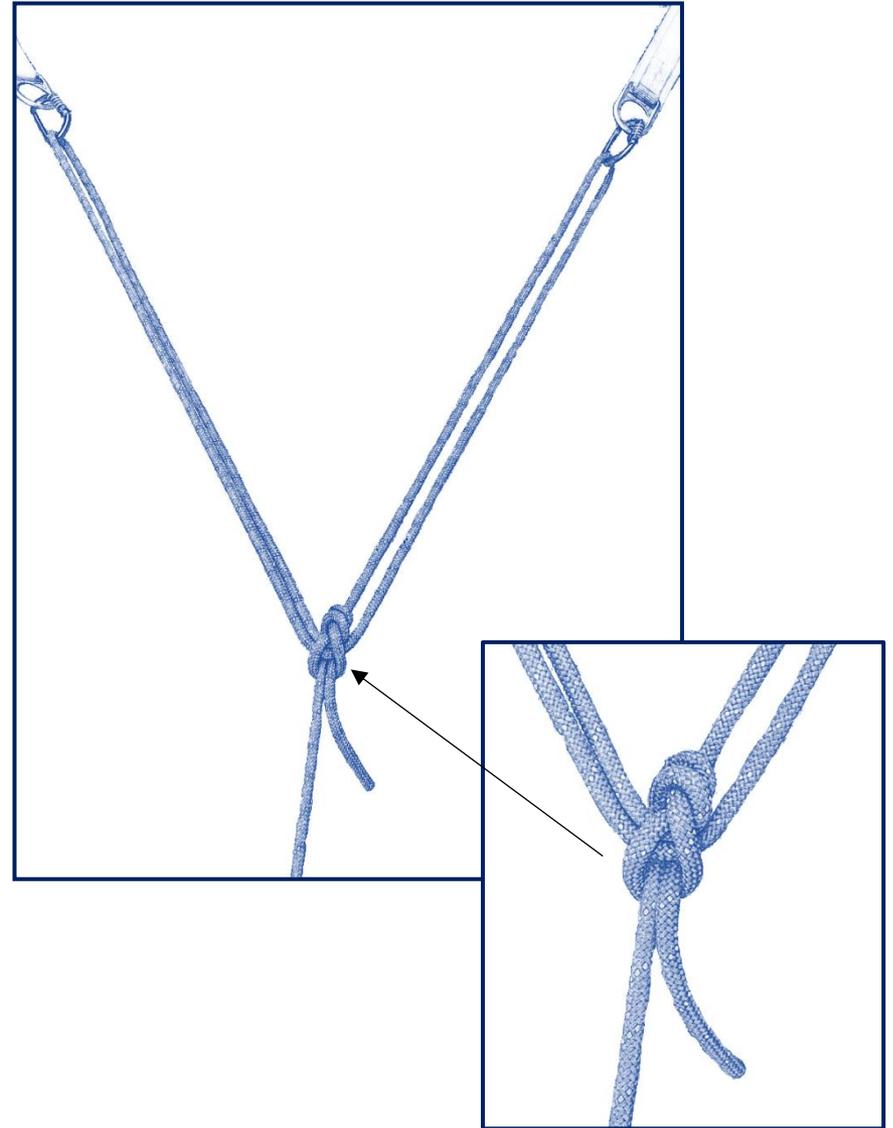


Pull the Standing end to invert the slipped overhand into a Bowline.

Finish the knot with a Yosemite backup.



The Portuguese Bowline provides a great method of quickly rigging a multipoint anchor system with nothing more than the end of the rope.



The Portuguese Bowline used as a 2 X 1 focused anchor system.

This is a wilderness operation using a Portuguese Bowline to rig a 2x1 multipoint anchor system for the purpose of focusing a tensioned back-tie supporting a smaller diameter tree being used as a natural high directional anchor at the edge.

This anchor system was completed with approximately 60' of a 300' 11mm rope. The remainder of this rope was used as the belay line.



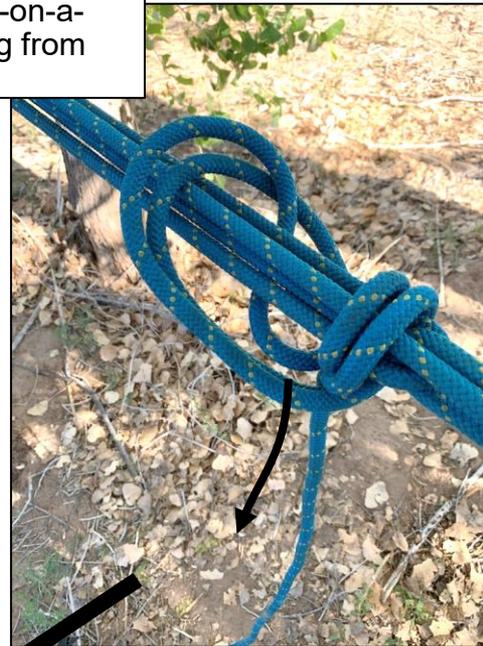
The working-end of Yosemite-on-a-Bight backup must be tied off with a Double-Overhand.



Double-Overhand tied to the associated leg of the Portuguese Bowline.



The final tie-off of the tensioned back-tie to the Yosemite-on-a-Bight is completed with two Half-Hitches-on-Bight coming from the haul end of the back-tie.

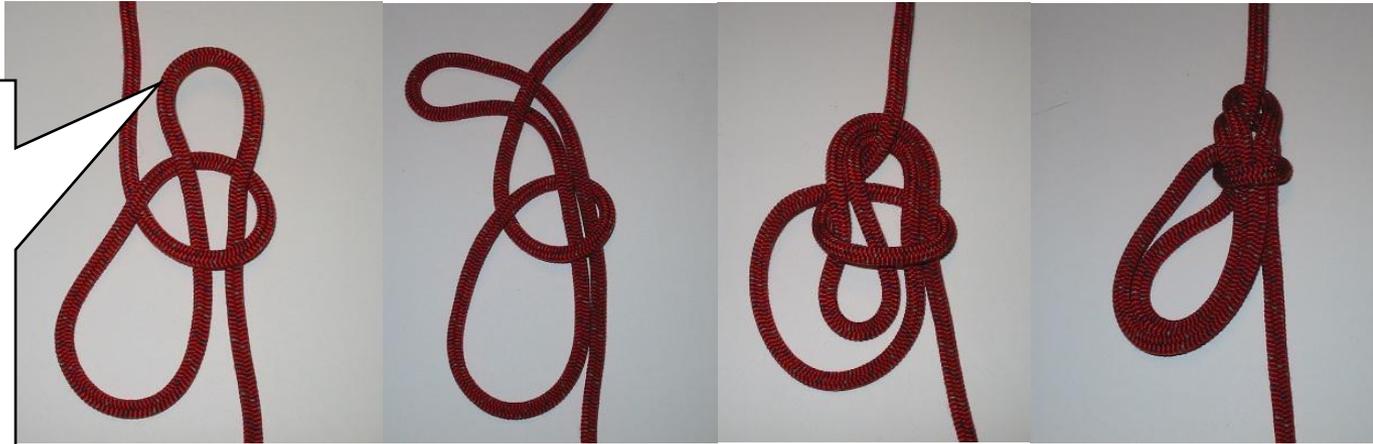


The Bowline with a Bight

The *Bowline with A Bight* is a great mid-line loop. It is easy to tie, untie, and is very recognizable.

There is the potential for problems if the loop created by the initial bight is pulled in the opposite direction of the intended flow of the knot. If this happens, the *Bowline with A Bight* may invert and turn into a slipped overhand. To address this potential issue, attach the carabiner through both, the main loop, and the loop created by the initial bight, or it must be backed up like the standard bowline.

The initial bight is used in the same manner as the working end of a regular bowline.



The initial bight should not be left unsecured. Either put a carabiner through both loops or finish it with a Yosemite backup.

Using the Yosemite backup for this knot is also a clever way to employ two secure loops pulling in separate directions. Also known as a Bowline with a forward loop.

The Bowline with a forward loop is another great method of creating a forward loop rigged through a Portuguese Bowline.

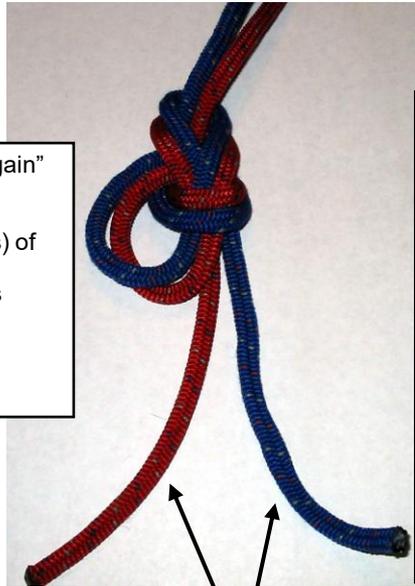
Doubled Long Tail Bowline and Interwoven Bowline

The *Doubled Long Tail Bowline* is used in creating the yoke, the culmination point at the rescue end of the mainline and the belay line. The yoke is the point of attachment for the rescue adjunct, i.e., high angle/steep angle litter attachment, and team-based pick-off rescue package attachment.

The doubled bowline is the adjunct attachment point, and the long tails are secondary attachment points for the rescuer and victim. The long tails may be tied at any length to meet the need of the type of adjunct used.

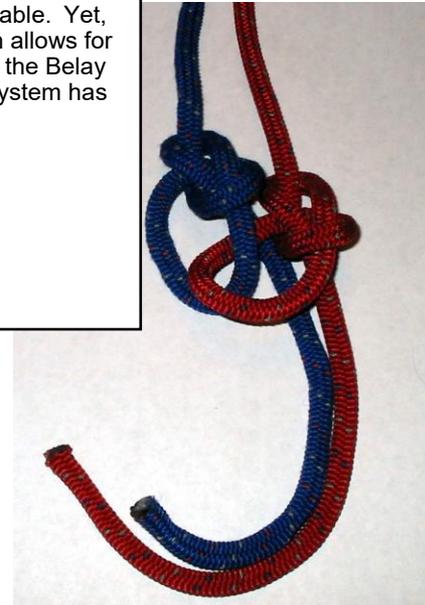
Doubled Long-tail Bowline

Keep the "gain" (the top to bottom dimensions) of the knot as compact as possible.



The Interwoven Bowline (Also known as the Interlocking Bowline) is also quite acceptable. I find the Doubled Long-tail to be a little cleaner and more recognizable. Yet, the Interwoven allows for adjustability of the Belay line after the system has been loaded.

The long tails may be adjusted to meet the secondary attachment needs of the rescuer and victim.



Interwoven Bowline

The Doubled Long-tail Bowline is the perfect knot for a collection point for team-based rescue adjuncts, easily and safely loaded in multiple directions.

This knot is half the gain of a Figure Eight on a Bight, allowing for added space under a high directional anchor system.

The Bowline is substantially easier than the Figure Eight on a Bight to untie after it has been used for system loads.

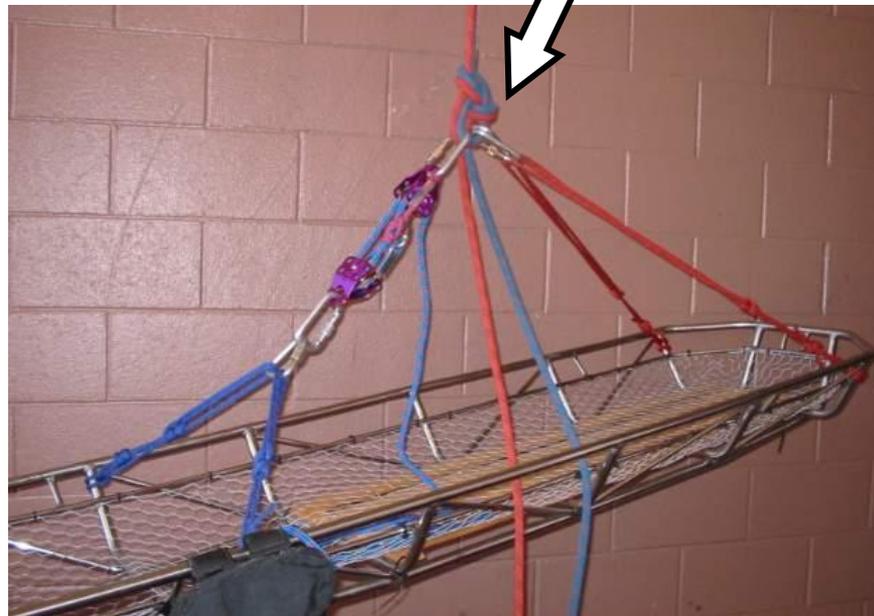


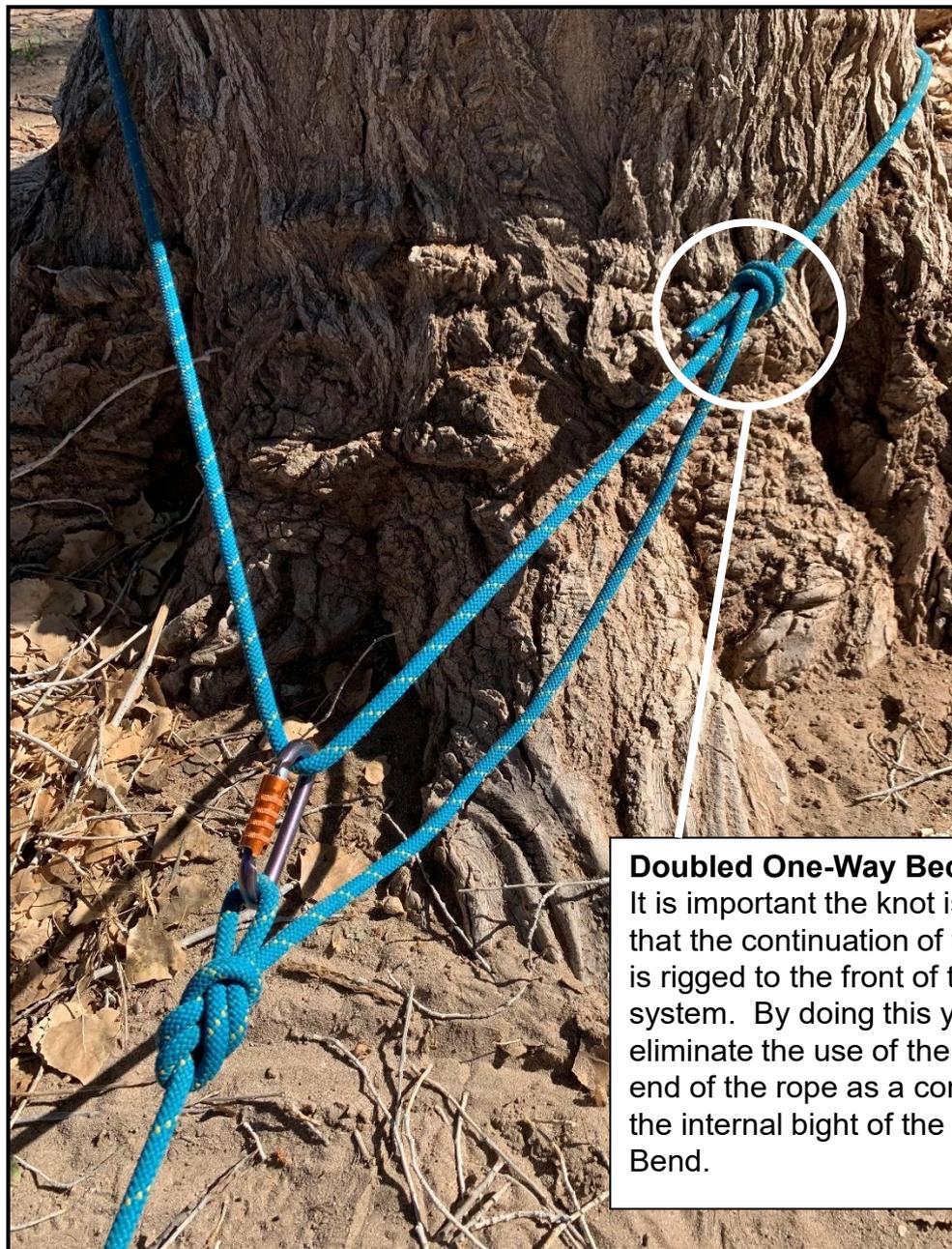
Figure Eight Becket Bend – AKA the One-Way Becket

The *Figure Eight Becket Bend* is nothing more than a method of backing up the *Becket Bend* and the *Double Becket Bend*. It most likely got its name because of the resemblance the backup has to a *Figure Eight*. The term *One-Way Becket* is due to the fact that all strands (continuations of the strands) are routed the same direction when the knot is complete.



The Blitz Anchor

The Blitz Anchor is a great anchor knot system for minimalist rigging. This works well on very large anchors where flexibility and equalization of the resultant forces are desirable. This system requires only one rope for a repel line and/or mainline plus the rigging of this anchor, the Blitz Anchor system can initially be used for rapid victim contact by recon then easily converted as a mainline anchor for the extraction.



Doubled One-Way Becket Bend
It is important the knot is tied so that the continuation of the strands is rigged to the front of the anchor system. By doing this you eliminate the use of the working end of the rope as a component of the internal bight of the Becket Bend.