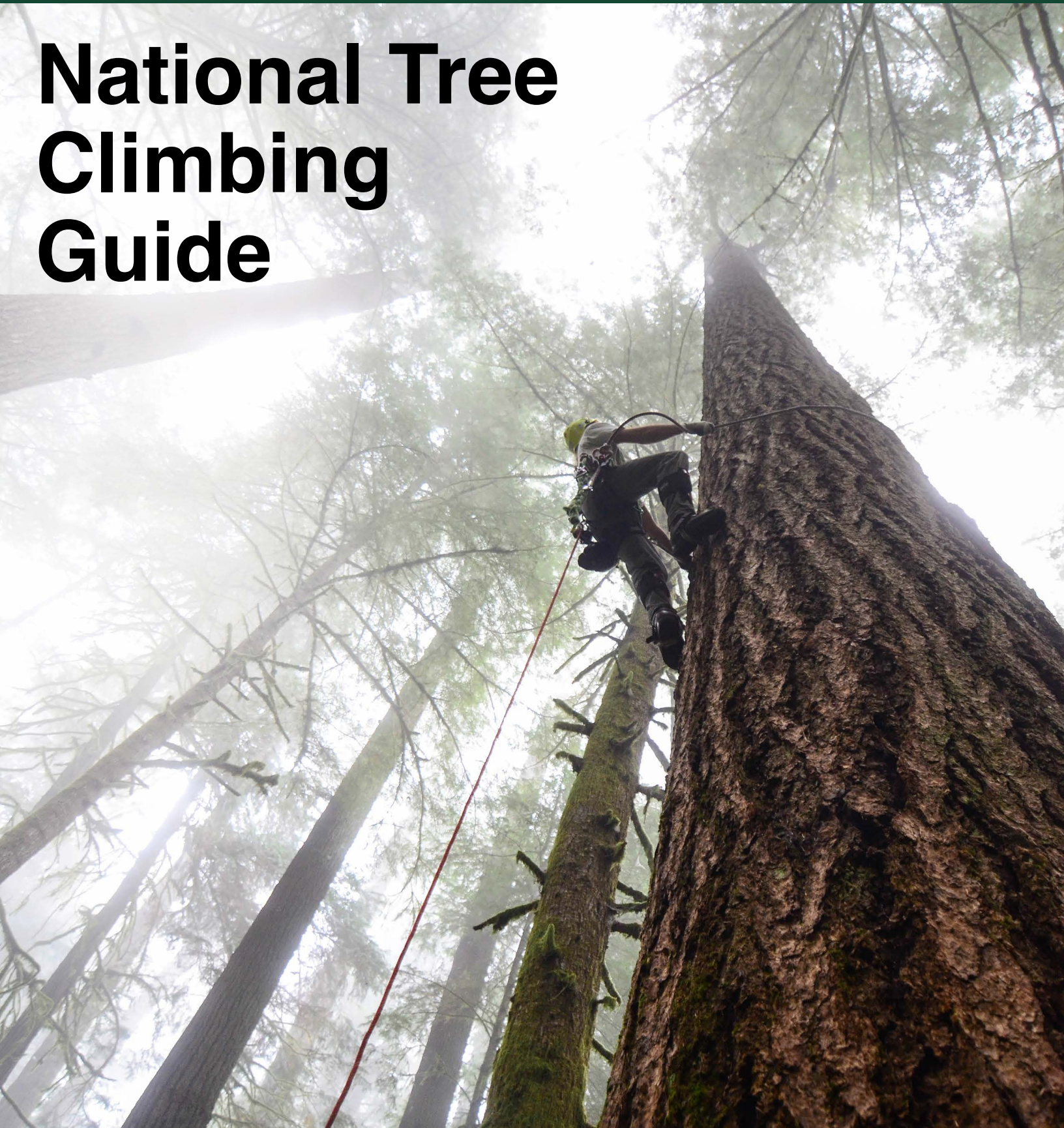




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National Tree Climbing Guide



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National Tree Climbing Guide

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51.08 - National Tree Climbing Program Technical Advisory Group

The National Tree Climbing Program Technical Advisory Group, composed of the National Tree Climbing Program Manager, the tree climbing coordinators at the regions, stations, area, and institute, and tree climbing technical advisors, performs the following:

1. Provides program recommendations to the National Tree Climbing Program Manager.
2. Provides operational and technical advice to Forest Service Tree Climbers.
3. Serves as a board of appeal on issues relating to tree climbing.
4. Recommends changes to the Forest Service Tree Climbing Program policy in section 51.03 and to the technical guidelines referenced in the National Tree Climbing Guide.
5. Establishes and/or approves tree climbing training programs through which applicants for certification can satisfy the requirements of section 51.3.
6. Establishes criteria for equipment selection, approval, and use.
7. Approves the use of new equipment, techniques, and practices.
8. Addresses national issues at annual National Tree Climbing Program workshops.

Chapter 1 Introduction

The Forest Service Tree Climbing Program provides direction that protects Forest Service employees while ascending, descending, and working aloft in trees by establishing national direction based on recognized industry standards, procedures and practices.

Climbing and working in trees demands specialized equipment and skills. The potential for a serious injury or fatal fall is always present, so employees shall be trained and certified before they engage in tree climbing operations and activities. The Forest Service Silvicultural Practices Handbook, FSH 2409.17, Chapter 50-Forest Tree Improvement, shall be followed.

Tree climbing is arduous, demanding work that requires upper body strength and overall flexibility. Besides being physically fit, you must be able to identify and compensate for any physical or mental condition that might temporarily impact your climbing ability. Compensating may mean not climbing until the condition is no longer a problem.

Tree climbing work can be hazardous and hazardous duty pay is appropriate as outlined in the Forest Service Manual (FSH 6109.12.92b).

1.1 Training

Only Forest Service employees who hold a valid tree climbing certification card issued by the Forest Service may engage in tree climbing. All tree climbers must be trained and certified before commencing work projects and activities. Tree climbers must use only the techniques and equipment they are certified to use.

Applicants for tree climbing certification must possess an American Red Cross first aid certification or equivalent, and demonstrate the required knowledge and skills of the certification level for which they have applied. Trainees must pass a written or verbal examination that demonstrates their knowledge of at least the following:

1. Safety requirements set forth in the National Tree Climbing Guide and FSH 2409.17, Chapter 50,
2. Identifying, mitigating and/or reporting hazards associated with tree climbing work,
3. Function, care, use and maintenance of tree climbing equipment.
4. Trainees must also demonstrate their ability to safely perform the following minimum requirements after completion of the written or verbal examination:
 - A. Successfully tie all task specific knots,
 - B. Demonstrate proficiency in tree climbing using the three-point climbing technique, including installation of a lanyard and limbing-over on a task specific basis,
 - C. Perform an aerial rescue using an approved rappel system.
 - D. Training must be conducted by at least one certified Tree Climbing Instructor, who may certify the trainee as a Tree Climber Trainee, or Tree Climber. Applicants for Tree Climbing Instructor certification must successfully complete a basic tree climbing instructor training workshop, and meet the approval of the Evaluating Facilitator(s). Tree climbing certification is valid until the end of the calendar year three years after issuance, unless revoked earlier.

Work supervisors should promptly withdraw a climber’s certification or remove the climber from climbing duties when the climber

1. Is physically or mentally unable to climb safely,
2. Has an unsound safety attitude, or
3. Has exhibited unsafe climbing habits.

1.2 Obtaining Climbing Equipment

Before buying any equipment, check with your Regional Tree Climbing Coordinator. Make sure equipment meets safety standards and is fit for purpose. Buy only from reputable dealers familiar with the equipment and its construction, materials, and breaking strengths. Several such dealers are on Government contract. Visit the Forest Service tree climbing website: <http://www.fs.fed.us/treeclimbing/resources/> for a list of some equipment manufacturers and distributors.

1.3 Terms and Definitions

Nomenclature associated with tree climbing and tree climbing equipment includes a number of commonly used terms. Sometimes, one term has several different meanings. To avoid confusion and possible climbing accidents, key terms are defined:

Field Guide Terms (Other Terms in Use)	Definitions
Anchor Point	A secure point of attachment for a life line or lanyard strong enough to support the climber.
Ascender	Any climbing device used to ascend a vertically fixed rope. The term ascender usually refers to a mechanical device.
Belay	A method of protecting a climber in case of an accidental fall. A safety rope tied to a climber is paid out or taken in as the climber moves by a second person (the belayer) or by the climber in a self-belay (using the 4-inch tie-in). By controlling the safety rope, the belayer can stop the climber from falling.
Bole (Tree Bole, Tree Stem, Tree Trunk)	The main vertical part of a tree.
Carabiner (Biners, Locking Carabiners)	An oblong metal ring with a spring loaded gate on one side used for various purposes in climbing, such as attaching equipment to the climber or securing the climber to a rappel system. Carabiners used in life-support applications shall be self-closing and self-double-locking and shall have a gate-locking mechanism that requires at least two consecutive, deliberate actions to unlock (ANSI Z133 8.1.10) These carabiners are also known as positive locking, double auto locking, triple action, or three stage
Chest Harness	Straps placed around the chest and shoulders only to secure proper positioning.

Field Guide Terms (Other Terms in Use)	Definitions
Chicken Loops	Sewn, tied, or buckled bands of webbing or rope that fit around the ankle to prevent the ascender slings from slipping off the climber's foot.
Climber	A person certified to climb a tree; the person climbing.
Climber's Belt (Lineman's Belt, Body Belt, Safety Belt)	A wide padded belt usually having two large metal D-ring attachment points on the sides. A climbing belt does not have an attached chest harness or leg loops.
Climbing Harness (Safety Harness, Full Body Harness)	Tree climbing harnesses are of two general types: work positioning and fall arrest. Work positioning harnesses are generally preferred for their superior comfort and mobility. Work positioning harnesses, also referred to as sit harnesses or saddles, offer life support to the pelvis and legs, usually with attachment points at the hips via D rings for lanyard use (positioning rings), and one or more points at the front center waist area for ascent/descent rope attachment (suspension rings). Fall arrest harnesses similarly provide life support to pelvis and legs, with the addition of upper body life support by suspenders or attached chest harness, from which fall arrest is provided via a dorsal attachment point.
Climbing Helmet	Designed specifically for climbing, this helmet has a three-point chinstrap and is designed to remain in place during a fall. It is rated for the helmet's ability to protect against side and top impacts. A hardhat is not an acceptable substitute.
Climbing Line	A rope used in tree climbing that may be used for ascending into a tree, descending from a tree, and/or working aloft in a tree.
Climbing Spurs (Climbers, Tree Climbers, Gaffs, Pole Gaffs, Spurs, Tree Spurs, Lineman's Climbers, Spikes)	L-shaped metal shanks that attach to the foot and lower leg and are used to ascend or descend a tree bole by means of a sharp spike (gaff) that penetrates the tree bark and sticks into the wood of the tree.
Climbing Team	All team members shall be certified climbers who are qualified to perform every aspect of the climbing assignment in order to perform a rescue, if necessary.
Descent Device	Any rappelling device used to descend a vertically fixed rope.
DRT (Doubled Rope Technique)	A method of tree access, movement within the tree canopy, and descent where the climber employs a doubled length of rope in a loop over an overhead tie-in point, and adjusts his position by means of a friction hitch.

Field Guide Terms (Other Terms in Use)	Definitions
Etrier (Step-Up Sling, Aider)	A webbing ladder or aid sling used to span distances of up to 6 feet where tree branches are missing. Usually constructed of flat or tubular webbing in a step fashion. Manufactured etriers are usually sewn to create the steps; however, knots may be used to create the steps from a length of webbing.
Fall Factor	Divide the length of the fall by the length of the rope in the system arresting the fall. Fall factors greater than 1.0 can cause injury from the force of the sudden stop.
Foot Lock (Secure Foot Lock)	A method of safely ascending a free-hanging rope without mechanical assistance by wrapping the rope around the feet. In a secured footlock the climber is protected from falling by a friction hitch attached to the climber's harness.
Four-Inch Tie-In	A self-belay system usually consisting of a rope, prusik loop, webbing, and carabiners. It is used as a safety line to secure the climber to the tree below the 4-inch bole diameter and at 3-foot intervals along the bole when climbing above the 4-inch diameter.
Friction Saver (Cambium Saver, Tree-crotch lanyard)	A piece of rope or webbing, preformed leather tube, or rubber coated flexible metal conduit designed specifically for rigging a rappel rope in a tree. This reduces abrasion to the lanyard, rappel rope and the tree. A doubled rope rappel can be rigged so that the rappel rope does not contact the tree bole, and the rappel rope and friction saver can be retrieved from the ground.
Haul Line (Equipment Line, Tag Line, Work Line)	A small rope or cord used for raising and lowering equipment and materials to and from the climber.
Lanyard (Safety Lanyard, Adjustable Lanyard, prusik Lanyard, Flip Line)	A short piece of rope that secures the climber to the tree. It usually consists of a rope with a mechanical grab or friction hitch used to adjust the length and a snap catch or carabiner on each end for attaching to the climber's harness.
Rappel Rope (Main Line, Descent Rope)	A rope used to rappel or descend from a tree.
Saddle (Sit Harness)	A type of work harness that is designed specifically to support the climber for long periods in a sitting position. A saddle differs from a safety harness by not having a chest component.
Safety Knot (Backup Knot)	A secondary knot added to a primary knot to provide additional security. A true safety knot should ensure that the primary knot cannot untie itself. Two common safety knots are the double overhand and the double fisherman's knot.
Safety Line (Safety Rope, Belay Rope)	A rope that is either attached to a climber and used for belaying by a ground person or is attached to a secure anchor point and adjusted by the climber (such as with the 4-inch tie-in).

Field Guide Terms (Other Terms in Use)	Definitions
Safety Strap (Sling)	A length of rope or webbing used as a protection point in a belayed ascent by either the ground person or the climber in a self-belay (as in the 4-inch tie-in). These straps are placed around the tree bole and secured by either a knot or carabiner, then secured to the belay rope with a carabiner.
Sectional Ladder (Swedish Ladder, Tree Ladder)	A specially designed ladder for tree climbing that interlocks and individually secures to the tree. This ladder comes in 10-foot sections that can be stacked to provide a continuous ladder.
Secured	A climbing system that is attached to the climber and connected to the tree that protects the climber from unintended movement. Climbers are secured when they are tied in, using a lanyard, on belay, or when they are ascending a climbing line with the footlock technique while using a prusik loop or ascenders.
SRT (Single Rope Technique)	A method of tree access, where the climber ascends a single, statically set rope by means of ascenders.
Snap Catch (Rope Snap, Snap Link, Snap Hook)	A metal device with a ring on one end that usually attaches permanently to a rope or cable. The other end has a spring-loaded, locking gate. Unlike the gate on a carabiner, the gate on a snap link does not lock into the body of the snap link and does not offer any additional strength when closed. Snap catches shall be the self-closing, auto-locking type.
Steel-Core Lanyard (Flip Rope, Spur Rope, Cable-Core Lanyard)	A manila or synthetic rope with a steel cable core in which a snap has been spliced at one end. This rope is recommended when spur climbing and is required when cutting, trimming, or pruning in a tree.
Stopper Knot	A knot tied in a rope to ensure that an object sliding along the rope will stop. Commonly used at the ends of rappel ropes to protect the climber from rappelling off the rope. The double overhand knot is recommended as a replacement for the less secure single figure eight.
Throwing Knot	A knot tied in the end of a climbing line used to throw the rope into the crown of a tree.
Tree Climbing Work	Any task performed in or on a tree where access is accomplished by means of free climbing, friction knots or mechanical ascenders, climbing spurs, bole gripping systems, permanently or temporarily mounted steps, or stacked sectional ladders.
Tree Steps	A metal, L-shaped step that attaches to the tree with a chain or strap that is wrapped around the bole and secured to the step.

Additional terms are defined and discussed throughout the guide. Become familiar with all terms associated with tree climbing work to improve communication with fellow climbers.

Chapter 2 Preparations for Climbing

2.1 Job Hazard Analysis and Communications

Preparations shall include obtaining any special training the assignment might require, discussing with other team members the best way to accomplish the job, thoroughly rehearsing climbing methods to be used, and preparing a job hazard analysis for each assignment. The job hazard analysis shall include the following:

1. Establish a check-out and check-in procedure.
2. Analyze the assignment, and then obtain the equipment needed.
3. Inspect the equipment.
4. Establish radio contact with the local Forest/District office or central dispatch from the climbing site. If direct radio contact is not possible from the climbing site, an alternative method for summoning emergency help shall be established before climbing.
5. Assess the environment for potential hazards.
6. Assess the tree and immediate area for potential hazards.

2.2 Required Personal Protective Equipment

The following personal protective equipment is required for all climbing assignments:

1. Climbing harness.
2. Climbing helmet.
3. Long sleeved shirt and sturdy pants.
4. Eye protection.
5. Gloves are recommended, but not required for general climbing. Sturdy gloves are a must for any rappelling.
6. Logger-style boots with lug-type soles are appropriate for most tree climbing work. Soft-soled hiking boots, tennis shoes, and crepe-soled work boots may be used. When working with climbing spurs, wear boots that have suitable heels to keep the spurs in place and rigid arch supports to reduce fatigue and discomfort.
7. Hearing protection for power tool use.

2.3 Working as a Team

Two certified climbers make up the basic climbing team. One ground person can serve several climbers, but must be able to maintain visual and unassisted natural voice communication with all climbers at all times. Both members of the basic team may climb simultaneously, so long as both have quick descent capability, and remain within unassisted natural voice communication with each other. The team can also utilize additional non-climbers as ground personnel to provide support and facilitate unassisted voice communication among team climbers. All team climbers shall be qualified to perform every aspect of the climbing assignment in order to perform a rescue, if necessary. All team climbers shall have current medical training equivalent to at least an American Red Cross basic first-aid course. The team shall establish radio communications with the Forest or District office or central dispatch from the climbing site before climbing. An established sign-out system shall also be in effect with the local Forest / District office or central dispatch.

All team climbers shall be completely equipped to climb and shall thoroughly rehearse the climbing methods and techniques they will use. Working as a team includes the following:

1. Team members shall perform an equipment check on other team member's equipment before climbing.
2. All ground personnel shall remain alert while climbers are aloft.
3. All team members should remain alert to hazards in the tree and the environment, discussing potential problems as they arise.
4. The ground person should carefully watch the climber and communicate any problems; it is often easier for the ground person to identify hazards and recognize unsafe climbing practices than it is for the climber to do so.
5. The ground person should maintain verbal and visual contact with the climber. When the climber is collecting cones, the ground person should assist by pointing out areas where cones can be collected.
6. All climbers shall be prepared to perform a rescue or render first aid at all times.
7. The ground person shall not be directly underneath the climber at any time unless first cleared by the climber to be there. Whenever a ground person is underneath a climber, the climber remains in an "at rest" position until the ground person is no longer there.

2.4 Hazard Assessment

Any number of hazards may prevent a tree from being climbed. Hazards are generally grouped into two categories: environmental hazards and tree hazards. The following lists of potential hazards represent a starting point for the focus of a hazard tree assessment. In special situations where hazards cannot be mitigated, consider seeking additional help from specialists or receiving additional training before performing any work. The climbing team must perform both a thorough environmental and tree hazard assessment before any tree is climbed. Remember, no tree is worth a human life.

2.4.1 Environmental Hazards

The climbing team must assess the environmental hazards at each tree and monitor the weather throughout the day for changes that could make climbing more hazardous. Never climb a tree under any of the following conditions unless properly mitigated in your job hazard analysis.

1. The **wind** speed exceeds 25 mph or the wind is blowing in gusts. In light winds, try to keep your back to the wind. Do treetop work first, when conditions permit. If winds increase later, it may still be safe to work lower in the tree.
2. It is not fully daylight. **Visibility** is especially important late in the day when fatigue is a factor. Do not start a tree climb that cannot be completed in full daylight.
3. Air **temperature** is low enough to create an unsafe condition. Be particularly aware of cold temperatures. Cold impairs dexterity, especially in the fingers, which can jeopardize your ability to accomplish tasks safely.
4. A **lightning** storm is close. If you are in a tree when a lightning storm appears imminent, descend as quickly and safely as possible.
5. A **powerline** is close enough to the tree that you, your equipment, or the tree branches could come in contact with the powerline. Consider any tree suspect if a powerline is anywhere in the vicinity. DO NOT climb any tree that is closer than 10 feet from energized electrical conductors, unless qualified as a line clearance arborist.

2.4.2 Tree Hazards

Hazardous situations should be avoided as much as possible, unless a specific need for climbing exists. A thorough tree hazard assessment is crucial for determining the extent of the hazard and the climber's ability to deal with it. Although trainee climbers can successfully compensate for many hazards, as the severity of the hazard increases so does the level of experience required. The type or severity of a hazard may warrant additional training, specialized equipment, or outside expertise.

When climbing, if you discover a hazard that was not spotted from the ground, or that appears to be more hazardous than you originally thought, descend immediately unless the hazard can be mitigated.

Check every tree thoroughly before the climb. Both team members shall walk around the tree and assess it for potential hazards. Many hazards can be compensated for easily, allowing the tree to be climbed safely. Other trees have severe hazards that preclude them from being climbed unless a special need exists, the climber is properly trained and equipped, and any hazards are mitigated. Climbers should familiarize themselves with species-specific characteristics which may prove hazardous.

The following hazards may prevent a tree from being climbed, if it is not possible to compensate for them.

1. **Rain-, ice-, or snow-covered branches.** These branches pose slipping hazards that may affect climbing performance. Climbers may need to use a safety line or lanyard at all times for added safety.
2. **Moss and lichen.** Moss and lichen create a slippery climbing surface. This hazard is especially prevalent in the Northwest. Climbers may need to use a safety line or lanyard for added safety.
3. **Brittle limbs caused by low temperatures.** Use the same precautions you would use with any brittle limbs. If the temperature is too low to climb safely, then you should not be climbing.
4. **Tree species with brittle limbs.** When climbing species with brittle limbs be sure to install your climbing line or lanyard around the bole of the tree.
5. **Small-diameter boles and limbs.** Keep hands and feet as close to the bole as possible. When climbing above the 4-inch diameter point in conifers, a safety line shall be used. A safety line may be used earlier in the climb for added safety.
6. **Steeply sloping limbs.** Always keep your hands and feet as close to the bole as possible. Wedge them close to the bole when you are using sloping limbs for support. If your hands or feet continually slip, consider climbing with your lanyard attached at all times or use a safety line for a belayed ascent. Exercise caution on trees with branches that slope upward. To avoid getting your feet stuck, do not use them for support. If these branches cannot be avoided, consider using tree steps or using webbing slings for steps.
7. **Damaged limbs.** Avoid the use of damaged limbs to support your weight.
8. **Branch stubs or dead branches.** Never use branch stubs or dead branches for support. Consider removal of dead branches while ascending the tree if there is a chance they might be used inadvertently while descending.
9. **Abnormally large amounts of branch mortality.** These conditions may indicate unsafe limbs and hidden rot. This is mainly a problem in conifers.

10. **Weak branch unions.** Weak branch unions are places where branches are not strongly attached to the tree. A weak union occurs when two or more branches of similar size grow so closely together that bark grows between the branches, inside the union. This is usually a problem with branches that are growing upright. The included bark weakens the branch union. The included bark may also act as a wedge and force the branch union to separate when loaded. Species such as elm and maple have a tendency to form upright branches, often producing weak branch unions. Weak branch unions also form after a tree or branch is tipped or topped (when the main stem or a large branch is cut at a right angle to the direction of growth, leaving a large branch stub). The stub inevitably decays, providing very poor support for new epicormic branches that usually develop along the cut branch. Inspect all branch unions at or below your tie-in point before choosing them to install your climbing line or lanyard.
11. **Poor tree architecture.** Poor architecture is a growth pattern that indicates weakness or structural imbalance. Trees with strange shapes are interesting to look at, but may be structurally defective. Poor architecture often arises after many years of damage from storms, unusual growing conditions, improper pruning, topping, and other damage. A leaning tree may or may not be a hazard. An arborist knowledgeable about that tree species should examine leaning trees that might be a hazard.
12. **Forked boles and spiked top.** Unless the tree species naturally forks, do not climb above a forked bole. Treat any fork with suspicion, because the fork is potentially a weak point. Never climb into a dead or spiked top. Forks sometimes indicate an old, broken top. Frequently, they are associated with wood decay, which further weakens the area, making it unsafe for climbing. Most hardwood trees fork naturally, so a forked hardwood tree would not cause as much concern as a forked conifer.
13. **Cankers.** A canker is a localized area on the stem or branch of a tree, where the bark is sunken or missing. Wounding or disease causes cankers. Stems are more likely to break near the canker. A tree with a canker that encompasses more than half of the tree's circumference may be hazardous even if exposed wood appears sound.
14. **Cracks.** Deep splits through the bark that extend into the wood of the tree are extremely hazardous, because they indicate that the tree is failing. These trees should be evaluated by a person familiar with the species and climbed by certified climbers who are properly trained and equipped for the hazards associated with the job.
15. **Decay.** A decaying tree can be prone to failure. The presence of decay by itself does not indicate that the tree is hazardous. Advanced decay (wood that is soft, punky, or crumbly, or a cavity where wood is missing) can create a serious hazard. Signs of fungal activity, including mushrooms, conks, and brackets growing on root flares, stems, or branches indicate advanced decay. A tree usually decays from the inside out, eventually forming a cavity. Sound wood is added to the outside of the tree as it grows. Trees with sound outer wood shells may be relatively safe, but this depends on the ratio of sound to decayed wood and other defects that might be present. If decay is evident and you have doubts about the tree, avoid it. Arborists are best qualified to evaluate the safety of a decaying tree.
16. **Root problems.** Trees with root problems may fall without warning for any number of reasons, especially when the tree's leaves grow in summer, increasing the weight the tree must support. Besides decay, roots may have a number of other problems. They may have been severed; they may have been paved over; they may have been harmed when the soil grade was raised or lowered; or a car may have driven over or parked on top of them. Mounded soil near the base of the tree, twigs that have died back, deadwood

in the crown, and leaves that are off color or smaller than normal often are symptoms associated with root problems. Because most defective roots are underground and out of sight, aboveground symptoms may serve as the best warning.

17. **Indications of root, butt, or bole rot.** The soundness of any tree with rot cannot be trusted. Indicators of rot include fruiting bodies of decay fungi, exposed wood that is decaying, and other indicators of internal wood decay. Wood is generally a strong material, but its strength is greatly reduced by decay. Some decay is obvious (for example, rotten wood in an exposed scar), but other decay may be hidden (for example, internal wood decay in a forked top).
18. **Loose bark.** Loose bark may peel off when grabbed for support or when spurs are used. In dead conifers, large sections of bark may break loose and fall, injuring a climber or damaging equipment. Certified climbers who are properly trained and equipped for the hazards associated with the job should do critical work in such trees.
19. **Dead wood.** Dead trees and large, dead branches are unpredictable and may fall at any time. Dead wood is often dry and brittle and cannot bend as a living tree or branch does. Dead branches or treetops that are already broken off (“hangers” or “widowmakers”) are especially hazardous. Certified climbers who are properly trained and equipped for the hazards associated with the job should do critical work in such trees.
20. **Multiple defects.** Recognizing multiple defects in a tree is critical when evaluating the tree’s potential to fail. Multiple defects that are touching or close to one another should be examined carefully. The combined potential of multiple defects can far exceed the sum of the individual hazards considered separately. If more than one defect occurs on a main stem, you should assume that the tree is potentially hazardous.
21. **Large portions of other trees or snags lodged in the crown.** Trees or snags lodged in the crown of another tree may move or fall, striking the climber or pinning the climber in a tree. Tree climbing to remove these hazards, or to perform critical work in the tree, should be done by certified climbers who are properly trained and equipped for the hazards associated with the job.
22. **Bee, hornet, or wasp colonies.** Look for insect colonies in trees to be climbed or in trees adjacent to the one to be climbed. Climbing may disturb the colony. Often colonies cannot be seen from the ground. When you are climbing, always let your ground person know when you spot a colony. A can of bee and wasp spray that will stun bees, wasps, and hornets should be carried during high-risk seasons. Climbers allergic to insect stings should have the appropriate medication with them. The climbing team’s first-aid kit should include an insect-sting kit, which may have to be purchased separately. Climbing to monitor or remove insect colonies should be performed only by certified climbers who are properly trained and equipped for the hazards associated with the job.
23. **Animals in the tree.** Unexpected encounters with wildlife in trees can cause enough commotion to startle a climber and create a hazardous situation. It is best to return to the tree at a later date and climb it when the animal is not present or to designate the tree as unsafe to climb without special training and precautions. Tree climbing to monitor animals, or for other animal-related activities, should be done by certified climbers who are familiar with the behavior of the animals being monitored, are properly equipped for the job, and are properly trained in the methods necessary to minimize and mitigate the associated hazards.

Chapter 3 Equipment

3.1 Use of Climbing Equipment

A variety of equipment has been developed for tree climbing work or adapted from activities such as rock climbing and caving. The climbing assignment and personal preference largely dictate the equipment selected. This chapter contains information on recommended uses, advantages and disadvantages of equipment, procedures for use, and recommendations for care.

3.2 Care of Climbing Equipment.

Continue to check the condition of your equipment frequently during the climbing assignment. After the job, inspect the equipment, clean, and refurbish as needed so it is ready for the next assignment or for emergency use. Restrict equipment access to certified climbers only and use the equipment exclusively for tree climbing work. A locked storage area is advisable. Storage areas should be secure from rodents and chemicals—a must for rope, webbing, and harnesses. Clearly mark or tag all defective equipment to prevent further use and repair or take it out of service. Certified climbers should be responsible for all of their own climbing equipment. Keep manufacturers' equipment specifications and care recommendations on file for ready access.

Equipment, especially ropes, webbing, and loops, should never be walked on or driven over. This kind of abuse causes damage in ways that are not always apparent and could cause failures.

Climbing equipment, especially life-safety ropes, shall not be left unattended in a tree. The equipment needs to be closely inspected before each use, and it cannot be if it is left in the tree. Tree sap, insects, animals, abrasion, sunlight, and rain affect climbing equipment, and equipment cannot be monitored or controlled when it is left in the tree. If a tree will be climbed more than once, a utility cord can be left in a position that allows climbing ropes to be easily put in place for future climbs.

When life-safety equipment shows significant wear, it should be taken out of service. Significant wear could be a frayed leg loop on a harness or a small crack in a gaff. Do not use any safety equipment that was involved in a significant fall. Harnesses, ropes, and any slings or webbing that helped arrest a fall can receive damage that is undetectable during inspection. The climbing components might fail the next time they are used.

Do not paint metal equipment. Paint can hide defects that can cause failure.

All equipment used for climber life support shall meet or exceed ANSI, or European PPE Directive 89/686/EEC standards for breaking strength. This requirement is consistent with search and rescue requirements for a 15:1 safety margin. Haul lines should be capable of supporting items being hauled into the tree and lowered from the tree without exceeding their working-load limits.

Equipment used in life support applications and not specifically mentioned in the National Tree Climbing Guide, or FSH 2409.17, Chapter 50, may only be used in tree climbing operations and activities when the equipment:

1. Is approved in writing, by the Regional Tree Climbing Coordinator and technical advisor(s).
2. Meets the applicable standards set forth in ANSI A10.14, Z133.1, or European PPE Directive 89/686/EEC, or by a nationally recognized testing and certification organization.
3. Is defined in the job hazard analysis.

Equipment meeting the intent of (2) above, may also be approved by the National Tree Climbing Technical Advisory Group for agency-wide application.

Ropes: Ropes used for safety lines, safety straps, lanyards, and climbing lines should have an abrasion resistance and a melting point that is equal to or greater than nylon rope and a minimum breaking strength of 5,400 pounds (24kN). Climbing lines that are UIAA approved and meet the standard for single-rope use are suitable. Smaller diameter rope of less than 5,400-pounds breaking strength may be used to construct slings and prusik loops if the finished product meets or exceeds 5,400-pounds breaking strength. However, the margin of safety will be lower because the smaller diameter rope will have less resistance to friction wear for these purposes.

Webbing: Webbing should have a breaking strength of at least 5,400 pounds. It is acceptable to use webbing with less strength if the safety strap or sling is constructed to form a finished product with at least a 5,400-pound minimum breaking strength.

Climbing Belts, Saddles and Safety Harnesses: Climbing belts, saddles and safety harnesses shall meet the requirements of ANSI A10.14, or European PPE Directive 89/686/EEC

Carabiners and Screw Links: Carabiners used in life-support applications shall be of the self-closing, positive-locking type, (triple action, double auto-locking, three-stage) and along with screw links, shall have a minimum tensile strength of 5,000 pounds (22 kN). Standard one-quarter-turn, twistlock carabiners do not have a positive-locking mechanism and shall not be used in life-support applications.

Climbing Helmets: Helmets used for tree climbing shall be UIAA (Union Internationale des Associations d'Alpinisme) approved or certified as meeting ANSI Standard Z89.1. These helmets have been tested for side impact and puncture resistance, shock absorption, and the ability to remain on the head during impact. The most desirable of these helmets have an adjustable suspension system and shock-absorbing foam padding. Climbing helmets should be inspected on a regular basis for hairline cracks by flexing. Refer to manufacturer's recommendation on when to retire a climbing helmet.

3.3 Ropes

The working characteristics of a rope depend on the materials used to construct it and the construction method. Not all ropes are suitable for tree climbing work. When selecting rope, consider these points:

1. How will the rope be used— haul line, climbing line, rappel line, lanyards, or 4-inch tie-in?
2. What rope properties are required for the intended use— static, dynamic, or semi-static/dynamic?
3. What type of material is best for the intended use— nylon, Kevlar, manila, polyester, or polyolefin?
4. What type of construction is best for the intended use— laid, kernmantle, or braided? Because most tree climbing ropes are used for life support, it is critical that you be thoroughly familiar with all aspects of the rope from the time it is purchased until it is retired from service. Maintain a rope log documenting use. If you are not personally familiar with the history of the rope you are going to rely on, do not use it. Purchase ropes only from reputable dealers knowledgeable about materials, construction, and breaking strengths. Never purchase used ropes.

3.3.1 Characteristics of Rope

Consider the following when selecting a rope for tree climbing work:

Elasticity. This refers to how much a rope can stretch before it reaches its breaking strength. The elongation is measured as the percentage of increase in the rope length under a given load. The amount of elongation at the breaking strength determines whether a rope is considered static or dynamic.

- A. A static rope has less than 20-percent elongation at the breaking strength and less than 2 percent elongation at a working load of 500 pounds. As a rule, these ropes are stiffer than dynamic ropes, which can make knot tying more difficult. Generally, static ropes are more resistant to abrasion and dirt penetration. Principal uses for static ropes include haul lines, lanyards, safety straps or slings, SRT ropes, and rappel ropes. Never use static ropes in situations where a fall could occur, such as with the 4-inch tie-in system, or as a safety line for a belayed ascent.
- B. A dynamic rope has an elongation of 40 to 60 percent at the breaking strength and less than 10 percent elongation at a working load of 176 pounds. A dynamic rope absorbs the shock of a fall, giving the climber added protection. Principal uses for dynamic ropes include safety lines and 4-inch tie-in systems. Because of their versatility, dynamic ropes are suitable for lanyards and rappelling. They are NOT recommended for haul lines, SRT, and DRT because of their tendency to stretch.
- C. Semi-static/dynamic ropes fall into the elasticity range between fully static and fully dynamic. Ropes designed for use in DRT climbing systems are commonly in this elasticity range, i.e. from 3 to 4 percent elongation at working loads of 500 pounds.

Abrasion resistance. Stiffer ropes generally resist abrasion better than more flexible ropes. All ropes may be abraded from within by dirt particles rubbing against the fibers or from the outside by contact with rough or sharp surfaces.

Tensile strength. Tensile strength is the resistance of a rope to a force tending to tear it apart. Tensile strength is determined by steadily applying an increasing load on a rope until it breaks.

Breaking strength. Breaking strength refers to the value at which a rope breaks when subjected to a sudden force from a known weight over a specified distance.

Resistance to sunlight. All synthetic and natural fiber ropes will deteriorate with continued exposure to sunlight. Ultraviolet degradation of synthetic rope and webbing is the most significant factor affecting the aging of rope, especially when the cordage is in storage longer than in actual use (assuming it has not been damaged). Rope made from Kevlar is especially sensitive to ultraviolet degradation and should be stored according to manufacturer's instructions. It is impossible to assess the strength of a rope or webbing that has been stored for long periods in direct sunlight. The cordage may be unsafe to use long before it shows any signs of wear. Rope condition can be assessed by visual and tactile inspection when it has been protected from damage and stored in a cool, dark place.

Heat resistance. Heat resistance is the ability of a rope to withstand overheating and melting due to normal or rapid (6 feet per second or more) rappelling or other friction caused by a rope rubbing against or over a surface. When heated, a rope will soften. Softening always permanently weakens the rope and may result in rope failure.

Water absorption. The more water repellent a rope the better. A rope that is wet is usually not as strong as when it is dry. A rope's abrasion resistance and tensile strength may be reduced when it is wet.

Chemical resistance. Chemicals such as bleach, acids, oils, spirits, lacquer, battery acid (including any residual acid that may be found on jumper cables), petroleum products, and lacquer thinner can damage ropes. Vapors these chemicals give off may also do damage. Avoid contamination with any of these chemicals. Ropes constructed of nylon or polyester have good resistance to petroleum products, but are susceptible to acids of all types.

Aging. Ropes have a finite service life, even if they are not used. A rope's strength decreases over time.

3.3.2 Types of Rope Materials

The type of material a rope is made of determines how it can be used in tree climbing applications. Types of rope material include:

1. **Manila.** Manila is a natural fiber that is treated with oily compounds when manufactured into rope. These oily compounds are lost as the rope ages, reducing its strength over time. Never use a plain manila rope for life-supporting lines or other important uses. Quality control is difficult because natural fibers tend to rot and degrade. Degradation occurs not only during use, but also in storage and often is not evident on inspection. Manila rope is not as strong as nylon rope of the same diameter, and breaking strengths may vary widely depending on the manufacturer. Water absorption is high compared to synthetic fibers. Manila ropes are only suitable for utility purposes, except when combined with steel cable such as steel-core rope lanyards that are acceptable for life-safety use. Manila ropes are considered static ropes.
2. **Polyolefin.** Ropes of polypropylene and polyethylene melt at 310 °F, but may begin to soften and weaken at 100 °F. These temperatures can be easily reached or exceeded when the ropes are subjected to abrasion and friction. Use ropes made exclusively of these materials only for haul lines or other uses that do not include life support.
3. **Nylon.** Nylon is a durable, strong, synthetic fiber with widely varying physical properties. Of the many types of nylon yarn manufactured, the two most common in rope construction are nylon 6, also known as Perlon, and nylon 6,6. Nylon 6,6 has a slightly higher melting point (500 °F) than nylon 6 (419 °F) and also a higher breaking strength; these differences, however, are not always apparent because other factors, such as rope design, contribute to the overall properties of a rope. Nylon ropes have a high breaking strength relative to their size and a high abrasion resistance when dry. Untreated, they readily absorb water, which reduces their tensile strength by up to 10 percent. Nylon ropes that have a minimum breaking strength of 5,400 pounds are suitable for climbing when they are new. Ropes of nylon may be either static or dynamic, depending on their construction.
4. **Polyester.** Dacron® and Terylene® are trade names for polyester fibers. This material melts at 480 °F and is not affected by water. Breaking strength is about 75 percent of similarly designed nylon 6,6 static ropes. Elasticity is about the same as manila rope. Polyester ropes are considered static ropes.
5. **Kevlar.** Kevlar® is an extremely strong, high-temperature resistant fiber. However, it has a very low elasticity and breaks if bent too tightly, such as in a knot. This type of rope is often used by rescue teams for high-angle rescues when several lives may depend on only one rope. Because of the high cost and limited life of this type of rope, it is not recommended for tree climbing applications.
6. **Aramid.** This group of fibers offers high levels of resistance to abrasion and heat. On a per weight basis, they are five times stronger than steel. Known by trade names including Technora® and Nomex®, these fibers are mildly self-abrasive, and have poor resistance to ultra-violet (UV) radiation. These fibers do not melt, but begin to fail due to charring damage at 900 degrees F.
7. **Ultra-High Molecular Weight Polyethylene (HMPE).** This type of fiber is light in weight, extremely high strength and abrasion resistant, but melts at quite low temperatures, just below 300 degrees F. Well-known trade names include Dyneema® and Spectra®. Ropes or slings of this material are suitable for applications that are not subject to heat generating friction.

3.3.3 Types of Rope Construction

The most common construction methods for rope are kernmantle, laid, and braided.

1. **Kernmantle construction.** Kernmantle rope consists of a central core (kern) of fibers that support most of the load on the rope (about 80 percent). A woven sheath (mantle) covers this core and supports less of the load (about 20 percent). The sheath's tight weave protects the core fibers from abrasion, dirt, and sunlight. The resulting rope is strong and resists damage, yet is easy to handle.
2. **Laid construction.** In laid construction, small fiber bundles are twisted together and combined into larger bundles that are twisted around one another. The "lay" of the rope is the direction in which the strands are twisted. Most ropes are right-laid (strands spiral upward to the right when the rope is held vertically). The lay may be either hard or soft. Hard-lay construction creates a stiff rope in which knots are difficult to set and hard to untie after use. When under a load, these ropes resist abrasion and hold their shape better than soft-laid ropes. Soft-lay construction results in a flexible, easy-to-use rope, but one that unwinds easily and is not recommended for rappelling. All ropes of laid construction tend to untwist when loaded, causing spin and rope kinking. The amount laid ropes untwist when loaded depends on the strength of the lay. Because each fiber may appear at the rope's surface in several places along its length, the load-bearing fibers are more susceptible to abrasion damage.
3. **Braided construction.** Many types of braided rope are available. These ropes have gained popularity among tree climbers because of their excellent knot holding and handling characteristics. Common types include solid braid 12-strand and double braid mantle and core 16-strand. Both types of construction are used in life support climbing lines and in rigging ropes.

3.3.4 Care, Cleaning, and Storage

1. A rope should never be stepped on, driven over, or have other equipment piled on it. This can grind abrasive dirt into the fibers or abrade or cut the outside surface. Sharp or heavy objects can cause unseen damage that may cause unexpected failure.
2. New rope should never be washed, rinsed, or soaked before initial use because of the naturally slippery quality that makes it soft and supple. The fibers adjust favorably, depending on use. Washing a new rope tends to remove the natural slipperiness, causing it to become dry and brittle, thereby shortening its life.
3. Rope should only be washed when very dirty. Wash ropes to keep dirt from working its way inside, where it can abrade and weaken internal fibers.
4. When a rope must be washed, check the manufacturer's instructions. If acceptable, first soak pitchy areas with a non-abrasive hand cleaner. Commercial T-shaped rope washers that attach to a garden hose use tiny water jets to effectively and easily clean ropes. Ropes can also be washed by hand or in a front-loading machine with mild detergent in warm water. Drip dry out of direct sunlight; never machine dry.
5. Proper storage maximizes a rope's useful life. Store rope in a cool, dark, dry place. Exposure to direct sunlight rapidly deteriorates rope fibers. Untie all knots before storage and never hang a rope over a nail, small diameter peg, or hook. Ideally, rope should be flaked or coiled and stored in a rope bag that can be closed tightly.

3.3.5 Hazards

Even normal wear and tear can, over time, seriously reduce any rope's strength. That's why it is important to purchase only high-quality ropes and implement a documented monitoring system with frequent inspections, proper storage, and strict rope retirement standards as a way to minimize hazards. Even when using high-quality ropes, potentially hazardous situations exist in tree climbing work, including:

1. Using the wrong rope for the job.
2. Using inappropriate knots or tying knots improperly.
3. Hauling equipment up a tree or using sharp tools aloft.
4. Using a knife or saw where it can come into contact with a rope under tension. A rope under tension cuts quite easily. Whenever rappelling or ascending on a rope, a knife or other sharp tool should not be used, except in an emergency when no other tool is available.
5. Bending ropes through knots or over carabiners. Bending reduces a rope's overall strength. A rope bent in an arc that is less than four times its diameter will reduce its strength at that point by as much as 25 percent.
6. Using wet ropes.
7. Climbing or rappelling with a rope that has been driven over, used for towing, or otherwise severely damaged.
8. Using a stored rope that was damaged by animals, particularly rodents.
9. Climbing with spurs—gaffs can cut rope.
10. Failing to retire stressed or seriously damaged rope.
11. Using a fixed rope being abraded by another rope passing across it, or using a fixed rope bearing against a fixed object during "bouncing" that is induced by a climber's use of ascenders or uneven rappelling.

3.3.6 Rope Retirement

Promptly remove worn-out and unsafe ropes from climbing kits. Either cut retired ropes into lengths unusable for climbing, or permanently mark them so they won't be mistaken for ropes suitable for tree climbing work.

The service life of a rope has been the subject of much debate. The history of a rope's use and storage conditions and the manufacturer's recommendations are important to consider when evaluating a rope's useful life. If a rope's age and history are unknown, it should be retired immediately and replaced. All new ropes should be marked with date of manufacture, type, and length. A log should be kept for all ropes that include this information as well as date of purchase and type of use the rope experiences.

Check ropes carefully for surface abrasion, cuts, burns, soft or hard spots, and regions of reduced diameter. A suggested test for kernmantle and braided ropes is to form a tight bend at one end and slowly move it down the rope to the other end. Damage to the inner core of the rope will reveal itself by allowing the bend to collapse or fold more tightly at the damage point. Treat any irregularity with suspicion and take the rope out of service.

Always retire a rope when it has been subjected to any heavy stress or shock load, such as a single fall or when wear or damage becomes obvious. Retire laid ropes if the surfaces of the inner strands show substantial powdering. This is a sign of severe chemical- or storage-induced damage. Powder residue may not be retained within the strands of a soft-lay rope, so this type of damage may be hard to detect. Retire braided and laid ropes when a significant number of fibers in the yarns of the outer sheath are cut (this includes the sheath of kernmantle-constructed ropes). Whenever you are uncertain about a rope's condition, retire it. Retire kernmantle rope immediately if the kern (core) becomes damaged in any way.

3.4 Webbing

Webbing is a form of flat cordage that comes in many different sizes and types. Wider webbing is generally stronger, but due to differences in construction and materials, width is not always a good indication of breaking strength. It is essential to know the breaking strength of any material used in tree climbing work. The climber is responsible for purchasing webbing that meets or exceeds approved safety standards.

Heavy-duty webbing that is 2 to 3 inches wide is available. Heavy-duty flat webbing may be difficult to handle or tie securely. Tubular webbing is usually stronger and more flexible than a similar width of flat webbing. Quality 1-inch tubular webbing usually has a breaking strength of about 4,000 pounds. This webbing will only meet life-support strength requirements when assembled and used as a loop sling (Figure 3a).

Two types of construction are used for tubular webbing:

1. **Spiral structure**, also referred to as shuttle loom construction. This type of webbing is suitable for life support.
2. **Chain structure**, also referred to as edge-stitched or needle-loom construction. This type of webbing is NOT suitable for life support.

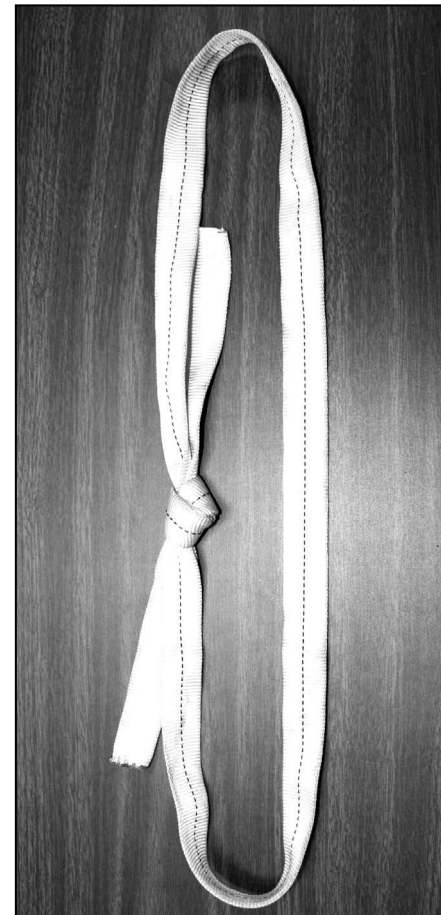


Figure 3a: Webbing used as a loop sling.

Some webbing on the market is constructed with a chain structure that is more susceptible to abrasion damage from rough surfaces or sharp edges. If a critical thread in the chain is pulled out or cut, this webbing tends to unravel and may fail.

Recent advances in webbing technology have resulted in a new class of tubular webbing (class 1A, tubular needle-loom webbing of MIL-W-4088, Webbing, Textile, Woven Nylon) that is constructed with a special, double-thickness lock stitch that prevents unraveling. Climbers should thoroughly research webbing products before purchasing.

To determine how a particular piece of tubular webbing is constructed, open the “tube” of the webbing and flatten it by laying the edge crease flat. If the crease forms a distinct irregularity at the edge where a chain stitch joins the two sides of the webbing, then it is a chain structure. The spiral variety has no such stitch, and the ribbed appearance of the surface spirals continuously across the webbing edge.

3.4.1 Suitable Uses for Webbing

1. Safety straps for protection points in the 4-inch tie-in system
2. Safety straps for protection in belayed climbing
3. Step-up slings or etriers
4. Utility cordage for attaching and hauling equipment aloft
5. Tree-crotch lanyard/friction savers
6. Re-direct anchors in DRT climbing systems.
7. Light rigging work
8. Anchors

3.4.2 Advantages of Webbing

1. Worn webbing is less expensive to replace than worn rope and is more convenient.
2. Webbing may be used to keep climbing rope away from points of wear and contamination.
3. Tubular webbing is extremely flexible, making it easy to handle. It is relatively resistant to breaking over rounded edges (such as carabiners and branches), and it generally withstands abrasion well.

3.4.3 Disadvantages of Webbing

1. Webbing does not have a protected core like a kernmantle rope, so the load-bearing elements are directly exposed to abrasion and ultraviolet deterioration.
2. Webbing is more vulnerable to cutting when exposed to sharp edges.
3. Webbing is not suitable for rappels.
4. Knots in webbing are difficult to untie once loaded.

3.4.4 Care, Cleaning, and Storage of Webbing

1. Never wash, rinse, or soak new webbing before initial use. New webbing is naturally slippery, which makes it soft and supple. Washing new webbing tends to remove the natural slipperiness, causing it to become dry and brittle and shortening its life.
2. Dirt will damage webbing over time through abrasion. When necessary, wash dirty webbing in warm water with mild detergent to reduce the likelihood of abrasion.
3. Avoid heat and direct sunlight when drying webbing.
4. Before storing, remove knots if webbing is to be retied in different configurations in the future. If webbing is tied in a permanent configuration (such as safety straps and etriers), leave knots in place to help them “set.”
5. Store webbing in a cool, dark, dry place.
6. Never store webbing where it can be stepped on or have equipment piled on top of it; this can cause internal wear by grinding abrasive dirt into the fibers or direct damage by abrasion or cutting.

7. Examine fibers closely for wear. Retire webbing before the surface fibers are worn at any place along the webbing.
8. Keep webbing used for life support separated from utility cordage. Mark utility cordage so it can be distinguished from material used for life support.
9. Never use life-support webbing for vehicle towing or subject it to other such abuse.

3.4.5 Hazards of Webbing

The cumulative effects of wear and exposure to unfavorable conditions can seriously reduce the safety margin of any webbing. It is important to emphasize the need for new, carefully monitored, high-quality materials in tree climbing work. Frequent inspection and strict retirement standards are essential. To minimize hazards:

1. Use webbing only in applications where a static rope would be appropriate. Webbing is not designed to absorb dynamic loading.
2. Make sure any webbing used for life support is constructed of nylon or polyester and applied in a manner that provides a minimum breaking strength of 5,400 pounds. “Spectra” webbing is a suitable alternative to standard webbing where exceptional strength with less weight and bulk is needed.
3. Commercially sewn slings with breaking strengths in excess of 5,400 pounds are recommended for tree climbing.
4. Commercial products not designed explicitly for life support applications are not acceptable substitutes, nor are home-stitched slings.
5. A tied sling using the water or beer knot is an acceptable substitute for commercially sewn slings. The knot must have adequate tails (3 inches or longer) and be smooth, tight, and secure (properly dressed). Carefully inspect the knot before each use.
6. Surface wear should be taken seriously in webbing products.
7. Avoid situations where a running line may abrade or cause friction heating of webbing. This may lead to rapid wear or sudden failure.
8. Not all webbing is suitable for tree climbing work because of its breaking strength or type of construction.

3.5 Safety Equipment

The climbing assignment dictates the type of equipment required. Collecting material or cones from a young seed orchard requires far less gear than working in trees in the field. But every climbing assignment requires basic safety equipment: harness, lanyards, helmet, carabiners, suitable rope, and slings (safety straps).

3.5.1 Safety Harness and Climbing Belts

Always wear a properly constructed safety harness or saddle designed for rescue and rappel. ANSI Z133.1 8.1.5 states that Type II arborist saddles shall be worn when above ground level. These saddles provide side positioning rings in addition to front point(s) of attachment for rappel suspension rings. A chest harness may facilitate rescue if the climber becomes incapacitated in the tree.

If a climbing belt with only side positioning rings is utilized, it must be used in conjunction with a harness that is suitable for rescue and rappel. A light weight rock climbing harness worn in conjunction with a climbing belt would fulfill this requirement.

3.5.1.1 General Care

The following procedure is recommended when checking climbing belts and safety harnesses for broken or rotten stitching, cuts and cracks, loose or broken rivets, and excessive wear.

1. Using your hands, firmly fold the pliable material and check for defects on the top of the fold.
2. Roll the fold along the pliable material and continue checking until one side has been completed.
3. Repeat the process on the other side of the climbing belt or safety harness.
4. During this process, carefully check all other parts of the climbing belt or safety harness for defects.

Do not store safety harnesses and climbing belts with sharp or abrasive objects; near heat, chemicals (especially acids), chemical vapors, or sunlight; or where the belt or harness may get wet.

3.5.2 Lanyards

Lanyards are adjustable lengths of rope or webbing that secure the climber to the tree, freeing the hands. While in a work position in a tree or when stopping to do anything with your hands, pass a lanyard around the tree bole or appropriate limb and attach both ends firmly to your climbing belt or safety harness. The exception to this rule is when you are working from an approved rappel or ascender system. Always use lanyards that can be easily adjusted while climbing. Practice adjusting them while still on the ground. Before ascending a tree, master throwing and catching the lanyard around the bole as well as limb-over procedures (Section 6.4.2: page 64). Always use the correct type and length of lanyard for the job.

Carefully inspect hardware for secure closure before placing your weight on the lanyard. Make sure the snap catch is compatible with the D-rings on your belt or harness.

Many types and styles of lanyards are suitable for tree climbing work. These can be divided into four categories:

- 1. Belt lanyards or lineman's safety straps.** Belt lanyards normally consist of a wide piece of nylon webbing with an adjustable buckle and a snap catch at both ends. Generally, these are not the best choice for tree climbing because they are awkward to adjust and come in just a few sizes.
- 2. Prusik lanyards.** Prusik lanyards may be equipped with a snap catch at one or both ends and are adjusted by means of either a prusik knot or other friction hitch. The lanyards come in a variety of sizes and styles that meet almost every climber's needs. Some styles may be awkward to adjust, but most adjust quickly and easily. The addition of a slack-tending micro pulley to the adjustment system increases ease of use significantly. The versatility of this lanyard has made it the preferred "all purpose" lanyard for tree climbing. Never use these lanyards for primary support when cutting, trimming, or pruning trees because of the possibility that the lanyard might be cut.
- 3. Mechanical adjuster lanyards.** Mechanical adjuster lanyards come with a snap catch at one end and a mechanical adjuster that can be moved along the lanyard and attached to the climber's belt or harness. These rope or cable steel-core lanyards are the easiest to adjust as the adjustment takes place at the climber's hip D-ring. Safety measures include placing an end splice or knot at the end of the rope to prevent the adjuster from going off the end and keeping the adjuster cam cleared of twigs and leaves.

4. **Cut-resistant lanyards.** These lanyards are typically made from cable core rope and are considered cut-resistant. Use of cut-resistant lanyards is recommended when spur climbing and required when cutting, trimming, or pruning in trees. Lanyards made from cable core rope have an eye spliced at one end of the rope that contains a snap catch. Always inspect the steel-cable core before use to ensure that the cable passes around the eye splice and is spliced or crimped back onto itself. The lanyard is snapped into a D-ring on one side of the climbing belt or safety harness and fastened to a D-ring on the opposite side with a Becket hitch, mechanical lanyard adjuster, or friction hitch. When using the lanyard for support, always maintain at least an 18-inch tail on the running end where the Becket hitch is tied.

3.5.2.1 Care of Lanyards

1. Fiber and synthetic lanyards
 - A. Check knots, splices, and metal parts for defects.
 - B. Inspect rope lanyards and retire them when the rope meets the criteria described in Section 3.3.6: Rope Retirement, page 22.
 - C. Never store lanyards with sharp or abrasive objects.
2. Steel-core rope lanyards
 - A. Remove sharp edges and protruding cable.
 - B. Check for weaknesses in the steel core.
 - C. Inspect the cable splice for defects.

3.6 Carabiners and Screw Links

Carabiners are considered safety equipment because they are a strong and secure means of attachment. Using carabiners instead of knots can save time and energy and avoid the mistake of tying a knot incorrectly or using an improper knot.

Carabiners come in a variety of shapes and sizes (Figure 3b). Carabiners can be used for attaching equipment to the haul line, joining two ropes, attaching equipment to the safety harness, reducing line abrasion, and various other applications.

Carabiners can be used for years if they are not damaged by a serious blow or long fall (hairline fractures can develop in aluminum carabiners after a fall). Inspect all carabiners frequently.

Carabiners used in tree climbing for life-support applications shall be the self-closing, positive-locking type also known as triple action, double auto-locking, or three-stage. Life-support carabiners shall have a minimum tensile strength of 5,000 pounds or 22kN. Several types of steel and aluminum carabiners meet these requirements.



Figure 3b: Carabiner types.

Steel carabiners are heavier than aluminum carabiners and will usually have a greater breaking strength. While the extra weight can be a disadvantage when carrying equipment into the tree, the steel carabiner is stronger.

A carabiner with a large gate opening is recommended for any rescue situation. Carabiners shall not be painted or covered with tape (other than a small piece for identification) because the covering may mask fractures or other defects.

Carry plenty of carabiners into the tree or have them available on the ground. When attaching a carabiner, always make sure it is properly attached, it is loaded only through the long axis, and its gate is closed and locked. **Never place a load on the gate of a carabiner.** Screwlock carabiners can be used only in applications that do not involve life support. When using these carabiners, don't overtighten the locking mechanism or tighten it when the carabiner is under load; doing so may cause the locking mechanism to jam.

Like carabiners, screw links are a strong, secure means of attachment and can be used instead of knots. They have a threaded sleeve closure instead of a spring-loaded hinged gate (Figure 3c).

Screw links can withstand multidirectional forces placed on them while carabiners are only designed to be loaded along their long axis. Consider using screw links when a semipermanent attachment is needed (such as chicken loops) or to attach tie-in points on a chest or seat harness. Do not overtighten the gate screw. When screw links have been under a heavy load, you often need pliers to loosen the threaded sleeve.

To clean carabiners and screw links, use compressed air to remove grit and use non-abrasive hand cleaner to remove sap. Thoroughly rinse and dry. Use graphite to lubricate components. Never use oil because it will attract dust.

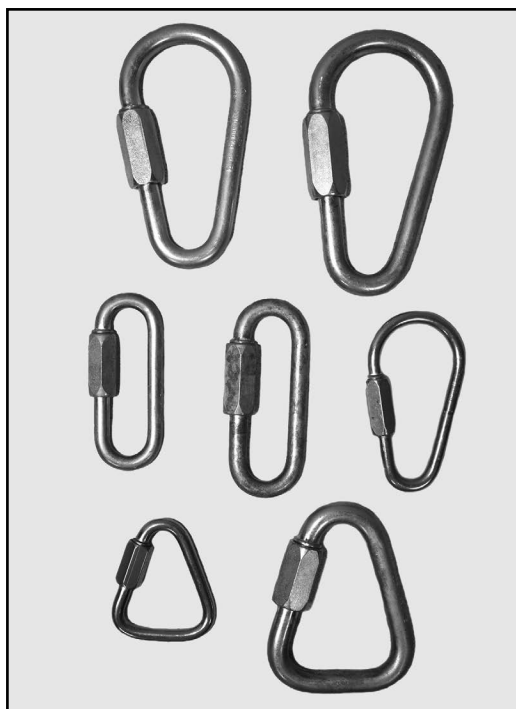


Figure 3c: Screw links

3.7 Helmets

Helmets shall be used on all climbing assignments by both the climbers and the ground persons. All helmets shall be certified as meeting the requirements of the UIAA (Union Internationale des Associations d'Alpinisme). Helmets meeting ANSI (American National Standards Institute) Standard Z89.1, Type II, which are equipped with a 3-point harness, are also acceptable. These helmets have been tested for multidirectional impact and puncture resistance, shock absorption, and the ability to remain on the head on impact. It is critical that the three-point chinstrap be worn at all times when climbing. Standard hardhats are not authorized for tree climbing.

3.8 Slings (Safety Straps)

Safety straps may be constructed from rope or webbing (by knotting) or bought commercially. They are generally used as protection or anchor points in the 4-inch tie-in system, during a belayed ascent, or as re-direct anchors with doubled rope technique (DRT) climbing systems. Where added protection is necessary (as when climbing above the 4-inch-bole-diameter level), place protection at least every 3 feet along the bole.

To construct a sling:

1. Prepare a length of rope or webbing that is long enough to accommodate the tree diameter, plus about one additional foot. The length will depend on the type of material used and the manner of sling construction. Material meeting the 5,400-pound breaking strength requirement may have a loop formed in each end. Material that does not meet the breaking strength requirement must be constructed in a manner that will provide a minimum 5,400-pound breaking strength for the sling.
2. When the ends of the rope or webbing have been prepared to prevent unraveling, either tie a figure-8 bend (rope), a water or a beer knot (webbing) to join the two ends into a continuous loop, or tie a figure eight on a bight at each end to form loops at both ends.

To use a sling:

1. Pass the sling around the tree bole and secure both ends of the sling with a single carabiner in a basket hitch. (Figure 3d). Do not use a girth hitch to secure a sling around a bole or suitable branch. This practice creates potentially dangerous stress on the sling.
2. Run the safety line through the same carabiner used to attach the sling to the tree. Never pass the safety line between the bole and your sling.



Figure 3d: Basket hitch

3.9 Basic Equipment List

Equipment needs are task specific and will vary greatly among climbing assignments. However, certain basic equipment is required for all tree climbing assignments and is listed below. Depending on additional specialized equipment needed, approximate costs per climber ran between \$1,000-\$1,500 in 2010.

Climbing helmet.

Climbing harness.

Carabiners. A minimum of 4, triple-action, double-locking life support style, and at least 2 standard ovals or Ds for gear attachment and other miscellaneous, non-life supporting uses.

Lanyards. At least 2, typically with some form of length adjuster

Rappel/rescue device. Typically a rescue 8 or Q-eight, unless an alternative prusik/friction-knot rappel system is being used. System must be capable of lowering the combined weight of an incapacitated climber and the assisting climber.

Climbing rope. Required for rescue, but useful for exiting tree crown. Length should be at least twice the expected tree height.

Other PPE as listed in Section 2.2: Required Personal Protective Equipment, page 12.

Additional useful equipment, task dependent:

Prusik cordage. Smaller diameter than primary rope improves prusik effectiveness; for tying prusik loops to use as an adjuster for lanyard or self-belay back-up in rappelling and the 4-inch tie in system.

Webbing. For constructing 4-inch tie-in anchors, re-directs, and gear slings.

Haul line. A small diameter, light weight line sufficiently strong to support intended equipment needing to be raised or lowered.

Tree crotch lanyard/friction saver. Removes branch friction from DRT rappel system and greatly reduces rope wear, pitch and dirt (Section 5.3.1: Friction Saver/Cambium Saver, page 51).

Spurs and pads. For traditional spur climbing. Upgraded pads improve comfort.

Throwline and weighted bag. For throwing a line into tree, commonly used with both DRT and SRT techniques.

Rope bag. Commercial rope bags or rucksacks facilitate packing, transporting, storing and protecting climbing ropes.

Pruning saw. Hand saw designed for tree pruning.

Chapter 4 Knots

Climbers should know a few specific knots and their proper use, rather than a myriad of knots that could confuse them when it is time to use one. Many knots are useful in tree climbing work, but only a few task-specific knots are essential for any given climbing technique.

Always check and test every knot you tie and, when practical, secure it with a double overhand knot or other suitable safety knot. Practice knot tying at frequent intervals so correct tying becomes automatic. All knots must be properly dressed and set to function safely.

4.1 Terms Used in Rope Work

Rigging point. The point where a rope is tied off to an object

Working end. The end of a rope used to tie off to something

Standing part. All the rope not fastened at the rigging point

Running end. The end of a rope that is not rigged, or the free end

Bight. A doubled section of rope that does not cross itself

Loop. A turn of the rope that crosses itself

Knot. All intentional complications in a rope

Hitch. A means of attaching a rope to an object (such as a Becket hitch or clove hitch)

Bend. A means of fastening two ropes together (such as a figure-8 bend)

Dress a knot. To orient the rope parts of a knot so they are properly aligned, straightened, or bundled to look like the drawings. This is often necessary for proper operation of the knot or to reduce rope stress

Set a knot. Tightening all parts of a knot so the rope parts touch, grab, and cause friction on the other parts of the knot, making the knot operational. Loosely tied knots can easily deform under strain and may fail

Working load. About 7 percent of a rope's minimum breaking strength when used for life support; about 20 percent of its minimum breaking strength when used for other purposes

Whipping. Tight binding around the end of a rope to prevent rope strands from unraveling

4.2 Figure-8 Knots

The figure-8 knot (Figure 4a) has three useful variations, making it one of the most versatile knots for climbers. The three variations are figure eight, figure eight on a bight, and figure-8 bend. These variations can be used for joining two sections of rope together; attaching rope to a rigging point; attaching ropes, lanyards, or safety lines to climbers; as a safety knot on the end of rappel lines; and for many other tree climbing applications.

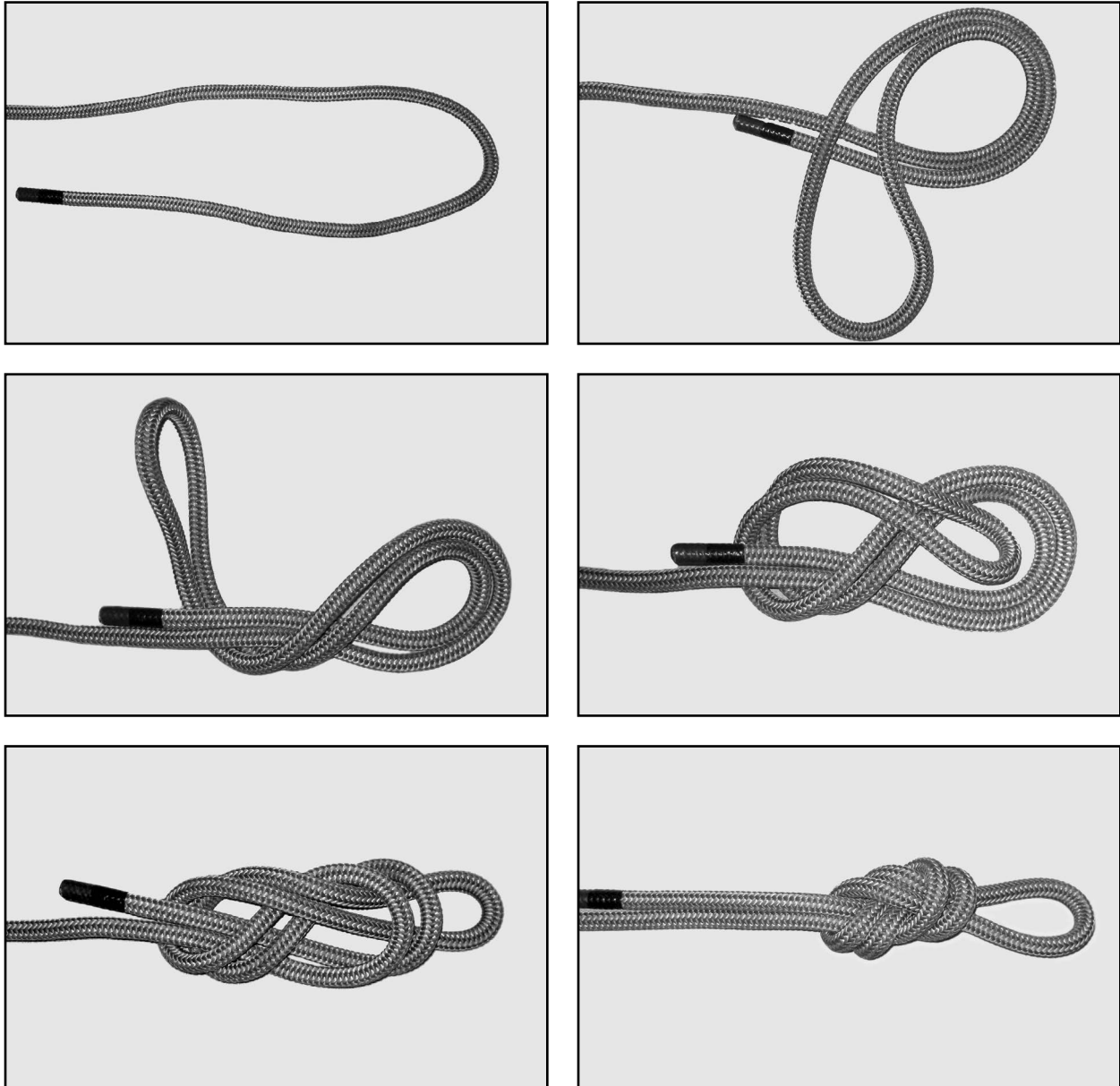


Figure 4a: Figure 8 on a bight

4.3 Friction Hitches

All friction hitches must be dressed and set, then thoroughly tested for proper function.

Prusik knot. The prusik knot is a friction hitch (Figure 4b). This knot is wrapped around and grips the main climbing line in such a way that it will not slide under tension. It is often tied using a separate loop of rope or cord. When there is no tension on the knot, it can slide freely up or down the rope. To slide the prusik knot, push or pull on the outside wrap. Holding the entire knot adds

friction, and the knot will be difficult to adjust or slide. For the prusik knot to work properly, it must be formed from rope that is no larger in diameter than the rope on which it is being tied. Generally, a more flexible or smaller diameter rope is used to tie the prusik knot onto the main climbing line when solid gripping is needed; a stiffer rope is used to tie the prusik knot onto the main climbing line when the knot must move easily. The prusik knot is commonly used to construct adjustable lanyards, 4-inch tie in systems, and prusik rappel systems. Unlike most other friction hitches, the prusik knot grips when pulled from either direction.

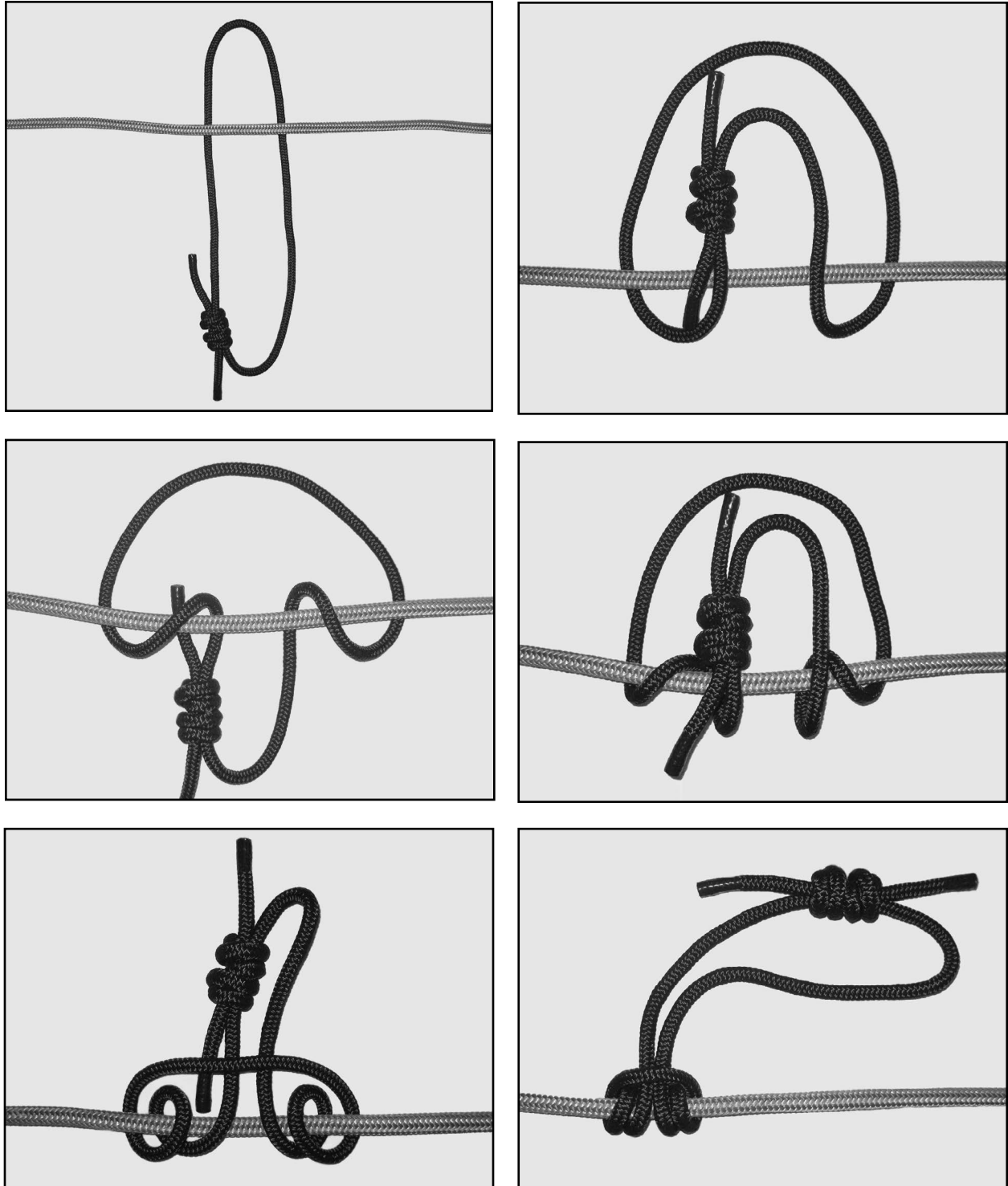


Figure 4b: Prusik knot

Blake's hitch. The Blake's hitch (Figure 4c) is another friction knot and is a slight modification of the prusik knot. It is growing in popularity because of its improved performance and because it has fewer limitations than the prusik knot. This knot maintains more uniform friction, which provides for a smooth-running friction hitch, does not bind readily, and does not have a tendency to "roll out." The tail does not slip or creep, but is subjected to greater friction damage as it slides along the standing part of the rope. This could be a significant concern during fast rappels (which should be avoided) or long rappels. The tail should be dressed with a figure-8 stopper knot or a double overhand knot (Figure 4c). This hitch grips when pulled from only one direction.

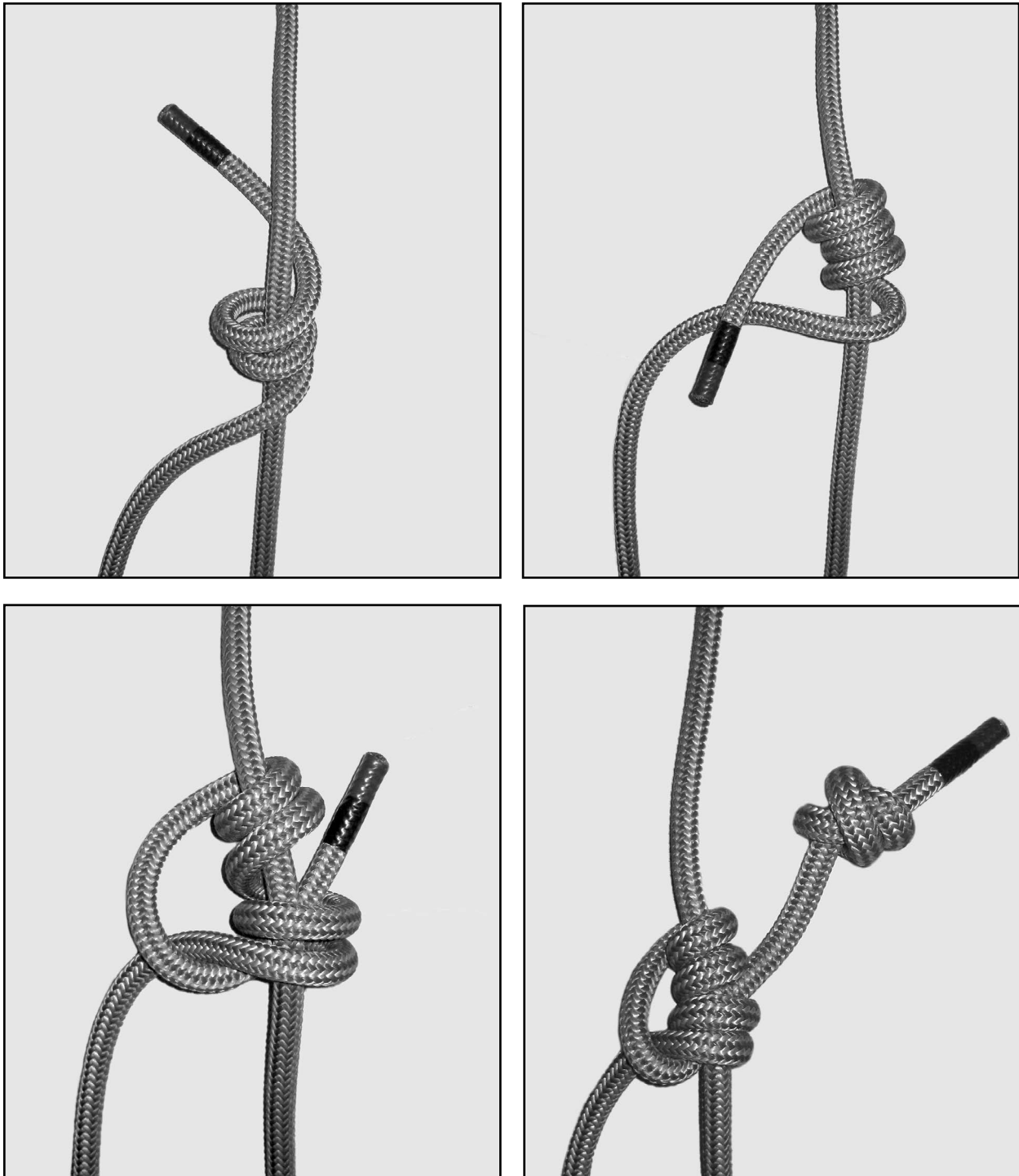


Figure 4c: Blake's hitch

4.4 Specialty Knots

Becket hitch. The Becket hitch (Figure 4d) is a specialty knot that is used with steel-core rope when attaching the rope to the D-ring of a climbing belt or safety harness. **CAUTION:** Do not use this hitch with soft or flexible ropes.

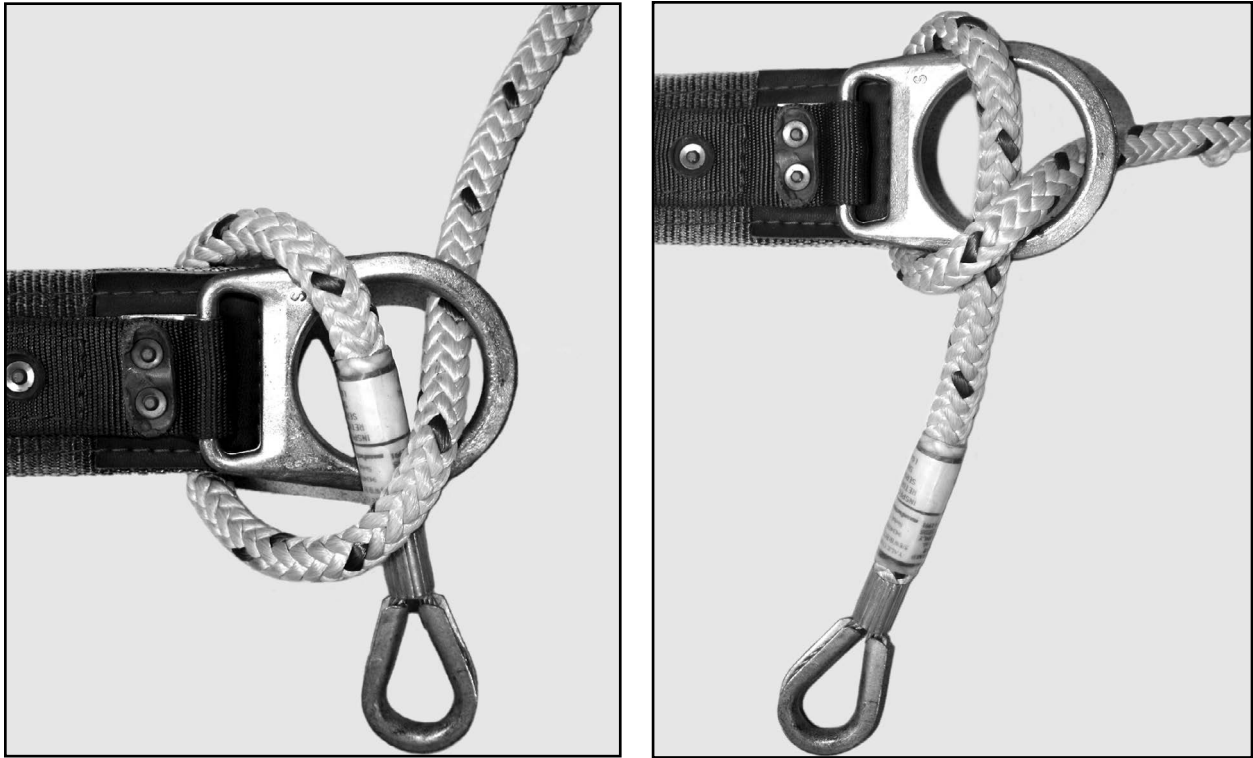


Figure 4d: Becket hitch

Tensionless hitch. This hitch (Figure 4e) is used to create an anchor point on a limbless tree trunk. While not retrievable from the ground, when used as an anchor aloft for a rappel rope it is quick to deploy and thus has advantages for aerial rescue applications.



Figure 4e: Tensionless hitch

4.5 Other Useful Knots

Other useful knots for tree climbing include the bowline, clove hitch, water knot, grapevine, buntline hitch, anchor hitch, Münter hitch, beer knot, and double fisherman's loop. The selection of these knots, as with other knots referenced, is based on their utility and safety.

Bowline knot. The bowline forms a nonslipping loop at the end of a rope (Figure 4f). This knot must be dressed and set to function properly. When used for life support the tail of the bowline must be secured. This is commonly accomplished with a double fisherman (Figure 4g) or the Yosemite finish (Figure 4h, page 37).

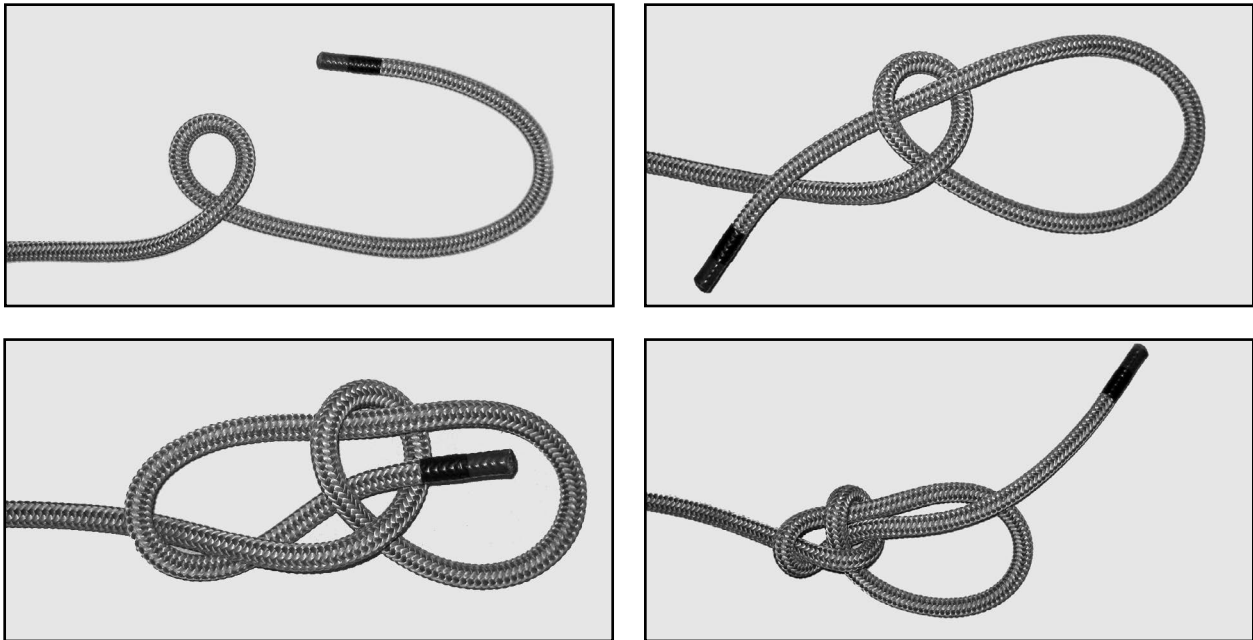


Figure 4f: Bowline knot

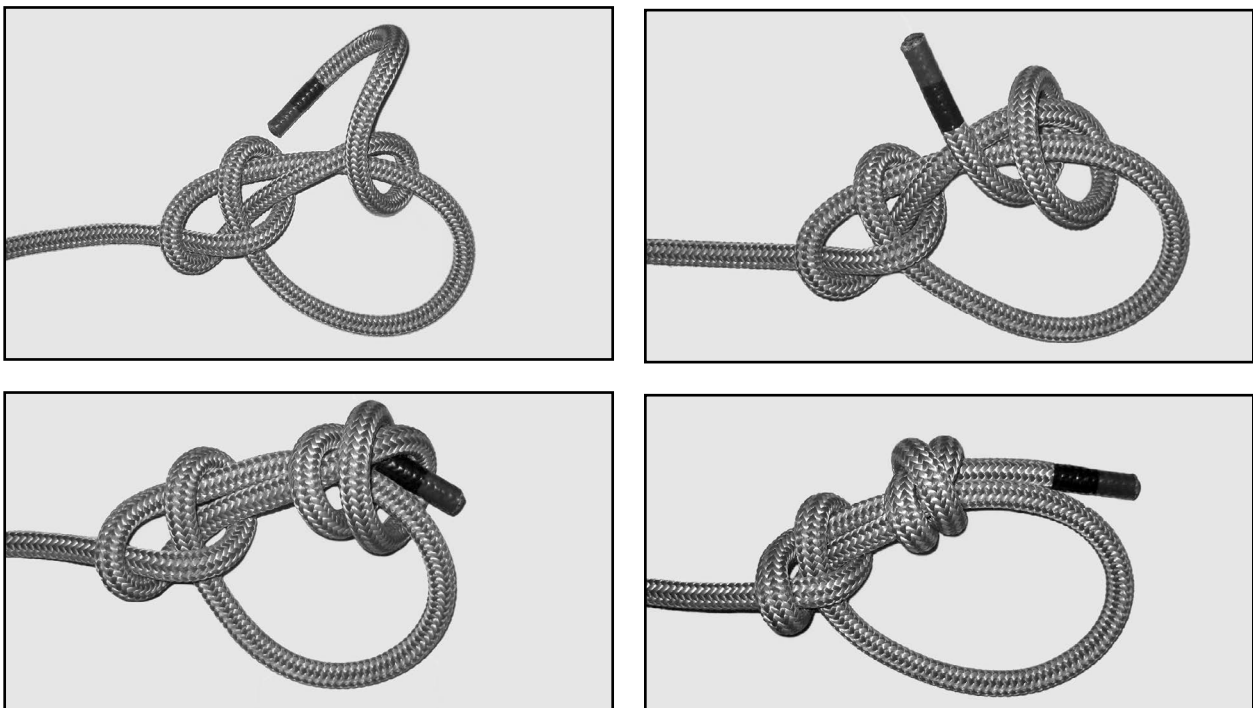


Figure 4g: Bowline with Double Fisherman's knot to secure tail

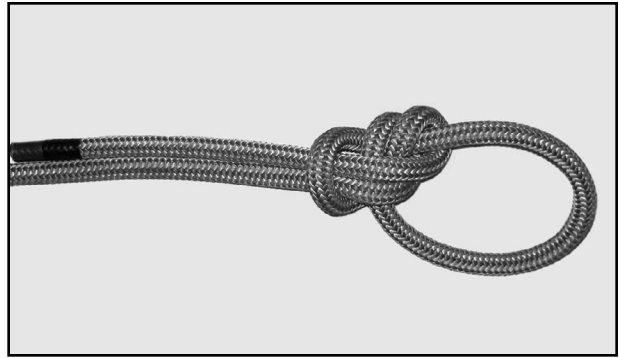
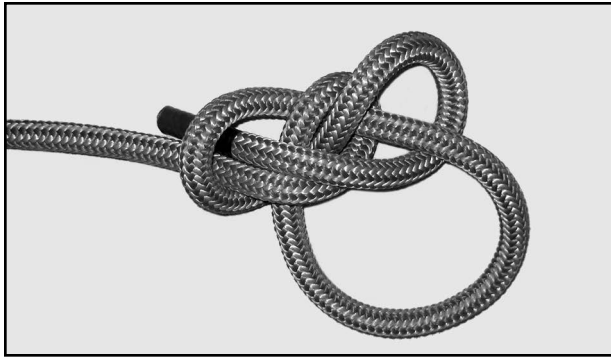


Figure 4h: Bowline with Yosemite Finish

Clove hitch. The clove hitch is used to temporarily attach tools and materials to a rope or tree (Figure 4i). The clove hitch is NOT suitable for life support.

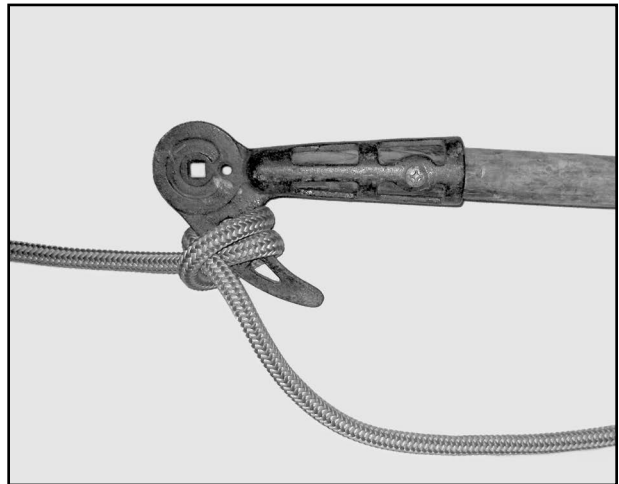
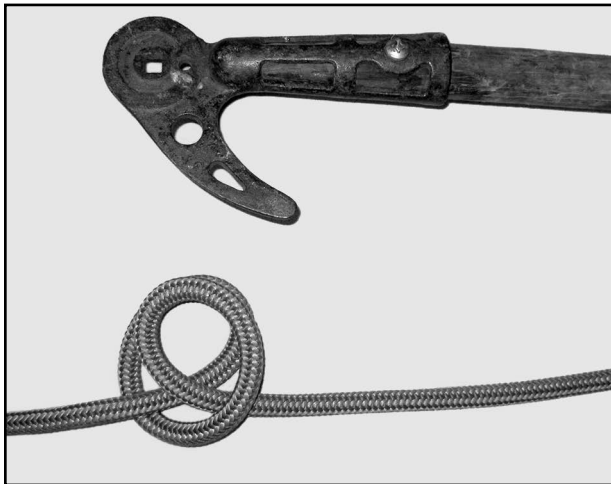
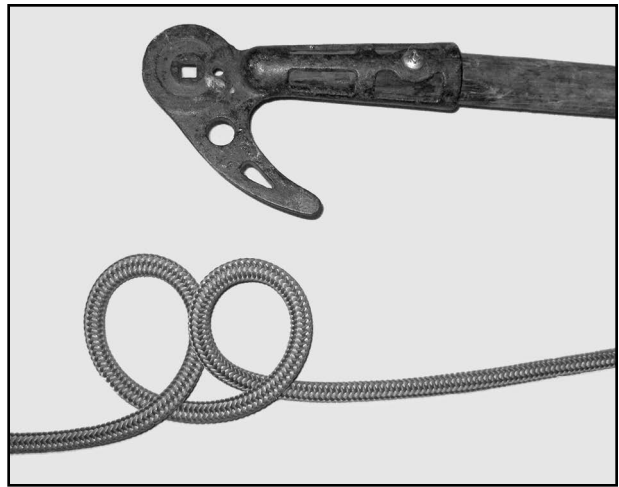
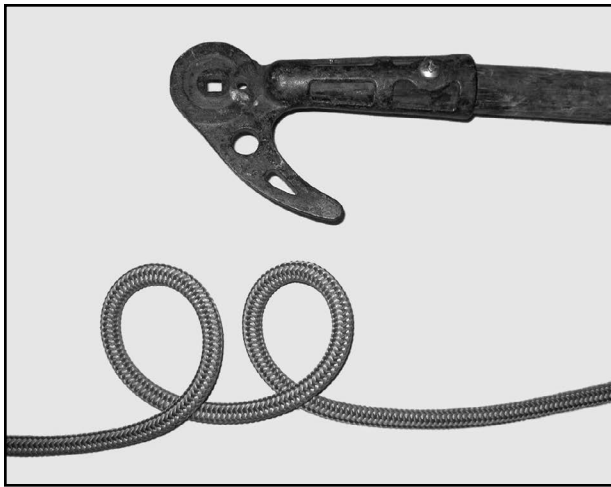


Figure 4i: Clove hitch

Water knot. The water knot is used to join two ends of webbing together (Figure 4j). This knot is the best knot for securing webbing and should only be used with webbing.

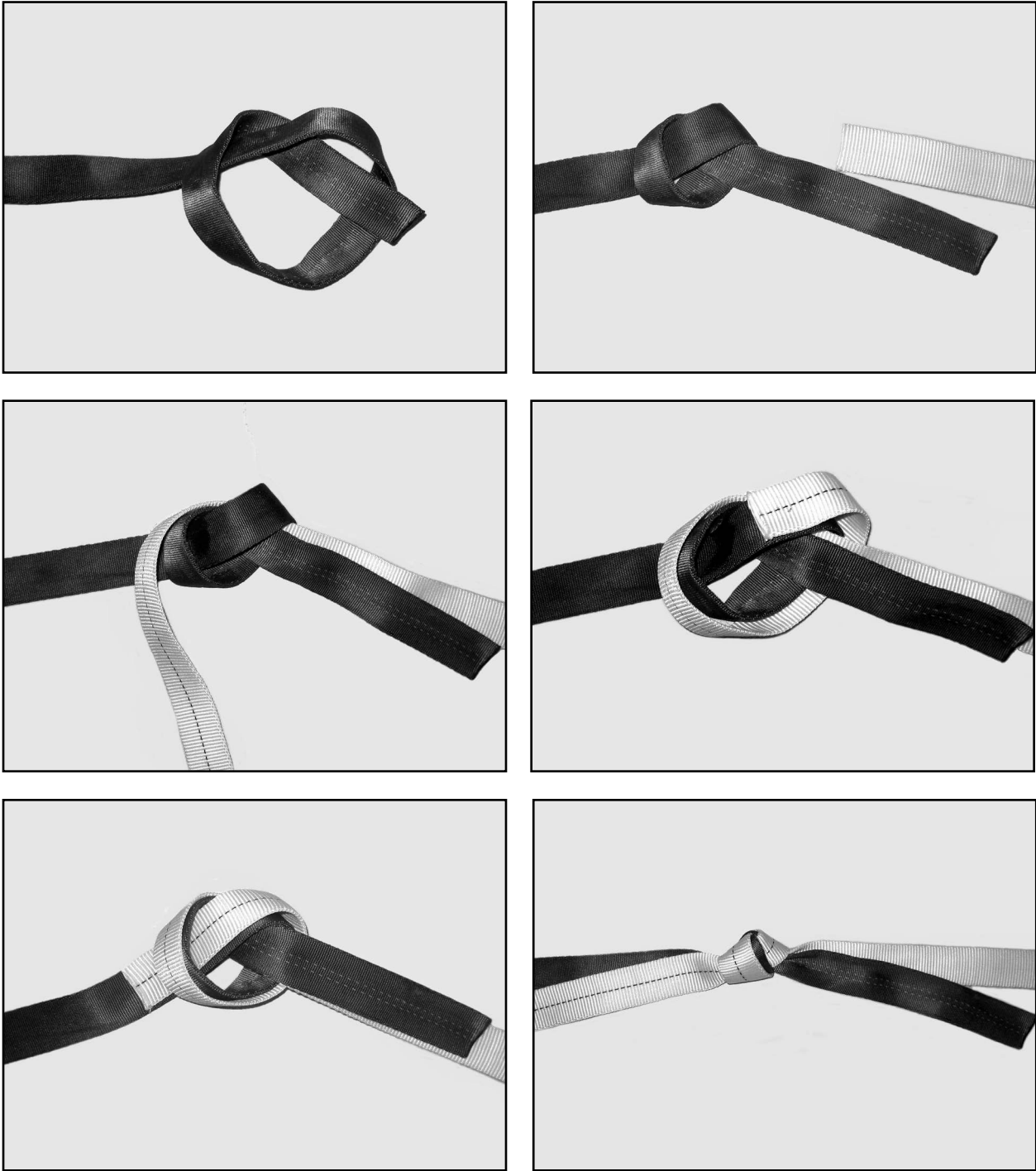


Figure 4j: Water Knot

Beer knot. A variation of the water knot, this knot (Figure 4k) is used to tie continuous loops in webbing. It offers the benefits of a tied sling without tails to snag when in use. This knot is unique in that one tail is slid inside the tubular webbing of the other tail. Care should be taken to ensure that the imbedded tail is long enough (approximately 3 inches).

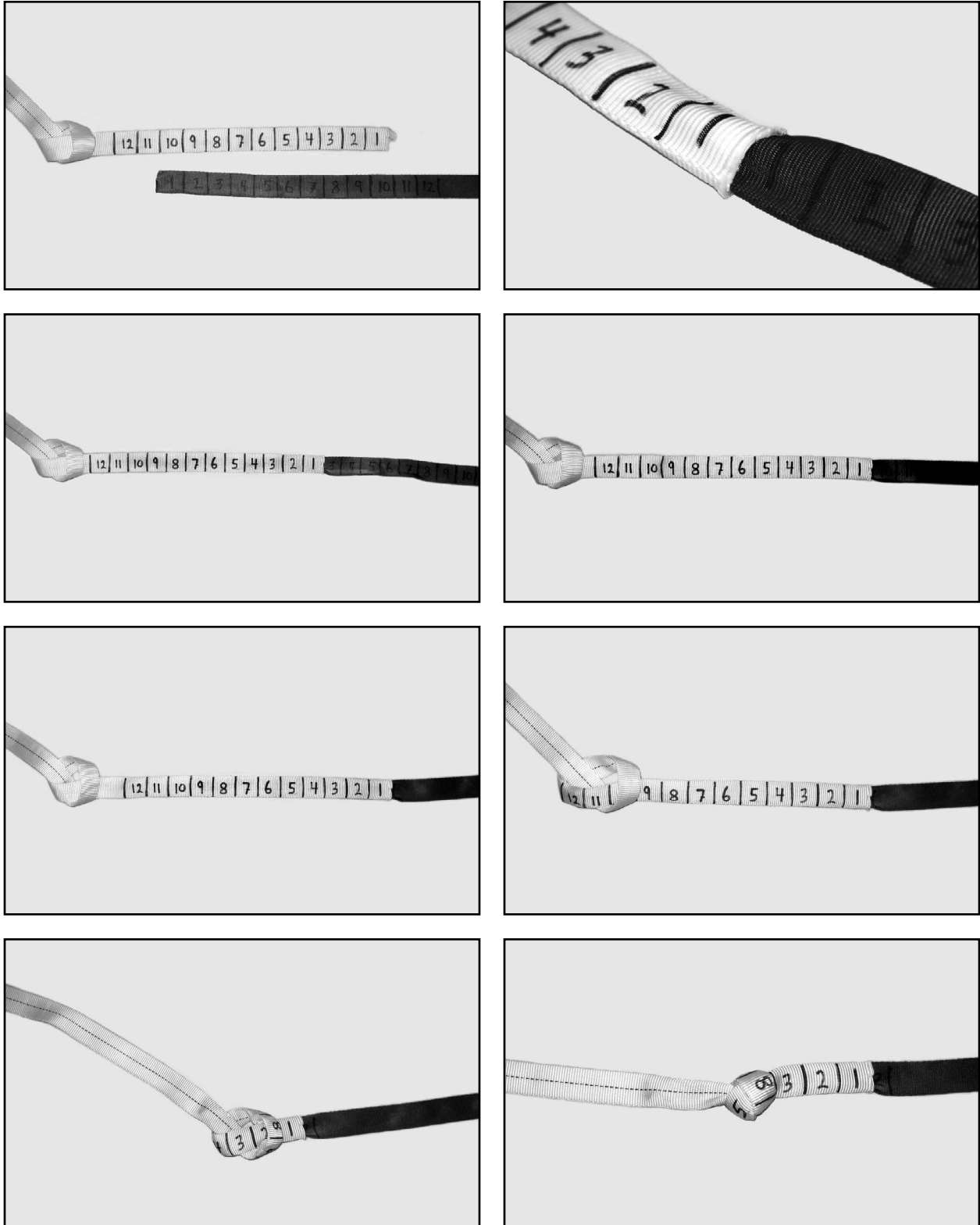


Figure 4k: Beer Knot

Grapevine or Double Fisherman's knot. The grapevine knot is another good knot for joining the ends of two ropes together (Figure 4I). DO NOT use with webbing.

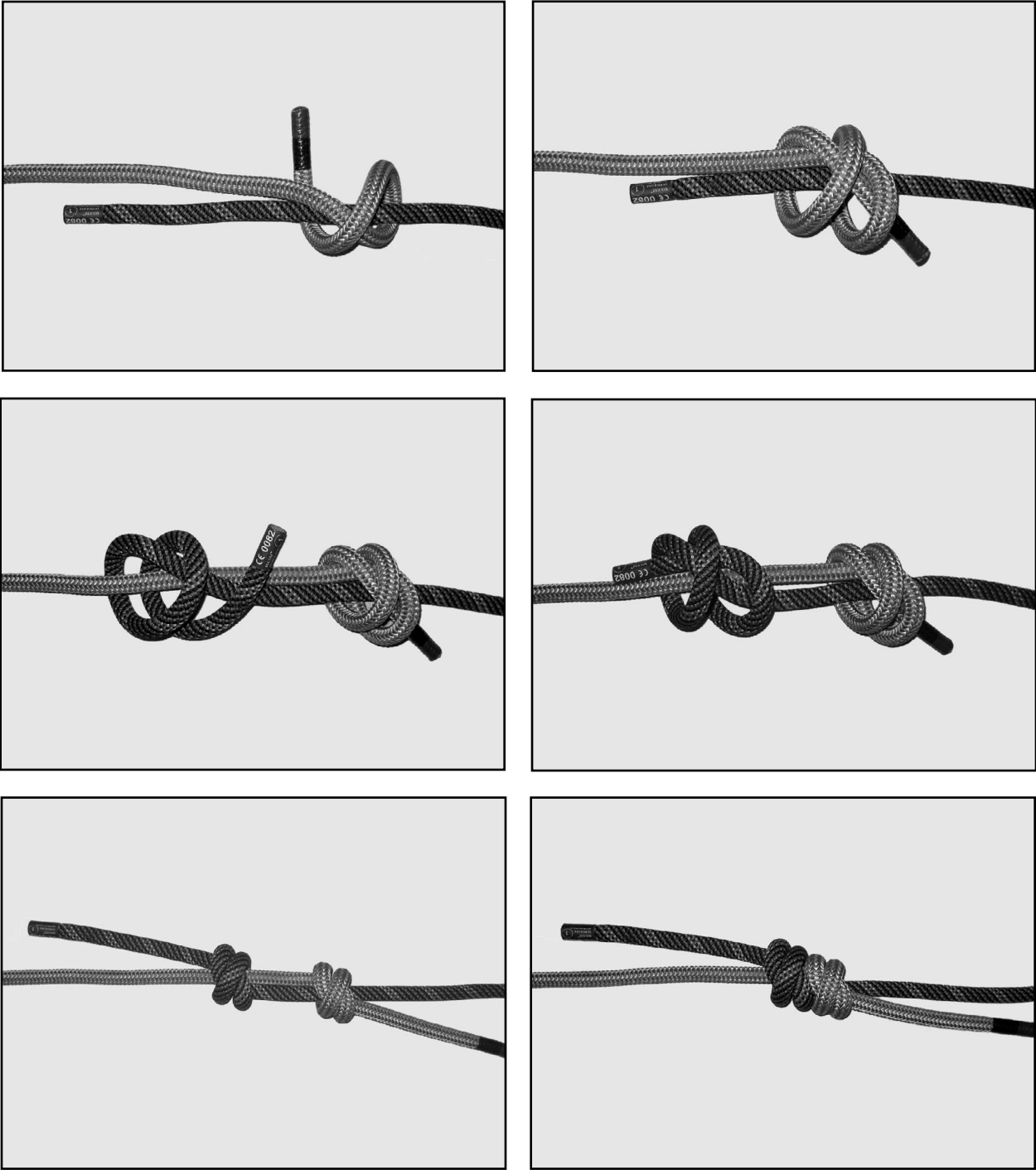


Figure 4I: Grapevine or Double Fisherman's knot

Buntline hitch. The buntline hitch (Figure 4m) is used to attach a climbing line or lanyard to a life-support device such as a carabiner or snap hook.

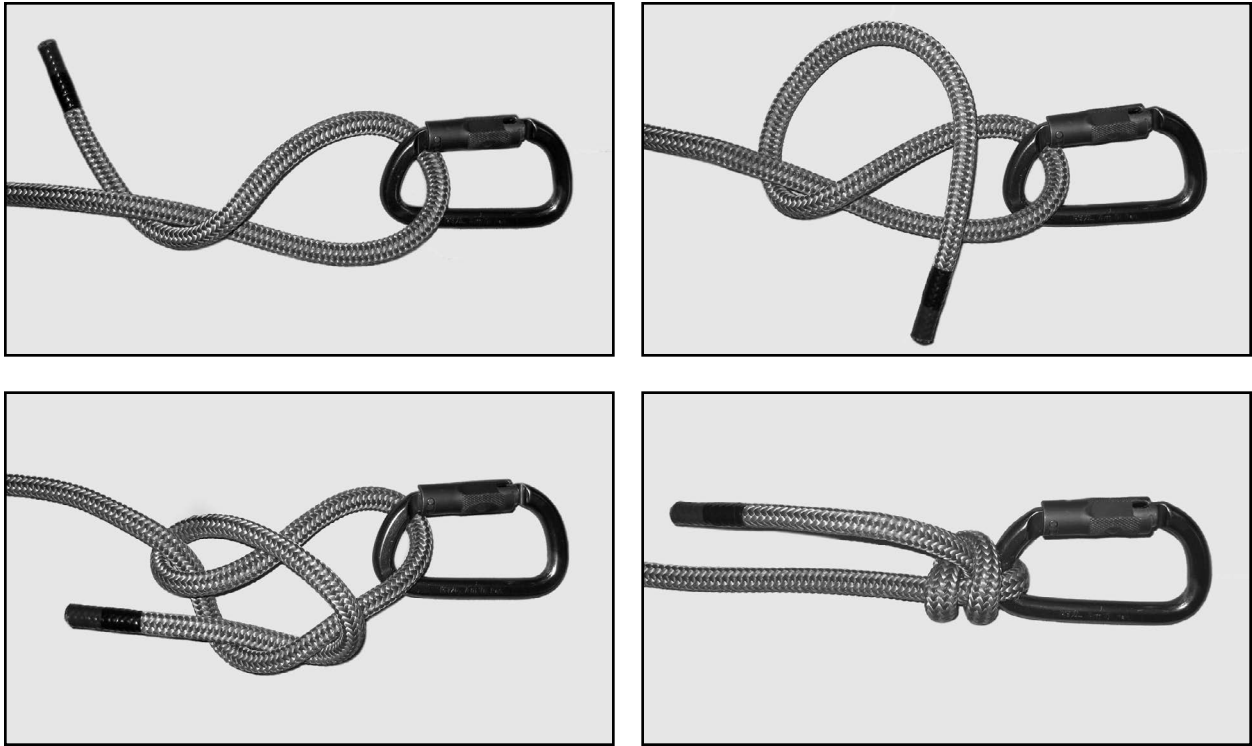


Figure 4m: Buntline Hitch

Anchor hitch. Use the anchor hitch (Figure 4n) to secure the climbing line to a carabiner or snap hook.

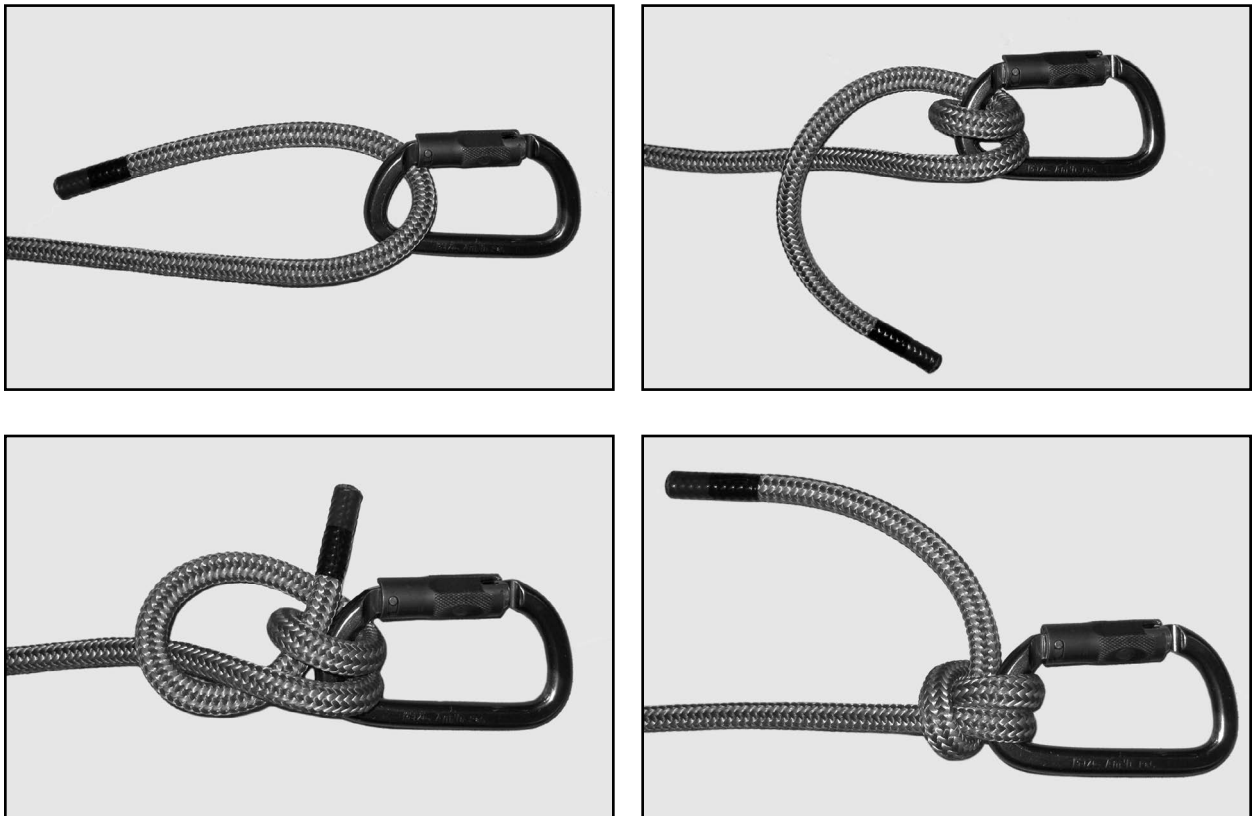


Figure 4n: Anchor Hitch

Double fisherman's loop. This knot also is used as an end-line attachment knot for a carabiner or snap hook. The buntline hitch, anchor hitch, and double fisherman's loop all snug down, capturing the attachment device and preventing unwanted movement at the attachment point (Figure 4o).

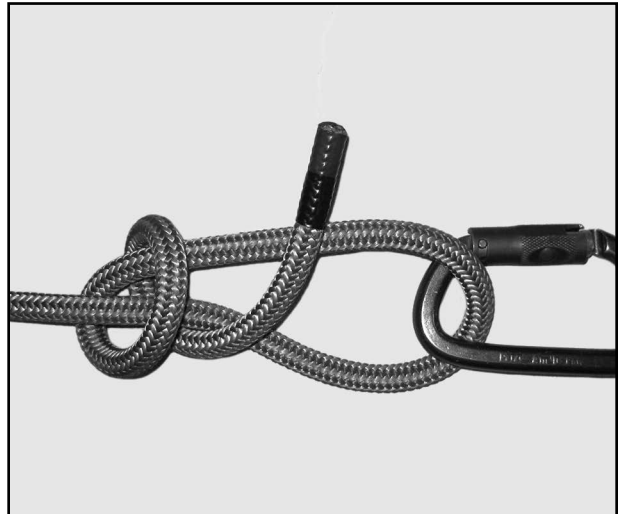
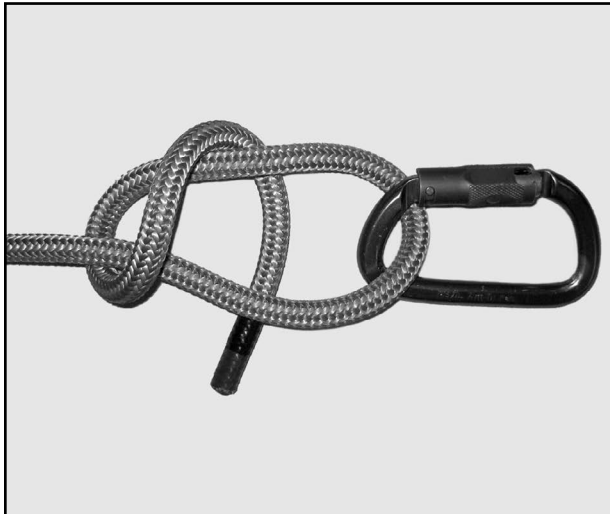
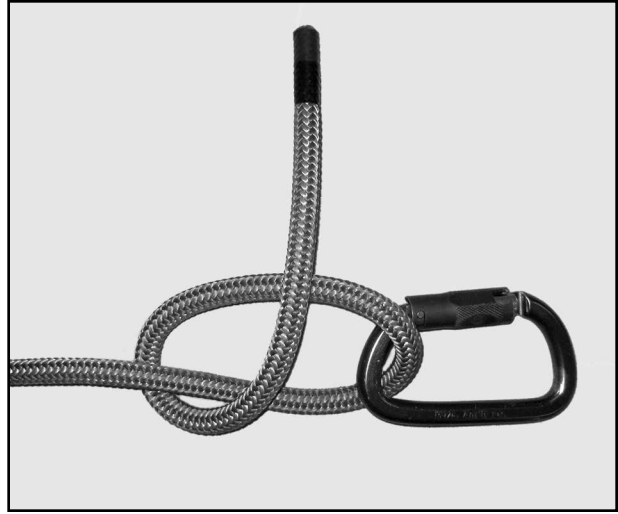
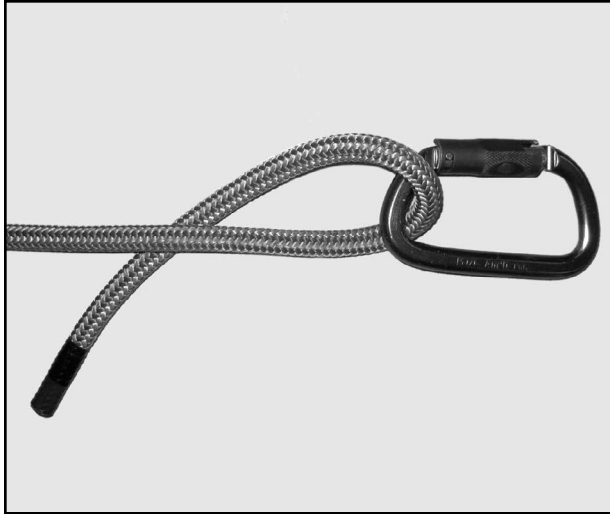


Figure 4o: Double Fisherman's Loop

Münter hitch. This belay hitch may also be used as a friction brake for rappelling in a pinch (Figure 4p). The Münter Hitch should be tied on an carabiner featuring a wide top and rounded upper corners. It is quickly tied and will reverse itself, proving effective when loaded from either direction.

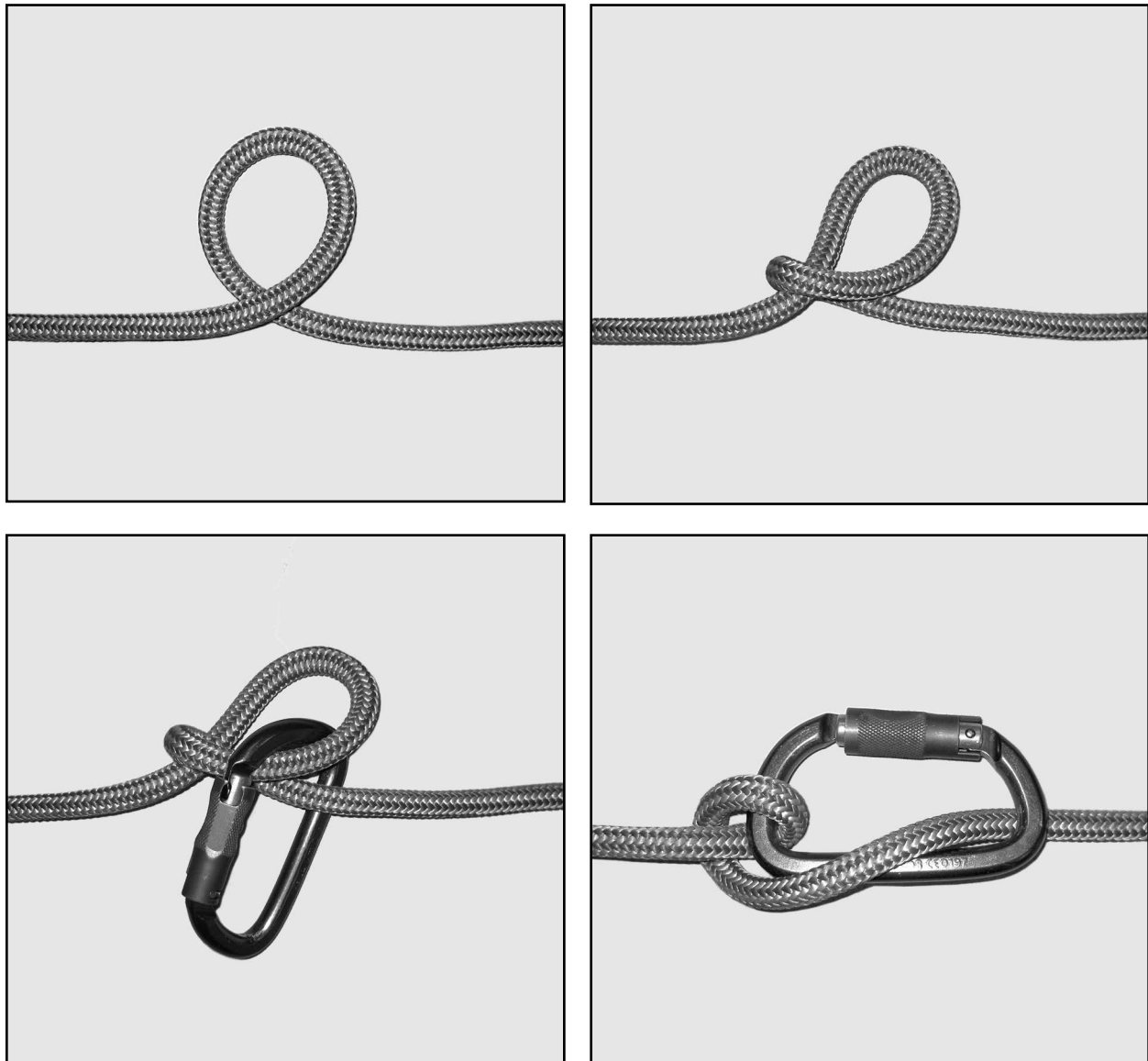


Figure 4p: Münter Hitch

Chapter 5 Tree Entry Methods

5.1 Climbing Spurs

Spur climbing (Figure 5a) is typically the fastest and simplest way to access a tree crown, however the gaffs (spurs) can seriously injure the tree bole. Job at hand, tree species, climbing location and value of the tree should all be considered when determining whether to use climbing spurs. Some species in more mesic (moist) climates tolerate damage from climbing spurs while other species on xeric (dry) sites may become more vulnerable to subsequent pathogens after being spurred.



Figure 5a: Climbing Spurs

5.1.1 Suitable Uses for Climbing Spurs

Spurs are suitable for climbing those trees NOT susceptible to long term problems from puncture wounds; five needle pines should particularly be avoided. Spurs can be used in a variety of situations, but are especially suitable for quick access to the crown in rescue situations if another climbing system (ladders, fixed rope) is not already in place.

5.1.2 Advantages

1. Climbing spurs are relatively lightweight and portable.
2. With skilled use, they can provide for a quick ascent.
3. Spurs provide climber adjustable footholds like having ‘portable branches’.
4. Can be relatively inexpensive.
5. Most types of spurs provide for adjustable fit.

5.1.3 Disadvantages

1. Climbing spurs can cause serious damage to some trees.
2. Spurs are sharp and pose the threat of accidental injury.
3. Improperly stored or carried, gaffs may also damage ropes, harnesses, and other climbing gear.
4. Multiple limb-overs may be required.

5.1.4 Procedures for Using Climbing Spurs

1. Mounting

- A. Ensure properly fitting spurs are established before going to the field. Adjust the shank to its most comfortable position on your leg (use a screwdriver or wrench to remove the holding screws and adjust the shank to about 2 inches below your knee).
- B. **DO NOT WALK IN SPURS.** Carry the climbing spurs to the base of the tree.
- C. Remove the sheaths from the gaffs and place them near the base of the tree.
- D. Place the stirrup on the instep of the boot with the gaffs to the inside of your leg, the shank in an upright position, and the shin pad across the front of your leg.
- E. Strap on the climbing spurs. Both the stirrup and the leg straps should be snug, but not tight enough to impair circulation.

2. Climbing belt, saddle and lanyard

- A. A safety harness or climbing saddle with D rings (positioning rings) mounted at the hips should be used. If a separate spur climbing belt is used, it shall be worn over a safety harness.
- B. Wear the climbing belt or waist band of climbing saddle low on your waist—it should ride on the upper part of your hips
- C. Standard climbing equipment includes two lanyards. Two lanyards are needed to pass limbs and resolve equipment difficulties safely.
- D. Check your lanyard to make sure it is in good shape and is the proper length for the job. Fasten one end of the lanyard to a D-ring on one side of the climbing belt or saddle. Use a Becket hitch, prusik, or mechanical adjuster if a cable-core lanyard is used. Refer to Section 6.4.1: Lanyard Throwing and Catching, page 63 for procedures used with cable-core manila and nylon rope lanyards.

3. Ascending and descending the tree

- A. Stand at the base of the tree and pass the lanyard around the tree. Snap the lanyard to the D-ring on the climbing belt on the opposite side of the Becket hitch, prusik, or mechanical adjuster. Visually check for proper attachment and security.
- B. Adjust the lanyard so you can lean away from the tree slightly.
- C. Start climbing, taking short steps while keeping your knees bowed slightly outward. Lean away from the tree against the lanyard, so body, legs and spurs are at an angle from the tree of about 30-40 degrees. Do not jam the spurs into the tree. Settle the gaffs into the bark on the face of the tree rather than on its sides, where the bark can flake off easily. Gaffs placed at too shallow of an angle may also flake off the bark.
- D. Keep the lanyard between your waist and chest by flipping the lanyard upward while ascending the tree. Pull your body toward the tree bole with both hands, firmly grasping the lanyard near the bole on both sides of the tree. With a quick, smooth, outward and upward motion of your hands, flip the lanyard away from the bole and up the tree. Smoothly allow your body weight to return to the lanyard and safety harness or saddle. Do not allow the lanyard to fall much below your waist.

- E. On large trees, flipping the lanyard upward may require employment of the “western roll” technique. Pull all the slack to one side, and then roll the lanyard on that side up and around the bole. As the rolling loop carries to the opposite side of the lanyard, lift that end up to complete the maneuver. Adjust the lanyard length periodically to compensate for bole taper using the procedure described in Section 6.4.3: Lanyard Adjustment, page 64.
- F. Where practical, prune or knock off dead branches and branch stubs on the way up to the live portion of the crown. You must be supported at all times by a lanyard until you enter safely into the live crown. Pass limbs using the limb-over procedures described in Section 6.4.2: Limb-Over Technique, page 64, and repeat as necessary. To ensure proficiency, practice limb-over procedures before climbing.
- G. Use the reverse procedure for descending. The gaffs should penetrate the bark to solid wood if possible. Otherwise, the bark may flake off when you apply your weight, leaving you with no support. Take care not to jam gaffs too deeply, making them difficult to remove. You may need to adjust the lanyards as the bole diameter increases. Due to the hazards associated with gaffs during descent, it is generally safer to rappel down, if possible.
- H. When dismounting from the tree, step to the ground (do not jump). Establish balanced footing before releasing the lanyard.
- I. After dismounting, immediately remove your climbing spurs and place sheaths over the gaffs. To minimize the danger of personal injury or damage to the equipment, **NEVER WALK AROUND WHILE WEARING CLIMBING SPURS.**

4. Climbing and working in the live crown

- A. It is generally better to remove your spurs at the base of the live crown. However, if you intend to wear the climbing spurs while in the live crown:
- B. When safely into the live crown, use a modification of the three-point climbing system. The points of contact are climbing spurs with the gaffs firmly placed in the bole, hands holding sound, live branches that support your weight, or both ends of the attached lanyard.
- C. Take caution stepping on branches in the tree. The steel stirrups may skin the branches, leaving a slippery surface, or the gaffs may hang up. Stand on the ball of your foot, with the sole of your boot on the limb rather than the stirrup.
- D. You must be tied in when stopping, resting or working.
- E. Do not climb above the 6-inch-bole-diameter level with spurs.
- F. To avoid injury, take special care while climbing with climbing spurs in the live crown.

If you are going to remove your climbing spurs, either lower them to the ground or tie them to the tree after you are safely in the live crown. Proceed using the three-point climbing system described in Section 6.1: Three Point Climbing, page 60.

5.1.5 Care of Climbing Spurs

1. Keep sheaths on the gaffs when the gaffs are not being used.
2. Store climbing spurs separately from other climbing equipment to minimize the risk of gaffs damaging ropes, harnesses or other climbing equipment, or being damaged themselves.

3. Keep climbing spur sets together. Fasten them together when they are stored or transported.
4. Keep gaffs sharp and maintain the gaffs' original shape as closely as possible during sharpening.
5. Inspect climbing spurs before and after each use for potential problems such as:
 - A. Metal fatigue or broken parts.
 - B. Loose or missing screws. (Tighten and replace as necessary.)
 - C. Improper mounting of straps and pads or loose, damaged, or missing straps.
 - D. Loose, dull, or improperly shaped gaffs.
 - E. Improper gaff length. Gaffs should be at least 1½ inches long when measured along the inner surface.
 - F. Gaffs of different lengths. There should be no more than a ⅛-inch difference in the lengths of the gaffs on a pair of climbing spurs.
 - G. Improper fit. (Make adjustments if needed.)

5.2 Ladders

The type of ladder most suitable for tree climbing is the Swedish sectional tree climbing ladder or an equivalent design (Figure 5b). Other types of stacking ladders are not as secure, increasing the potential for climber injury. Metal ladders should be prominently marked with electrical hazard warning labels that read: "Warning—Do Not Use Around Electrical Equipment."

5.2.1 Recommended Uses of Ladders

1. General tree work in larger trees.
2. Whenever more than one person must ascend a tree or when a number of ascents are needed to complete the project.

5.2.2 Advantages of Ladders

1. Easy to use
2. Can be used repeatedly until the job is completed.
3. Provide easy access into the live crown.
4. Provide access routes into trees whose boles may be easily damaged by other climbing methods.
5. Provides easy access into small trees.



Figure 5b: Swedish Tree Climbing Ladder

5.2.3 Disadvantages of Ladders

1. Sectional ladders are expensive compared with climbing equipment used in other access methods
2. Loss of control of ladder during initial setup may cause muscle strain and/or falling hazard to ground crew.
3. Sectional ladders are difficult to pack over steep or brushy terrain or for long distances

5.2.4 Procedures for Using Ladders

Do not climb wet ladders or ladders covered with ice or snow. Footwear must have rubber or neoprene soles and should be dry. When raising and lowering a large number of sectional ladders, use a pulley haul system.

1. Sectional tree climbing ladders
 - A. Set the legs of the base-ladder section on firm, nearly level ground against the base of the tree. Put your weight on the bottom rung and settle the ladder base into the ground to minimize settling as sections are added. Branches may need to be cut, using a pole saw, to position each section of ladder.
 - B. The base-ladder and the first section can be placed from the ground as one piece. This can help properly align the base-ladder to facilitate installation of additional ladder sections. Once the first two ladders are attached to the tree, the third ladder can usually be handed to the climber from the ground. After the first three ladders are secured, (base-ladder and two sections) hoist only one section at a time using a haul line.
 - C. Place a lanyard around the tree and secure it to a climbing belt or safety harness, leaving little slack in the lanyard, when erecting and climbing unsecured ladders. Keep the lanyard fastened until the ladder section's chain or strap is secured around the bole. You may need a second lanyard to limb-over branches.
 - D. When erecting ladder sections:
 1. Adjust the lanyard so you can lean slightly back from vertical. This position allows better balance while you raise the ladder section into position.
 2. Position yourself on the secured ladder section with the spacer bracket about chest high to erect additional ladder sections. This will permit you to place the next section without lifting it over your head.
 3. Maintain control of the section by walking or sliding the top of the ladder up the bole while keeping the base of the section away from the bole. This puts most of the weight on the tree. On rough-barked trees, you may have to flip the ladder around so the spacer spikes face away from the bole.
 4. Take care to avoid being struck with the dangling attachment chain.
 5. If you cannot maintain control of the ladder, let it go. Don't risk injury by trying to regain control. Warn the ground person before letting go of the section.
 - E. Pass the chain of the ladder section around the tree. The chain must be placed as horizontal as possible to minimize the possibility of the chain becoming slack, leaving the ladder section insecure or unstable. To tighten the chain (when the fastening bracket is on the right side of the ladder), push on the right side of the ladder with your left hand and your right foot or knee. Using a rocking motion, pull back on the chain. When the

chain is taut, secure it to the ladder. You may need to twist the chain to shorten it and to repeat the above procedure to secure the ladder firmly, but each ladder section must be secured firmly to the tree bole.

- F. Secure the chain by knotting it around the bracket and itself so it cannot slip out of the fastening bracket. Tire chain fasteners with a locking device, a turnbuckle system, or a tie-down strap with a ratchet tightener are all recommended over the original Swedish ladder bracket.
 - G. Fasten the chain for each succeeding section as described in paragraphs D and E.
 - H. Use a handsaw, pole saw, or a branch bat (a short weighted bat) to prune dead branches and stobs. Never use ladder sections to break off dead branches.
 - I. Climb ladder sections using the three-point climbing system without a lanyard only after the sections have been secured.
 - J. Secure yourself with a lanyard around the bole or to a rappel system when dismantling ladders.
 - K. Do not leave ladders unattended in trees.
2. Pulley haul system. A pulley, when combined with a haul line, can be used to raise and lower tree climbing ladder sections once the climber is above two mounted sections of ladder. Lightweight pulleys (commonly called “micro pulleys”) are most suitable. This haul system can also be used to raise and lower tools, equipment, tree cones, and similar materials. (See Section 6.5.1: Pulley Haul System, page 65)

5.2.5 Care of Ladders

- 1. Store ladders indoors in a dry location, either on a flat surface or standing nearly vertical with no weight on the span.
- 2. Remove dirt and pitch after each use.
- 3. Keep electrical warnings on metal ladders legible.
- 4. Before each use, inspect ladders for defective parts and for cuts, dents, bends, or burrs on the rungs and rails.
- 5. Inspect all screws, nuts, and bolts to ensure that they are securely tightened before use. Inspect rivets that hold the upright prongs on sectional ladders.
- 6. Make sure the prongs on stacking ladders fit firmly into, but do not bind in, the receptors. Remove burrs and sharp edges from the prongs.
- 7. Take precautions to avoid dropping ladders while they are in use or during transport.
- 8. Ensure that the attachment hardware is complete and in good working order. This includes turnbuckles, chains, and ratchet straps.
- 9. Pad and secure ladders when transporting them in or on vehicles.
- 10. Transport ladders with the chain and turnbuckles in the truck bed. Turnbuckles sometimes shake off and will be lost if they are hanging out of the truck bed.

5.3 Line Installation

Ascent by use of mechanical ascenders, secured footlock, or friction hitch climbing on doubled rope requires the placement of a climbing line from the ground prior to climbing. Below about 30 feet, the line can be installed with a throwing knot; above this height, an access line must be used. Several methods are available to accomplish this task:

1. **Throw bag and line.** The basic method for installing a climbing line is by use of a weighted throw bag mated with a light line for retrieval. Nylon bags filled with lead shot, weighing from 10 to 16 ounces, and a braided or kernmantle line of about 2mm size are perhaps the most common. Regular success requires practice, but accurate throws of 50 to 60 feet are within the capabilities of most within a short period. Tricks for manipulating the bags and line to optimize placement are limited only by the imagination of the climber. This method also allows you to reposition the rope while you are in the tree.
2. **Big Shot®.** This commercial product provides a very accurate and powerful launch for the throw bag. Heights of 90 to 100 feet are easily reached with regularity. By using a fishing reel and line and a lighter bag, heights of 150 feet and more can be attained. Setting lines on anchor points nearly straight overhead is a challenge for hand throwers. The Big Shot® performs this task with ease. The accuracy and distance readily achievable make it a tool greatly favored by many climbers.
3. **Slingshot.** Hand held slingshots, modified to allow their use with fishing reels, have allowed climbers to set climbing lines successfully. The projectile may be a $\frac{3}{4}$ or 1 ounce round fishing weight, painted a bright color for visibility. They are accurate and easy to pack, and can launch lines straight overhead. The fishing line must be used to place a standard throw line, which then can be used to haul in the climbing line.
4. **Crossbow.** A crossbow in the 150 lb range works well for accurately shooting a line into the crown of tall trees. Higher draw strengths can make it difficult to control the distance and trajectory beyond the target tree. Lighter weight pistol crossbows (50-75 lb draw) work well for lower line installations and are inexpensive, though reduced draw weight can also equate to reduced accuracy. Blunt, rubber tips prevent the bolts (crossbow arrows) from embedding in the target branches. Bolts typically need to be sufficiently heavy for gravity to draw them and an attached fishing line over the target branch to the ground. Lead shot can be poured into the hollow shaft of aluminum bolts if more weight than the rubber target blunt is needed and larger diameter fiberglass fishing arrow blanks also work well. The monofilament fishing line and reel are either attached to the crossbow (commercially such as used for bow fishing, or using hose clamps) or mounted on a short section of fishing pole and handle, and then held independently beside the crossbow operator. Reels should be open spool saltwater style, with capacity to hold 150-200 yards of line. Saltwater reels resist damage better in field conditions and open spool spinning reels allow the line to run freely after firing. High strength, none-braided line such as Berkeley Fireline or similar work well. Braided line abrades the branch during retrieval, and when working in conifers this can cause the line to become covered in sap. Accuracy is good (within 5 in at 100 ft), but as height and/or shooting angle vary, there is an inherent problem of the bolt shooting beyond the target branch and through the crown of the target tree. Lightly touching the line with a gloved hand as soon as the bolt passes the target branch will slow the bolt rapidly, and pulling back slowly on the fishing line will usually allow the bolt to swing straight down below the target branch, after which it can be lowered to the ground. A second haul line or cord, eg. 2 mm braided or kernmantle, is tied to the fishing line after the bolt is removed, pulled back over the branch, and then used to haul the climbing line over the branch.

5. **Compound/Long bow.** Compound bows typically provide greater draw strength and are easier to use than traditional long bows. Both are commercially available in a bow fishing configuration. Procedures are the same as for the crossbow above: shooting a blunt-tipped arrow with fishing line over a target branch, lowering the arrow to the ground, attaching a haul line and pulling it back over the branch, and then using it to pull the climbing line into position. This system works well on smaller trees but weighted arrows quickly diminish the height capability of the long bow. The balance between heavy enough for the arrow to drop with the fishing line and light enough to achieve the desired height can be difficult to achieve. Crossbows require less shooting skill, typically offer much more power, and greatly reduce this problem.

Of critical importance is the **selection of an anchor point** for the access line. Factors that must be considered are both the strength and the location of the branch or crotch over which the climbing line is to be placed. When using a line placement technique that has the capacity to set a line high in the canopy, such as a Big Shot[®] or crossbow, it is important to carefully examine the anchor point and line placement with binoculars prior to climbing.

1. **Strength.** The anchor point must be of sufficient strength to provide life support for the climber's weight in addition to the dynamic loads that are generated during the ascent. Knowledge of the strength characteristics of the species of tree being climbed is important in evaluating an anchor point. Declining conditions of the tree merit closer attention. Since the determination of an anchor point's suitability is made at a distance, be cautious and conservative. A pull test can be performed from the ground with body weight prior to ascending. Anything smaller than 3 inches in diameter for a hardwood branch crotch or 4 inches for a conifer branch should be studied carefully. When using anchor points of such small diameters in hardwoods, always capture the main lead or bole rather than just the limb. In conifers, ensure that the rope is placed at the union of branch and bole rather than farther out on the branch. Use of binoculars can be a great aid in inspecting potential anchor points.
2. **Location.** The anchor limb should be in the live crown area of the tree at such a location as to allow the climbing line to fall fairly freely to the ground, without weaving through branches that either impede ascender use or create extra friction to a doubled rope climbing system. Secured footlocking generally requires a free hanging rope. It is also best that there to be a convenient place to dismount from the ascent line and enter the live crown of the tree.

5.3.1 Friction Saver/Cambium Saver

When climbing by use of DRT (doubled rope technique, Section 5.5, page 56), in some cases use of a friction saver/cambium protector may be advisable. These devices provide protection to both the climbing rope and to the tree, and offer consistent and lowered levels of friction.

There are several types of these devices available. The ring and ring style consists of a rope or strap with a large metal ring on one end and a small metal ring on the other. It may be installed and retrieved from the ground (Figure 5c).



Figure 5c: (left to right) Ring and ring, conduit sleeve, leather sleeve friction savers.

An extremely simple design is the leather or conduit sleeve. It is effective and offers fewer potential problems during installation and retrieval than the ring and ring style. Additionally, the sleeve style friction saver can be readily advanced with the climbing line while moving through in the canopy (Figure 5c).

5.4 Single Rope Technique (SRT)

Single rope technique is a method of climbing where the climber ascends and descends a stationary or fixed section of rope. Unlike doubled rope technique (DRT), there is no mechanical advantage from the rope system, which allows the SRT climber to ascend long distances more efficiently than DRT. SRT has become increasingly popular over the years with numerous new techniques and devices available for use.

5.4.1 Recommended Use of Single Rope Technique

Single Rope Technique (SRT) is most often used for ascending long distances in large-diameter conifers, hardwoods, and trees with ornamental value.

5.4.2 Advantages of Single Rope Technique

1. SRT is often the quickest, most efficient way to ascend long distances
2. In large trees the access line can be left in place while working in the upper canopy leaving a relatively quick route to the climber if assistance should be needed.
3. The needed equipment is lighter and less cumbersome than other alternatives. This can be crucial when trees are located far from roads.
4. Ascenders are often the easiest and most effective way to climb large-diameter or multiple-stemmed trees, such as hardwoods and old growth conifers.
5. Hardwoods and conifers can be accessed without isolating a tie-in point around a single fork or branch, as required by Doubled Rope Technique (DRT).

5.4.3 Disadvantages of Single Rope Technique

1. The safety of the SRT system depends on the climber's evaluation of the supporting branch while the climber is still on the ground.
2. Installing the rope in the tree can be difficult and time consuming.
3. Suitable anchor points for the rope may be difficult to find in some trees.
4. Most SRT systems require a transition to descend. This can be time consuming when needing to ascend and descend multiple times to complete work.
5. A fall on a mechanical ascender can damage or sever the rope.

5.4.4 Procedures for Using Single Rope Technique

The safety of the climber depends heavily on the strength of the branch that the rope is placed over. The supporting branch must be strong enough to provide a good margin of safety while withstanding the forces placed on it during an ascent. The failure of this upper anchor point in SRT systems is extremely critical, even if backup branches will catch the rope, because the shock loading of a mechanical ascender can tear the sheath of the rope or sever the rope completely. For this same reason any slack in the SRT system should be regarded as extremely dangerous.

Friction knots can be used for SRT, but the most common tools for SRT are mechanical ascenders. A mechanical ascender is a device that is designed to allow you to ascend a vertically fixed rope. Mechanical ascenders may be either the handled or the cam-attachment type, depending on where the support sling is attached to the ascender. Handled ascenders may be right-handed or left-handed. Cam-attachment ascenders may be used in either hand (Figure 5d).

1. Assess the potential for using ascenders
 - A. Can the tree be climbed more safely and efficiently with other types of climbing equipment?
 - B. Are there suitable branches capable of supporting the climber's weight or tree crotches over which to anchor the rope? Downward-sloping limbs will generally prevent secure rope placement.
 - C. Can a smooth transition be made from the ascenders to the live crown of the tree? A fall at this point can put a severe strain on the rope from the ascender cam.
 - D. Are there dead branches or branch stobs that could cause injury?
2. Securing the ascender rope over a suitable live tree branch.
 - A. Throw or launch a small line over a strong branch in the tree using one of the techniques covered in Line Installation (Section 5.3: page 50).
 - B. A suitable live tree branch must be capable of supporting at least four times the climber's weight. This high strength requirement is necessary because tying the rope off at the base of the tree creates a 2:1 mechanical advantage on the branch that is compounded by the bouncing of the climber during ascent. Choosing a suitable branch comes with experience, anything smaller than 3 inches in diameter for a hardwood branch/crotch or 4 inches for a conifer branch should be studied carefully. Binoculars are a great tool for seeing distant branch placements.
 - C. The branch or crotch should be located within the live crown to facilitate a smooth transition into the live branches of the tree.



Figure 5d: Mechanical Ascenders

Parts of mechanical ascenders include:

Frame. The main component to which the other parts of the ascender are attached. The rope passes through the frame.

Handle. May either be an integral part of the frame or attached to the frame with rivets or bolts. Some handle-attachment ascenders may lack a true handle. Cam-attachment ascenders do not have a handle.

Nose. The part of the frame that forms the inside channel into which the cam pushes the rope.

Safety lever. Prevents full downward movement of the cam when in the locked position. This is designed to keep the ascender from coming off the rope accidentally.

Cam. The internal pivoting metal piece (often equipped with small teeth) that pinches the rope against the frame. The cam may be spring loaded or free running. A spring-loaded ascender generally provides a more secure attachment to the rope. Free-running ascenders may be more convenient in some applications.

Tie-in points. An integral part of the frame used to attach life support slings. Some ascenders also have an additional attachment point at the top used to advance the ascender as the rope is climbed.

Attachment. Ascenders are attached to the climber's harness using slings, webbing, or rope that meets or exceeds the 5,400-pound breaking strength requirement (described in Section 3.3 and 3.4). Rope slings should be constructed from static rope. Webbing slings should be sewn or tied into a loop to meet breaking-strength requirements. It is important to inspect slings often for signs of wear and abrasion.

D. Static rope is the best choice for mechanical ascenders because of its low stretch characteristics. This results in a smoother ascent with fewer bounces that stress the anchoring branch. Attach the climbing rope to the end of the small line and pull it over the live branch and back to the ground at the base of the tree.

E. Anchor one end of the rope to the base of the tree. When the SRT rope is anchored at the base of the tree the climber's weight on the upper branch is roughly doubled. This end can be tied off with a tensionless hitch or can be rigged using a lowering device such as a rescue-8 descender or rappel rack. Using a lowering device in the anchor setup takes a little extra time, but allows for a much quicker, safer, and smoother rescue, should one be needed (See Section 8.4: Rescue from SRT, page 80).

F. There are a few ways to rig a lowering device for SRT. If the climbing rope is three times the length of the ascent or longer, it can be rigged to a locked off lowering device such as a rescue-8 descender or rappel rack (Figure 5e). If the climbing rope is not long enough to do this then there are two other options. An extra rope can be joined to the climbing rope and then attached to the locked off lowering device just below the joining knot. If an extra rope is not available the two ends of the climbing rope can be joined to form a continuous loop. Attach the rope to a locked off lowering device just below the joining knot (Figure 5f). If the climber needs to be lowered while on any of these three SRT systems, the ground person can simply unlock the lowering device and lower the climber to the ground.

3. Constructing a mechanical ascending system

There are numerous methods for using mechanical ascenders. Many systems are described in rock climbing, caving, and rope rescue manuals and books. Whichever system is used, the climber should ensure that there is sufficient redundancy in the system to keep the climber safe if one ascender breaks or comes off the rope. Two of the ascenders should be secured to the rappel point of the climbing harness using slings or webbing. With any ascending system, proper sling length and proper setup are critical to efficient operation. It is important to note that both members of the climbing team understand the system being used in the event of a rescue.

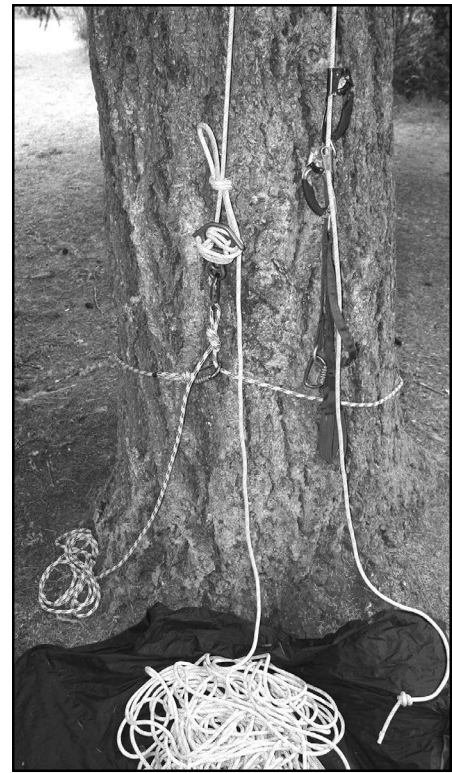


Figure 5e: Rescue-8 Descender with 3X rope

other options. An extra rope can be joined to the climbing rope and then attached to the locked off lowering device just

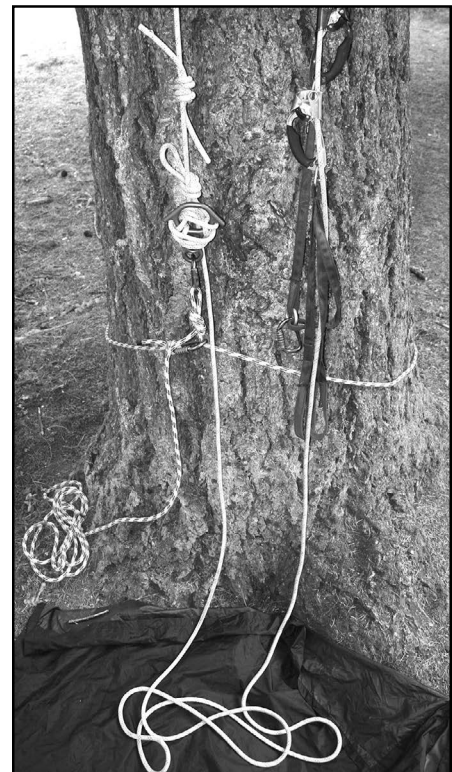


Figure 5f: Rescue-8 Descender using continuous loop

4. Setting up the system for ascent
 - A. Adjust the system so that it fits correctly, and ensure all components are in good working order.
 - B. Attach the foot loops to the climber's feet, the ascenders to the rope, and the safety slings to the harness, ensuring that everything is untangled and working properly.
5. Testing the mechanical ascender system and beginning the climb
 - A. To test the system before climbing, alternately weight each ascender to make sure that each one is gripping the rope. Test the tree crotch or branch anchoring your rope by pulling down hard with all your body weight.
 - B. Remove the slack from the rope by beginning to climb. The ground person should hold the rope taut from below initially. As the climber gains altitude (35 to 50 feet), the weight of the rope hanging below the climber is often enough to counteract the upward force of the ascender as it is moved up the rope. When beginning the ascent without a ground person, the lowest ascender can be opened with the climber's thumb while raising the ascender. Do not touch the safety lever!
 - C. Climb at a steady pace. If the climber cannot ascend 50 feet in 2 minutes, there's most likely an issue with the climbing system and its fit to the climber. Every SRT system must be fine-tuned and adjusted to the climber's body height and build.
 - D. Proper ascending technique requires little upper body strength; rather it relies on the strong leg muscles to ascend.
 - E. During the ascent, branches may be encountered that are difficult to pass. The climber can turn with their back to the limb and try to proceed up the rope or sometimes the rope can be pulled away from the branch with one hand while the other hand slides the ascender above the branch. A final option is to remove the upper ascender from the rope and position it above the branch. If one of the two life support ascenders is removed from the rope a temporary backup shall be installed until both ascenders are once again secured to the rope. This backup could be the climber's lanyard around a branch, an extra ascender (including a friction knot on a loop), or a knot tied below the ascenders and attached to the rappel point of the harness.
 - F. To transition to 3-point climbing in the live crown, pass a lanyard around the bole of the tree or suitable branch. With minimal slack in the system, place feet, hands, and lanyards on limbs as needed to maintain three points of contact while removing ascenders from the climbing rope.
 - G. Sometimes it may be necessary to descend while using mechanical ascenders. For short distances (less than a few feet), descent may be possible by alternately "thumbing" each cam and lowering one ascender and then the other. Do not touch the safety lever while "thumbing" the cam because it is quite easy to accidentally remove the ascender from the rope. Be careful to not snag the rope with the ascenders if descending using this method. It is easy to pull strands of a braided rope if descending using a toothed cam.
 - H. For longer descents (more than a few feet), it is better to change over from the ascent system to a rappel system. If possible, first pass a lanyard around the bole of the tree or suitable branch for additional support. One way to change over to descent is to attach a rappel device to the climbing rope below the ascenders and lock it off. The climber then slides the ascenders down until all their weight is on the locked-off rappel device. It may be necessary to remove an ascender from above the rappel device and place

it on the rope below the rappel device. Once the rappel device is fully weighted, the ascenders can be removed from the rope. The climber can then remove the lanyard, unlock the rappel device, and rappel. This change from ascent to rappel should be practiced a few feet off the ground until the climber can easily change back and forth while free hanging on the rope. Always be prepared to ascend while rappelling, and rappel while ascending with single rope technique.

5.4.5 Care of SRT Climbing Equipment

Ascenders should be kept clean and oiled as directed by the manufacturer. Dropping or mishandling ascenders may damage them. Before each use, inspect the slings attached to the ascenders for wear and abrasion and check for loose knots.

Ascenders may fail when misused. The most common types of failure are:

1. **Frame breakage.** The frame can crack under a painted surface without showing any sign of damage. As with other climbing equipment, it is important to know the ascender's complete history.
2. **Rope damage.** Damage can occur when the rope sheath is extremely worn or when stress on the ascender causes the cam's teeth to tear the rope sheath. Sheaths have been known to tear with as little as 800 pounds on the ascender and rope. Handled ascenders should never be used to support more than one person's weight
3. **Rope slipping out of ascenders.** When ascending, never touch the safety lever unless the ascender is being taken off the rope. Ascenders are designed to operate safely only on vertical ropes and only when moved in a direct line with the rope. Handled ascenders may slip off the rope when they are pulled away from the rope. This could happen when a rope is at an angle, such as when ascending between tree limbs.

5.5 Doubled Rope Technique (DRT)

This method of secured tree climbing employs a dynamic, or moving rope system. In a dynamic system, the climbing line used for ascent, working the tree, and descent is comprised of a long loop over a life supporting branch above the climber. This loop is adjusted by use of a friction hitch, and the size of the loop decreases as the climber moves up the tree and increases as the climber moves down. The ability to ascend and descend without changing from one system to another is the major advantage to DRT. Perhaps the greatest disadvantage of this technique is the various challenges the climber faces installing the climbing line from the ground. Generally, the tie-in point must be isolated within the loop formed by the climbing line. Extraneous limbs add friction to the system, rendering the ascent difficult or impossible, while requiring the climber to disconnect and reconnect to the climbing line numerous times while ascending.

Hip thrust is the most common method of ascending by DRT. The climber "walks" up the trunk by pulling in rope while thrusting the hips, and captures the gain made by advancing the friction hitch. The Blake's hitch is frequently employed in this application. The Blake's hitch may be tied in the traditional style (closed system), using the tail of the climbing line. However, many climbers prefer to use a short length of separate rope, known as a split tail (open system), for tying the friction hitch. The split tail allows the climber to move the tie-in point without having to retie the friction hitch and can be discarded and replaced without having to shorten the climbing line, by cutting off the worn end, as must be done with the traditional system. A modified hip thrust method of ascending may also be used. Climbers can footlock the tail of the climbing line below the friction hitch, capturing gain by advancing the hitch. A foot-mounted ascender can also be used in place of footlocking. These methods are significantly more effective than hip thrust alone when the climbing line hangs away from the trunk of the tree.

There are a number of improvements that may be applied to the basic DRT system. One of the most common is to incorporate a small pulley as a slack tender, simplifying advance of the friction hitch on ascents. Friction savers and cambium protectors can both reduce climbing effort and protect trees from damage resulting from dynamic rope friction. One popular variation of the split tail uses a short length of hitch cord with an eye on each end (eye & eye), a carabiner, and a slack-tending micro-pulley. The eyes may be tied with appropriate cinching knots or spliced to the cord manufacturer's specifications. A wide array of friction hitches, generally variations on the prusik hitch, have been developed for employing this system. They tend to be somewhat more difficult to fine tune for operation that is both secure and efficient, but offer the potential for high performance as well.

To descend, the climber grips the friction hitch with one hand and the running end of the climbing line below the hitch at about hip level with the other. By pulling down gently on the hitch while adding braking pressure, the climber attains a controlled rappel. To stop, the friction hitch is released. Care must be exercised to keep descent speed moderate, to avoid excessive heat and wear to the friction hitch. A double overhand stopper knot should be placed in the end of the climbing line to assure that the climber cannot rappel off the end of the climbing line.

There are several skills that must be developed to allow the climber to optimize the potential of DRT to most fully access all parts of the tree.

1. **Advancing the climbing line** from a preliminary tie-in point to a superior location for performing the job at hand is basic to attaining best work positions. Frequently, placement of the climbing line in the most preferred tie-in point for working the tree cannot be accomplished directly from the ground. Throw bags and line, throwing knots, or positioning with a pole saw provide methods for installing the climbing line in the tree initially, and it is these same methods that also allow the climber to advance the tie-in point to a more desirable location upon achieving a position in the tree. Of course, the climber must always be secured to the tree with a lanyard before advancing the climbing line, as this maneuver requires disconnecting and reconnecting to the DRT system.
2. **Re-directing the climbing line** can provide an improved work position relative to the task without having to re-deploy the climbing line. A re-direct can also significantly reduce the potential for an uncontrolled pendulum swing as the climber works farther away from the tie-in point. A webbing sling and carabiner, both of which must meet life support standards, can be used to create an artificial re-direct. Another method is to drop down through a suitable crotch, creating a natural re-direct.
3. **Double crotching** is a method of providing improved stability (Figure 5g). This can be particularly valuable when working the outermost portions of the crown of trees. In essence, double crotching entails the use of an additional tie-in point and DRT system to afford the climber a more balanced position. The second DRT system may be tied with the tail of the original system, or may employ a separate rope entirely.



Figure 5g: Double Crotching

5.6 Tree Steps

Tree steps are lightweight metal platforms that include a length of chain to attach them to the tree bole (Figure 5h). A lanyard must be used at all times when using tree steps for support.

5.6.1 Recommended Uses of Tree Steps

Tree steps serve to bridge gaps between live branches and provide access to the live crown. They also provide a temporary working platform for the climber.

5.6.2 Advantages of Tree Steps

1. Once installed, the live crown can be accessed repeatedly without climbing spurs or ladders.
2. Tree steps can be positioned below the 4-inch-bole diameter level in the live crown for free climbing in the tree.
3. Foot placement is more secure, compared to etrier or a piece of webbing.



Figure 5h: A Tree Step

5.6.3 Disadvantages of Tree Steps

1. Inefficient for long ascents.
2. Heavier than slings, etriers or webbing.

5.6.4 Procedures for Using Tree Steps

1. Determine the best position for the tree step, then pass the chain around the bole and pull it as tightly as possible. Be sure the chain is level and is not hung up on any obstructions on the back side of the tree.
2. Hold the tree step upside down. While pulling tightly on the chain, allow the open end of the right riser hook to pass through the tightest possible link of the chain.
3. Turn the tree step to a usable position. The two crossbars on the back of the riser will lock against the tree. When weight is put on the tree step, most of the stress is on these bars, which lock the step firmly against the tree.
4. Place the tree steps no more than 24 inches apart on the same side of the bole, or 12 inches from one step to the next when the steps are staggered on the bole. It is easier to place your feet when tree steps are staggered.
5. Use a safety harness and lanyard at all times when installing tree steps or when you are using them for support.

5.6.5 Care of Tree Steps

Tree steps require little care. Inspection for metal fatigue is the most critical maintenance requirement.

1. Inspect the metal platform, especially at all weld points or bends, such as at the riser hook and platform bend.
2. Inspect metal chain links individually for signs of metal fatigue or weld breakage.
3. Inspect the platform and the chain for signs of rust.

4. Store tree steps in a dry location.
5. Do not drop tree steps. Use a haul line when you need to transport tree steps to and from the live crown.
6. When signs of metal fatigue are evident on the platform portion of the tree steps, discard them immediately.
7. When the chain shows signs of metal fatigue, replace it with suitable 1/0 straight-link, welded coil chain.

Chapter 6 Working in the Tree

6.1 Three Point Climbing

The three-point climbing system incorporates the basic principles used at all times when tree climbing. The only exceptions to using the three-point system are when rappelling from a tree using an approved rappel system or when using an approved ascender system, including friction hitch climbing by DRT.

While climbing, each hand and foot is considered a potential point of contact (other parts of the body, such as a hooked knee or armpit, may be considered contact points if the point of contact is capable of supporting the full body weight). A lanyard around the tree bole or suitable branch that is secured to the safety harness or climbing belt on both ends counts as two points of contact.

While climbing, three points must be placed firmly in position on a secure surface before moving to another point. The secure surface may be sound, live tree limbs that can support your weight, rungs on a ladder, positions on a safety line or lanyard, climbing spurs, or pole steps.

All three points must be secure before you move. When you learn and apply this basic rule, it becomes a matter of habit to safely climb using the three-point system.

When climbing conifers, always place your hands and feet next to the bole on a sound limb. Never use a dead branch, branch stub, or unsound live branch for support. Never place both hands or both feet on a single sound live branch less than 3 inches in diameter.

6.2 Free Climbing

Free climbing, as used in tree climbing, refers to climbing without the added security of a safety line or lanyard. Free climbing may be done in the live crown of trees that have sound, live branches strong enough to support the climber's weight. Free climbing is limited to the area below the 4-inch-bole diameter level, where the density of branches is such that the installation of the lanyard poses a greater risk. Free climbing may also be used for ascending and descending a secured ladder. It should not be done in trees with steeply down sloping branches. When free climbing in the live crown you should do the following:

1. Use the three-point climbing system.
2. Place your feet and hands on branches as close to the bole as possible. When the limb diameter is less than 3 inches, wedge your foot into the bole at the base of the limb.
3. Never use a dead branch, branch stub, or unsound live branch for support. Remove unsafe branches, if possible, during the ascent to eliminate the possibility of using them.
4. Never place both hands or both feet on a single sound, live branch less than 3 inches in diameter.
5. Keep your body close to vertical and close to the bole.
6. When suitable branches are far apart in the live crown and it is difficult to maintain three points of contact, use a lanyard around the tree or suitable branch or place tree steps or etriers to aid in climbing.
7. When using etriers, attach them to the tree above a branch whorl with rope or webbing and attach the bottom of the etrier to the tree bole for secure placement. Always use a lanyard when using tree steps or etriers for support.
8. Whenever stopping to rest or perform any task, always secure yourself by placing a lanyard around the bole or a suitable branch.

6.3 Four Inch Tie-In System

A 4-inch tie-in is a self-belayed rope system required when climbing and working above the 4-inch bole diameter of a tree. It provides a secure anchor point and allows the climber to access the upper most canopy of a tree. The rope setup is the same as a long lanyard with a friction hitch adjuster, but used in a different way. The 4-inch tie-in can be time consuming to set up and take down and can hinder the climber's ability to descend quickly in an emergency.

The four inch tie-in system has these requirements:

1. The system shall be secured to the tree bole at or below the 4-inch bole diameter of the tree (Figure 6a).
2. Above the 4-inch bole diameter, protection (a rigging point) is installed at least every 3 feet along the bole to limit falls to no more than 6 feet.
3. The 4-inch tie-in system shall be constructed with dynamic rope. Static rope is not suitable because it will cause a high impact force on the anchor points and the climber in a fall.
4. The friction hitch or belay device shall be tested on the ground to ensure proper function.
5. Each part of the system shall be constructed of material that meets or exceeds the 5,400-pound breaking strength standard.

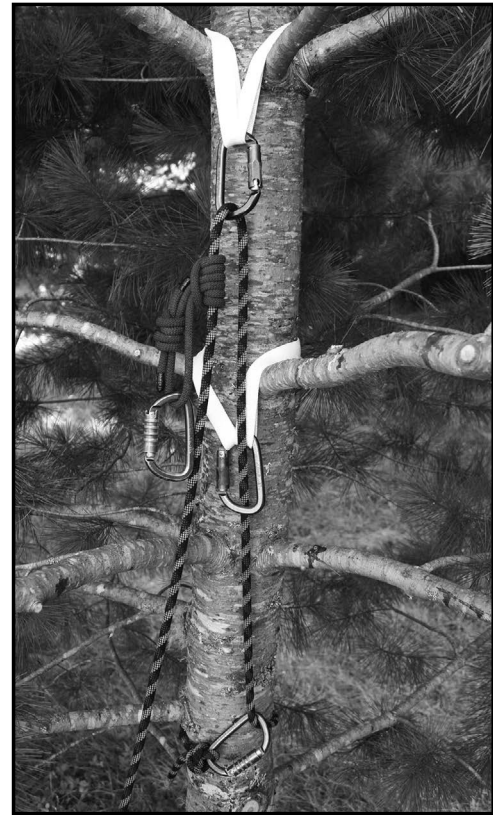


Figure 6a: 4-inch tie-in anchor

6.3.1 Constructing a Four Inch Tie-In System

See Figure 6b for construction details. The length of rope needed for the belay line depends on a number of factors such as species, age of the tree, growing conditions, and how far the climber has to go above the 4 inch diameter. The typical rope length for conifers is about 30 feet.

1. With one end of the belay rope, tie an end line attachment knot (e.g. Double Fisherman's Loop or Anchor Hitch) to a carabiner or snap hook.
2. Tie a secure stopper knot in the other end of the belay rope. (e.g. Double Overhand Knot)
3. Using a smaller diameter cord, tie a friction knot (e.g. Prusik) around the rope near the end with the carabiner or snap hook. Clip or girth hitch a carabiner or snap hook to the friction hitch. (If using a prusik, three wraps are preferred to the standard two wrap prusik, but this depends on the type of belay rope and prusik cord used and how they interact with one another).

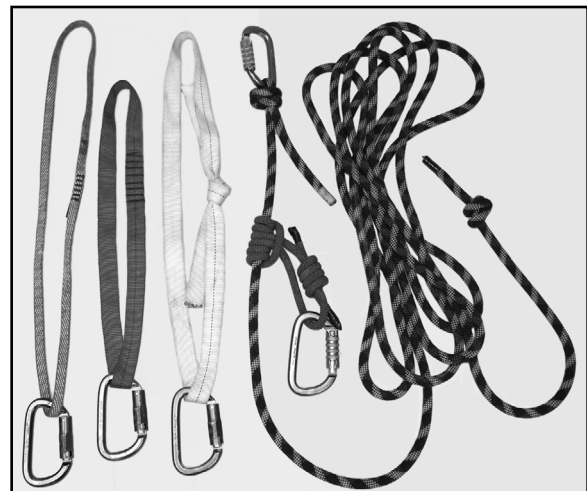


Figure 6b: Four Inch Tie-In System

4. To construct a prusik loop (Figure 6c) select an appropriate type of rope or cord that is a smaller diameter than the belay rope. Prusik cord is usually 7-9mm in diameter. Cut a 5 to 6 foot length of cord and tie the ends together with a grapevine (double fisherman's) knot (Section 4.5, page 40, figure 41). (Commercially sewn loops of cord or spliced eye to eye cords can also be used) Softer cord is preferred for the prusik loop to ensure a solid grab on the belay rope in the event of a fall.

5. Thoroughly test the friction hitch's grab on the belay rope before leaving the ground. If it is not holding firmly add a wrap to the friction hitch or try a different belay rope or friction hitch cord combination.



Figure 6c: Prusik Loop

6.3.2 Instructions for Using the 4-inch Tie-In

1. Climb the tree to the height at which the 4-inch tie-in will be anchored. This could be lower than 4 inches depending on tree structure, species, and climber's comfort level. It is common to anchor a 4-inch tie-in anywhere from 4 to 12 inch bole diameter.
2. Secure your lanyard around the tree and into both sides of the climbing harness.
3. Wrap the carabiner end of the belay rope around the bole of the tree and clip the carabiner back into the belay rope. Check the carabiner to ensure it has locked properly. This will secure the lower end of the belay rope to the tree (Figure 6a, page 61).
4. Clip the carabiner from the friction hitch to the center point attachment on the harness. Check the carabiner to ensure it has locked properly.
5. Remove lanyard from the tree and climb sliding the friction hitch up the belay rope with you.
6. Above the 4-inch diameter level, place protection around the bole of the tree every 3 feet. Remember to secure yourself with your lanyard each time you stop to set a protection point.
7. Protection is placed by:
 - A. Wrapping a sling in a basket hitch configuration (Figure 6d) around the bole and using a carabiner to attach it to the belay rope below the friction hitch. In most trees the basket hitch will have to be placed over a whorl of branches. Allow sufficient slack in the sling to prevent cross-loading the carabiner. The safety line should run through the carabiner, NOT between the tree and the sling.



Figure 6d: Basket Hitch and Girth Hitch

Note: This method exposes the climber and equipment to a fall resulting in lower force the higher the climber gets in the tree. (Fall factor less than 1)

Or by:

- B. Clipping a carabiner to the belay rope below the friction hitch, passing the carabiner and the attached portion of the belay rope around the bole of the tree, and clipping the carabiner back into the belay rope. Caution: This method will continuously expose the climber to a fall with a more abrupt stop. The force from this abrupt stop can cause injury. (Fall factor greater than 1)

Note: A girth hitch will reduce the strength of a sling. For climbing applications where a sling provides an artificial foot-hold, and for climbing line redirects where potential fall factors are low, the use of a girth hitch is acceptable. Use the basket hitch for life support anchors and protection points in climbing applications where the climber may be above the highest protection point.

6.3.3 Care and Cleaning of the 4-Inch Tie-In System

1. Inspect the rope for signs of wear or excessive pitch. If pitch cannot be removed, replace the rope. If the rope shows signs of excessive wear, replace it immediately.
2. Inspect slings (safety straps) for signs of wear. Replace them immediately if they show signs of excessive wear.
3. Inspect the friction hitch cordage for signs of wear or excessive pitch, especially at the friction side. If pitch cannot be removed or excessive wear is found, replace the friction hitch cordage.
4. Carabiners and snap hooks must be kept clean and pitch-free to allow proper auto-locking function.

6.4 Lanyard Use

6.4.1 Lanyard Throwing and Catching

Passing the lanyard around the tree must be done many times throughout a climbing assignment. It is not a difficult task on small-diameter trees where you can reach completely around the bole, but on larger trees, the end of the lanyard must be thrown around the bole and caught on the opposite side. This maneuver is sometimes complicated by tree limbs and the need to change points of contact. When throwing and catching a lanyard around the bole:

1. Establish a stable position with three points of contact (three-point climbing system).
2. Whenever possible, throw the lanyard with your dominant hand and catch it with your other hand. This may not always be possible, such as when limbing over during spur climbing. It is also advisable to throw the end that has the least amount of hardware or lanyard material (such as the end that does not contain the adjusting mechanism) to avoid snagging the lanyard on tree limbs.
3. Grasp the lanyard 1 to 1½ feet from the snap end. The farther the lanyard is held from the snap end, the less control you will have during the throwing maneuver.
4. Note the location of limbs around the tree bole and the area where the snap end will be thrown and caught.
5. With a slightly bent arm, throw the snap end around the tree with a sweeping, horizontal arm motion. As the snap end begins to pass around the tree, allow the lanyard to slip

through your throwing hand to add length to the lanyard being passed around the tree. Judgment and experience are needed to determine how much of the lanyard to let slip through your throwing hand.

6. Allow just enough of the lanyard to slip through your throwing hand so that the snap end will not hit you when it comes around the tree. It is safer to trap the snap end against the bole after it strikes the tree than to attempt to catch the thrown end directly.
7. Once you have captured the snap end, secure the snap to the safety harness. Check both ends of the lanyard to make sure they are securely fastened before putting your weight onto the lanyard.
8. When placing the lanyard during the climb for the first time, you may have to release one of your handholds to catch the end of the lanyard. You can maintain three points of contact by wrapping your throwing hand around the bole to support your upper body or by keeping your throwing arm over a live limb capable of supporting your weight. Remember, when you throw the first lanyard the first time you may reduce the number of points of contact, putting you temporarily in a potentially hazardous position. Hanging the snap end over a limb and reaching around is one way to maintain contact with the tree.

6.4.2 Limb-Over Technique

When climbing with spurs, or when ascending unsecured sectional ladders, you must often pass one or more live limbs while keeping a lanyard around the tree or suitable branch for support. To pass the limbs safely, you need to perform a limb-over maneuver:

1. The limb-over maneuver requires you to pass a second lanyard around the tree above the limb or limbs being passed. Fasten the second lanyard to your climbing belt or safety harness. Make sure the second lanyard is properly adjusted for length and properly fastened to your belt or harness before releasing the first (lower) lanyard.
2. Use two different types of lanyards or lanyards of different colors if you anticipate having to perform limb-overs. This ensures that you can tell them apart during the maneuver. Make sure the lanyards are long enough to allow ready adjustment during long limb-over reaches. Typically each lanyard is attached and adjusted on opposite sides of the climber's harness which helps isolate each during limb overs.
3. Transferring your weight to the upper lanyard makes it easier to release the lower lanyard.
4. The limb-over maneuver is also performed during a descent by reversing the procedure. The limb-over descent technique requires you to pass a second lanyard around the tree below the limb or limbs being passed. Again, make sure the second lanyard is properly fastened to your climbing belt or safety harness and adjusted before releasing the upper lanyard.

6.4.3 Lanyard Adjustment

Adjusting a lanyard that is supporting your weight can be awkward, depending on the type of lanyard.

1. Lanyards that adjust by means of doubling back on themselves can be awkward because the adjusting mechanism may be behind the tree. This should be planned for, and precautions should be taken to prevent this from being a problem.
2. A prusik lanyard can be easily adjusted at any time because the adjuster knot is always within reach.

- A. To shorten the lanyard, simply grasp the rope behind the prusik knot and rotate your hips, pulling the lanyard around the tree to the same side of the tree as the prusik knot. Then, while counter-rotating your hips, push the prusik knot along the lanyard rope toward the tree.
 - B. To lengthen the lanyard, simply pull the prusik knot and slide it along the lanyard rope toward you.
3. When a steel-core manila rope lanyard or a steel-core nylon rope lanyard is used with a Becket hitch, adjust the lanyard as follows:
- A. With both ends of the lanyard attached to a climbing belt or safety harness, rotate your hips and pull the lanyard around the tree bole toward the side containing the Becket hitch.
 - B. Reach across the front of your body from the side where the lanyard is snapped and grasp the lanyard near the tree bole between the bole and the D-ring where the Becket hitch is tied. Pull your body forward, rotating your hips back to their normal position to remove pressure from the Becket hitch.
 - C. With your free hand, adjust the Becket hitch to lengthen or shorten the standing part of the lanyard.
 - D. Check the Becket hitch. Make sure it is properly positioned with sufficient length tail and secured on the D-ring before placing your weight back on the lanyard.
4. When a mechanical adjuster is used, taking up or letting out slack is much easier.
- A. Rotate your hips slightly toward the side that the adjuster attaches to the D-ring of the climbing saddle, belt, or harness, and pull the lanyard through the adjuster. Make sure the spring-loaded cam retracts to “bite” the rope before placing your weight back on the lanyard.
 - B. To lengthen the lanyard, reach across the front of your body from the side where the lanyard is snapped and grasp the lanyard near the tree bole between the bole and the D-ring where the adjuster is attached. Pull your body forward, unweighting the adjuster. Gently depress the cam and either pull the lanyard through the adjuster away from your body or rotate your hips away from the adjuster.
5. A lanyard that adjusts by means of a friction hitch assisted with a slack-tending micro pulley is perhaps the easiest of all lanyards to lengthen or shorten. These work very much like a mechanical adjuster to shorten. While most other lanyard adjusters require some degree of unloading of the lanyard to lengthen, this style can be adjusted while loaded by simply grasping the friction hitch and pulling it towards your hip.

6.5 Handling Materials in Trees

6.5.1 Pulley Haul System

Pulleys, when combined with a haul line, can be used to raise and lower tools, tree climbing ladders, equipment, tree cones, and similar materials. Lightweight pulleys (commonly called “micro pulleys”) are usually suitable, though with heavier loads, a larger diameter sheave may prove useful. The pulley haul system allows the ground person to raise gear to a climber, as well as to control the gear’s descent. It is easier to haul the materials from the ground than from the tree, and the ground person can be hauling materials while the tree climber is busy with other tasks.

To use a pulley haul system:

1. Use a haul line that is longer than twice the maximum climbing height (required for a doubled haul line). Static kernmantle utility line is recommended because of its handling characteristics.
2. Form loops at each end of the haul line by tying bowlines or figure eights.
3. Pass the haul line through the pulley and attach it and the pulley to the climber's harness during the ascent.
4. The climber ascends the tree. If possible avoid weaving through the branches while climbing. The straighter the haul line's path, the easier it will be to raise and lower materials. The climber can always reroute the haul line by pulling it up and lowering it in a straight path or climb with the haul line bagged and lower it to the ground from the work position.
5. The climber removes the pulley from the harness and secures it with a sling to the bole, sturdy branch, or climbing ladder. The climber must be careful not to drop the haul line. The pulley system may be left attached to the climbing harness when raising or lowering lightweight materials, but should be attached to the tree or the ladder rung for heavier equipment.
6. For raising materials or equipment to the climber, the ground person attaches the load to the knot at the end of the haul line and pulls on the other end of the haul line, raising the material or equipment for the climber.
7. For lowering materials or equipment, the climber attaches the load to the knot at the end of the haul line and signals to the ground person. The ground person takes control of the haul line and lowers the material safely to the ground. Use a Münter hitch or belay plate to lower heavy objects in a controlled manner.
8. The climber and the ground person will need to work together (moving the haul line up, down, or sideways) to prevent materials from hanging up on limbs during long hauls.

Note: A carabiner may be used in place of the pulley. The additional friction may help when lowering materials, but makes raising them more difficult. The pulley increases the safety and efficiency of the haul system and is preferred.

6.5.2 Cone Hook

Frequently climbers engaged in collecting cones, scion, or other vegetative material in trees find that accessing outer branch ends or the very uppermost portions of the crown is greatly assisted by use of a cone hook. The cone hook can take many forms, but can generally be described as a 5 to 6 foot wooden or PVC pipe handle with a metal hook affixed to the end. A tether of some type is attached to the other end of the handle, and clipped to the climber's harness to prevent dropping the tool.

6.5.3 Tool Pouch

Many varieties of harness-mounted tool pouches are available. They range from commercial models designed for the task, featuring elastic or drawstring closures, to re-purposed stuff sacks and ditty bags. Mesh bags can be particularly useful, allowing the climber to more easily find small items within; however they may be more easily torn than one made of more sturdy materials.

6.5.4 Daisy Chain

This webbing product, which can be found in both life support strength ratings, as well as for material handling purposes only, offers a series of sewn or woven loops. When multiple items need to be available for use in working aloft, the daisy chain may be worn or attached to the tree, giving the climber many options for attachment of tools or materials in a readily accessible manner.

Chapter 7 Rappel Systems

Rappel systems make climbing and working in trees easier and safer. The systems recommended in this guide should only be used below the 4-inch-bole-diameter level in conifers, or a tie in point capable of providing life support in hardwoods.

7.1 Mechanical Rappel Devices

Many different rappel devices are on the market, but not all are suitable for tree climbing applications. Some common devices are the Rescue 8, Q-8, and Rappel Rack (Figure 7a and b).

1. Required characteristics of acceptable descending devices.
 - A. Minimum breaking strength of 5,000 pounds or 22kN.
 - B. Adjustable friction control for different situations.
 - C. Tie-off capability in work or rescue situations.
 - D. Commercially designed and manufactured for intended use.
2. Desired characteristics of acceptable descending devices.
 - A. Suitable as the primary device in both work and rescue situations.
 - B. Capability to accommodate many types of ropes.
 - C. Adjustable friction control while under a load.
 - D. Easy to rig and use correctly.
 - E. Device remains attached to the climber during rigging.

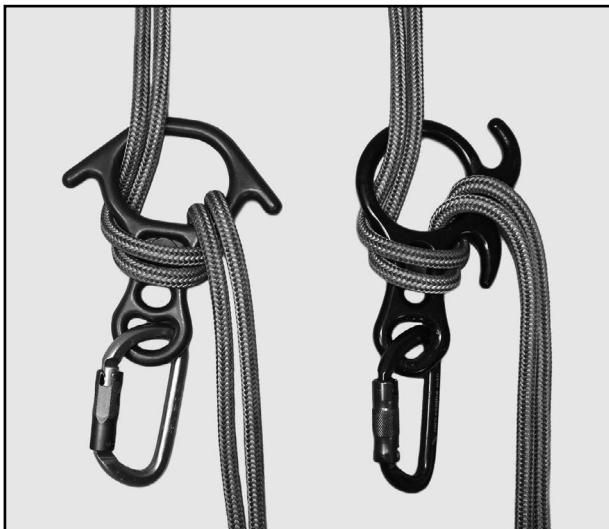


Figure 7a: Rescue 8 and Q-8

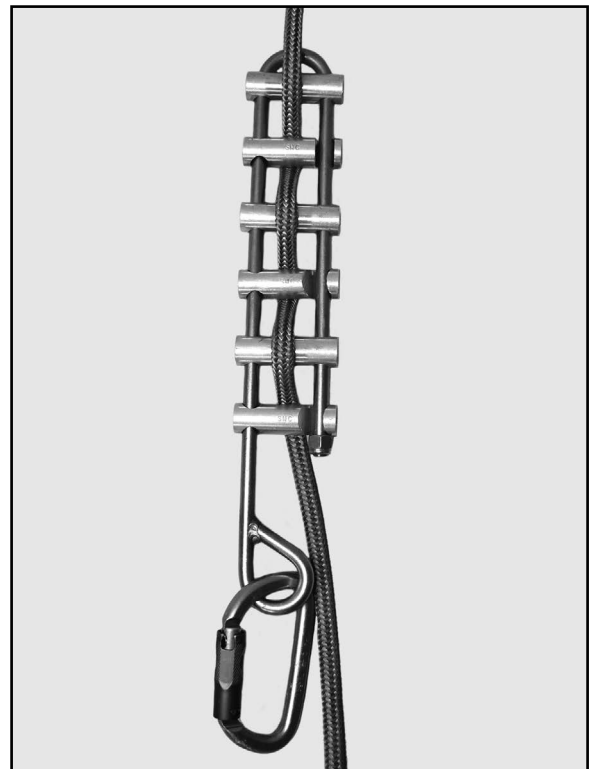


Figure 7b: Rappel Rack

7.2 Friction Knots

There are many friction knot systems that are used in climbing and rappelling. Two of the most common are the Prusik Rappel and Blake's Hitch (Figure 7c and 7d).

1. Required characteristics of acceptable friction knot systems:
 - A. Meets ANSI breaking strength standard of 5400 lbs. as constructed.
 - B. Is constructed of rope suitable for this use and fit for the purpose.
2. Desired characteristics of acceptable friction knot systems:
 - A. Easy to tie.
 - B. Does not bind yet grabs firmly.
 - C. Adjustable friction control (e.g. ability to add wraps to accommodate greater weight.)
 - D. Releases easily.
 - E. Can be used with a variety of ropes.

For more in-depth information on Doubled Rope Technique and friction knot systems see Section 5.5. page 56.

7.3 Rigging

Most of the recommended rappel devices may be rigged for either a single or doubled rope, or DRT rappel. The climber has these options:

1. Looping the rope around the bole or through a cambium or friction saver (tree-crotch lanyard) below the 4-inch-bole diameter level (both ends of the rope must reach the ground) and rappelling on both lengths of rope simultaneously
OR
2. Attaching one end of the rope to a suitable anchor point on the ground or to a point in the tree below the 4-inch-bole-diameter level and rappelling on a single length of rope.
OR
3. Passing the rope around the bole above a whorl of branches or over a suitable anchor point (or using a friction saver), attaching this working end to the climber's suspension ring, and then attaching an appropriate mechanical device or friction knot to the standing part of the rope running to the ground, and rappelling down in similar fashion to descending with a DRT system (Section 5.5, page 56).



Figure 7c: Prusik Rappel



Figure 7d: Blake Hitch Rappel

7.3.1 Deploying the Rappel Rope

When ascending a tree to rig a rappel system, three methods for installing the rappel rope are:

1. Ascend the tree in as straight a line as possible with the rappel rope attached to the safety harness. The rope is pulled from the storage bag on the ground as you ascend. With this method the ascent route will also be the descent route.
2. Ascend the tree without regard to the route with a haul line in a storage bag attached to the safety harness. At the desired rigging point, lower the end of the haul line through the tree branches along the intended descent route. The ground person attaches the rappel rope to the end of the haul line, and you pull up the rappel rope with the haul line.
3. Ascend the tree carrying the entire rappel rope in its storage bag. At the desired rigging point, secure the end of the rappel rope to the tree and drop the rope bag along the intended descent route. Occasionally, the rope and bag can get tangled or deflected by branches. 100' of rope weighs about 8 pounds, so this means greater effort is needed to ascend and therefore this is the least desirable approach.

7.3.2 Rigging for a Doubled Rope Rappel

The doubled rope rappel is the most common means of rigging a rope for a rappel. This type of rigging allows the climber full control of the rope independent of a ground person. Doubled rope rappel allows for easy retrieval of the rope and any type of cambium saver deployed within the tree. Two methods of rigging for a doubled rope rappel are:

7.3.2.1 Standard Method

1. Pass the running end of the rope around the tree bole and over one or two branches of a whorl at a secure point below the 4-inch-bole-diameter level. You only need to pass the rope over one or two branches on the back side of the tree to avoid excess friction, which will make it more difficult to retrieve the rope from the ground.
2. Tie a loop (a figure eight on a bight, or equivalent) on the running end of the rope.
3. Attach a carabiner to the loop, and clip the carabiner onto the standing part of the rope.
4. Feed the loop and carabiner end down toward the ground. The carabiner will follow the line already in place through the branches to the ground. The two lengths of rope will be used together during the rappel.
5. Feed the end of the rope to the ground. Provide a few extra feet of slack for attaching the rappel device when the carabiner touches the ground. Have the ground person verify that both ends of the rope reach the ground.
6. Attach the rappel device to both lengths of the rope as if they were one.
7. Follow the directions for attaching the rappel device to the safety harness and for proper use of the rappel device.

To retrieve the rappel rope from the ground:

1. Remove the rappel device, untie any knots in the system, and remove the carabiner from the main line.

2. Pull on the longer of the two lengths of rope to retrieve the rappel rope from around the anchor point in the tree.
3. Before the end of the rope reaches the anchor point in the tree, make sure the area around the tree is clear. Pull the rope from the tree, taking care to avoid being hit by the falling rope. Alert people by shouting “ROPE” before pulling rope free.

7.3.2.2 Friction Saver Method

You may use a manufactured friction saver or cambium saver device or one that is properly constructed from a piece of webbing or rope that meets the 5,400-pound breaking strength requirement and terminal hardware that meets the 5,000-pound or 22kN breaking strength requirement.

1. When installing a friction saver, make sure that the length will easily reach around the tree at the attachment point.
2. The friction saver shall be installed around the tree bole at a secure point. It is best to install the friction saver at an angle over only one or two branches on the back side, otherwise it will be difficult to remove the lanyard plus a longer lanyard will be needed.
3. The friction saver must have rings or carabiners on each end. One end must be of a smaller diameter that will stop a small knot on the rappel rope from passing through. The other end should be large enough for the knot to pass freely to remove the system.
4. It is important to pay attention to the direction in which the system is set up, in order to successfully remove the system after use by pulling on the correct end of the rope. (See #8, below).
5. After passing through both ends of the friction saver the rope is then fed down to the ground, assuring that it follows the same path as the line already in place. The two lengths of rope will be used together during a doubled rope rappel. In a friction hitch rappel, the working end of the rope will be attached directly to the climber’s harness and the climber will follow the path of the rope down to the ground. In this case it is expeditious to thread the rope through the small ring first then through the large ring, allowing retrieval by pulling the shorter end of the climbing line.
6. Follow directions for rappel as described elsewhere in this chapter.
7. To retrieve the friction saver from the ground:
 - A. Tie a small knot such as a figure-8 or overhand knot in the end of the rappel rope. This knot must be tied on the side of the larger diameter opening in the tree-crotch lanyard so that it will pass completely through this end yet catch on the small diameter end.
 - B. Pull on the rope so that the knot is pulled up to the friction saver and completely through the larger diameter ring or carabiner.
 - C. Once the knot stops at the small diameter end of the friction saver, clear the area around the tree and pull hard on the rope so that the friction saver is freed from its rigging point.
 - D. Take care to avoid being struck by the falling rope and friction saver. Shout “ROPE” to alert people in the area.
 - E. Occasionally, the friction saver will remain stuck at its rigging point. If this happens, the tree must be climbed to retrieve the rope and lanyard.

- F. A throw line attached to the knotted end of the climbing line before retrieval allows for a controlled descent of the friction saver and can help free a stuck friction saver without reascending the tree.

7.3.3 Rigging for a Single-Rope Rappel

1. This method is NOT commonly used in tree climbing because it requires reascending the tree to retrieve the rope. It would be used primarily in a rescue when there is a long, clear bole, or when no suitable branch or crotch is available for an anchor point.
2. To set up for this type of rappel, secure the upper end of the rope around the bole of the tree using one of several possible methods. The tensionless hitch (Section 4.4: Specialty Knots, page 35) is commonly recommended for this purpose. In a rescue situation installation can be accomplished quickly using two or even one wrap on the bole. A half hitch or marl can be added below the single wrap to provide additional grip on the bole of the tree. Using only one wrap does place additional loads on the rope and carabiner.
3. An adjustable friction saver can also be used to anchor the single rope rappel. (Section 7.3.2.2: Friction Saver Method, page 71).

7.4 Rappelling

Rappelling is the act of sliding down a rope in a controlled manner. Climbers rappel using either the Single Rope Technique (Section 5.4: Single Rope Technique, page 52) or the Doubled Rope Technique (Section 5.5: Doubled Rope Technique, page 56). Proper technique and attention to basic safety procedures are necessary.

1. Basic safety procedures for rappelling
 - A. Tie a figure-8 or other suitable stopper knot at the end(s) of the rappel rope to stop the climber from rappelling off the end of the rope.
 - B. If rappelling using a doubled rope, make sure both lengths of rope weave through the branches together to avoid hang-ups.
 - C. Be sure that there is enough rope for the climber to either reach the ground or another suitable anchor point for re-rigging.
 - D. Ensure that the rappel device is properly rigged, attached to the harness, and tested with the climber's weight BEFORE using for life support.
 - E. Ensure that the rappel system is attached properly to the harness. Always attach the rappel system to the harness at the central tie-in point. If the harness only has tie-in points mounted at the hips, the system must be attached to both points with auto-locking carabiners.
 - F. A belay is recommended when rappelling. This can be done by a person attending a ground belay system, or by self-belay. The ground person provides the ground belay by holding the single or doubled rope throughout the rappel. A fall can be arrested by applying downward pressure on the rappel rope. In the absence of a ground belay, the rappeller may provide self-belay by use of a friction hitch mounted below the rappel device and secured to the lower leg strap of the seat harness. The rappeller brakes with one hand on the friction hitch. If control of the rappel is lost, the resulting fall is arrested automatically by the friction hitch. Care must be taken to use a friction hitch that is of a length such that the hitch cannot come in contact with the bottom of the rappel device at any time, or the self-belay function could be rendered ineffective.

- G. Never allow the rappel rope to rub against the safety harness webbing. Such rubbing can quickly damage synthetic webbing.
 - H. Keep beards, long hair, and loose clothing secured and away from the rappel device. Unsecured material can jam in the device, halting descent and causing painful injury, or accidents. If clothing or hair becomes lodged in the rappel device, an ascender, prusik knot, or footlock may be used to allow the climber to take pressure off the rappel device while dislodging the material. Use EXTREME caution if cutting clothing or hair free from a jammed descent device is unavoidable. A rope under tension cuts very easily.
 - I. Before beginning to rappel, recheck all the rigging. Make sure that:
 - The rope is rigged properly.
 - The rope is threaded correctly on the rappel device.
 - The rappel device is attached correctly to the harness.
 - The system is tested with the climber's weight.
 - The carabiner gates are locked.
 - J. Wear appropriate gloves
2. Proper rappelling techniques
- A. Rappel at a moderately slow speed. Heat is generated by the friction of the rope against the rappel device or friction knot. Excessive heat can damage the rope or burn exposed skin.
 - B. Rappel smoothly. Bouncing or a fast rappel with a sudden stop causes shock loadings that shorten rope life. Shock loads may cause an unrecognized weak anchor to fail or may lead to failure of other critical system components.
 - C. Assume a sitting position in the seat harness. Keep your legs nearly horizontal with your knees slightly bent. Keep your feet comfortably spread, if practical, to help prevent pivoting around the tree.
 - D. If rappelling close to the bole, always walk down the tree while rappelling remaining in contact with the bole. This reduces loads and possible shocks on the entire rappel system.
 - E. If rappelling with a mechanical rappel device, maintain the brake hand near your hip. Always keep the brake hand away from the rappel device except to lock off.
 - F. If rappelling with a mechanical rappel device, the rappeller can create additional friction by wrapping the rappel rope under the buttocks or leg and braking with the opposite hand. Take care not to run the rappel rope across the harness webbing.

Chapter 8 Rescue

The basic tree climbing team is composed of two persons, so both team members must be certified climbers qualified to perform the climbing assignment. All certified climbers should be equipped and trained to render emergency care if a climber becomes incapacitated while in a tree. Training includes first aid and techniques to secure an injured climber in a comfortable position in the tree and to remove a climber from the tree.

Climbing teams should be prepared for potential problems on any assignment. They should sign out with the local unit and carry portable radios or cell phones. Climbers should also be aware of other climbing teams in the area and their general location.

When climbers reach their climbing area, they should establish contact with their local unit or dispatch office. Climbers should note the legal description of their work area, as well as detailed access information, so they can provide accurate directions in an emergency. If immediate contact with the local unit or dispatch office cannot be established from the job site, a contingency plan should be developed to summon emergency help, or the climb at that job site shall be abandoned.

During a rescue, the potential for suspension trauma should be considered. Suspension trauma can occur when a person is suspended vertically, such as from the chest or back D-ring attachment point of a fall protection harness. Blood begins to pool in the legs and the heart must work harder to pump blood to the brain. If the heart cannot keep up, it will slow down, leading to a loss of consciousness. Death can occur in as little as five minutes. If an incapacitated climber is suspended vertically and unable to correct the situation, the assisting climber needs to reach the incapacitated climber and correct their position as quickly as practical. Simply bending the legs at the knees to form a sitting position will solve the problem. If the incapacitated climber is unconscious, do not immediately move the incapacitated climber to a horizontal position. If suspension trauma is occurring, the sudden flow of blood to the brain can be fatal. Keep the incapacitated climber in a seated or reclining position for a period of time before repositioning to a prone position.

The main thing in choosing a method for rescue is to settle on a few basic methods that require the least amount of gear, and practice them until everyone on the climbing crew can do the rescues quickly and safely. For the minimalist, it should be possible to do any rescues with no special gear except for a few carabiners and some scraps of rope or webbing. The time to develop these skills is before something bad happens, not after!

8.1 Rescue Equipment

Equipment to aid an incapacitated climber in a tree consists of the basic equipment described in Chapter 3: Equipment on page 17, plus additional rescue and first-aid items.

Place rescue equipment in a pack reserved for rescue purposes only. Plainly mark the pack for this use. List the pack's contents on a tag or include a contents list inside the pack. Before each assignment, make sure all the items are in the pack and that they are in good condition.

8.1.1 Recommended Items for the Rescue Pack

1. One 10-unit (minimum) first-aid kit that includes a body-fluid barrier kit
2. Flashlight and extra batteries
3. Roll of brightly colored flagging
4. Waterproof matches

5. Two blankets sealed in plastic. These can be used for treating shock or for splinting
6. Long and short splints (in addition to those that may be in the first-aid kit)
7. Eye wash or a bottle of sterile water to wash out the eyes (in addition to materials that may be in the first-aid kit)
8. Two pulleys (minimum)
9. Four approved carabiners (minimum)
10. Several 10- to 12-foot lengths of webbing or rope, plus 50 feet of 1-inch tubular webbing or rope
11. Heavy-duty metal shears, bolt cutters, or a small hacksaw for cutting jammed carabiners or steel-core lanyards
12. A rope suitable for rescue, if such a rope is not included with basic climbing equipment (see Section 3.3: Ropes, page 18)

8.1.2 Constructing a Body Harness

Climbers shall wear a climbing harness designed to provide life support on all climbing assignments. If this harness is damaged in a fall, a rescue harness will need to be constructed and fitted to the incapacitated climber.

A chest harness may be constructed as shown in figure 8a, or the assisting climber's lanyard can be placed diagonally over the shoulder and chest of the incapacitated climber. The diaper sling can be constructed from about 12 feet of nylon webbing or nylon rope as shown in figure 8b. Use a water knot to secure webbing and the grapevine knot or figure 8 bend to secure a rope.

The rescue harness has two parts:

1. Upper body supporting device (using a chest harness or lanyards).
2. Diaper sling.

8.1.3 Rescue Procedures

The ground person must follow this sequence of actions (in order) when aiding a climber incapacitated in a tree.

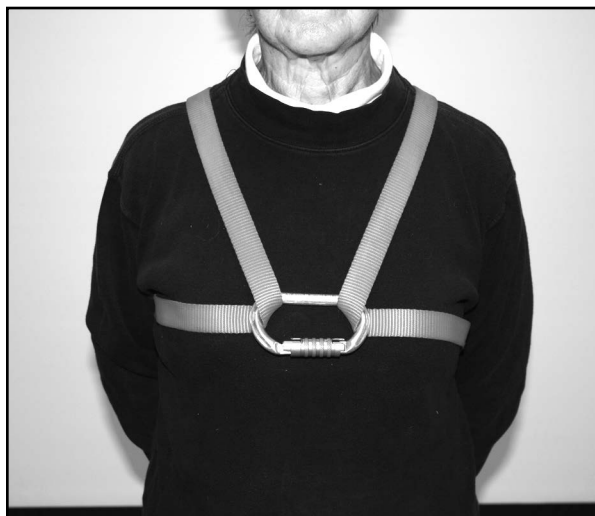


Figure 8a Upper body supporting device



Figure 8b Diaper sling

8.1.3.1 Assessing the Incident

1. Attempt to assess the incapacitated climber's situation from the ground.
 - A. Is the incapacitated climber breathing?
 - B. Is the incapacitated climber bleeding profusely?
 - C. Is the incapacitated climber conscious and responsive?
 - D. Is the incapacitated climber secured (by a lanyard or safety line)?
 - E. What is the incapacitated climber's apparent emotional stability?
2. Assess your ability to make an immediate rescue.
 - A. Evaluate scene safety
 - B. Who is available to help?
 - C. What equipment is on hand?
 - D. What is the rescue proficiency of the available personnel?
3. Assess your needs for assistance.
 - A. What resources are on call (such as emergency medical technicians, fire departments, ambulances, and search and rescue organizations)? What is the anticipated response time?
 - B. What is the potential for the situation to deteriorate while you are waiting for assistance?

8.1.3.2 Requesting Assistance

Call or send for assistance. A radio chest harness worn over the safety harness allows the ground person to be in constant contact with support personnel while continuing to help the injured climber.

1. Do not leave an incapacitated climber alone, if possible. If you must leave, make sure the climber understands why you are leaving and when you will return. Make sure your absence is as short as possible. If your only option is to leave your team member unattended, you were not adequately prepared.
2. While assessing the incident, consider requesting that support personnel and resources be activated to standby status.
3. Before seeking help, think over the whole situation and take time to assess all the facts. If possible, write down some information before making the call, including:
 - A. Extent of injuries.
 - B. Exact location.
 - C. Personnel and equipment on the scene.
 - D. Probable time to reach the scene by ground.
 - E. Type of terrain.
 - a. Is a helispot nearby? If so, what is its exact location?
 - b. Is the terrain favorable for smokejumpers? If the location is remote, seriously consider using smokejumpers because of their skill and training in this type of rescue.
 - F. Special markings (such as flagging) or landmarks from the road or trail to the scene of the incident.
 - G. When, where, and how support personnel will contact the assisting climber.

The ground person may need to begin rescue before help arrives if the incapacitated climber is not or cannot be secured in the tree or requires treatment that cannot be provided in the tree.

8.1.3.3 Grounding All Climbers In the Area

When notified of an accident in the area, all climbers should return to the ground and proceed to the scene to lend their assistance. Once enroute, climbers should radio dispatch to report their estimated time of arrival at the accident site, if possible.

8.1.3.4 Developing a Plan of Action

Before attempting a rescue, take a minute to develop a plan of action for the incident. Unforeseen problems or changes in the incapacitated climber's condition or the environment may require you to modify your plan. Do not unnecessarily jeopardize your safety to save someone if more qualified help is available in an acceptable amount of time.

8.1.3.5 Climb to the incapacitated climber's location

Use the most efficient ascending method available to reach the incapacitated climber. This could include: climbing sectional ladders that are already in place, using climbing spurs, climbing a fixed rope with ascenders (SRT), or doubled rope technique (DRT). Do not ascend the tree directly below the incapacitated climber if there is any doubt about how well the incapacitated climber is secured to the tree. The assisting climber's first responsibility is personal safety.

8.1.3.6 Providing Immediate First Aid

Assess the ABCs (airway, breathing, circulation) and secure the incapacitated climber's airway, if necessary. Mouth-to-mouth resuscitation and CPR cannot be performed in the tree; if necessary, get the incapacitated climber to the ground as fast as possible regardless of the extent of injuries.

8.1.3.7 Extricating the Incapacitated Climber

Decide whether or not to extricate the incapacitated climber without additional assistance.

1. It is almost always best to obtain assistance before moving an incapacitated climber unless one or more of the following is true:
 - A. The incapacitated climber's position in the tree is precarious.
 - B. The incapacitated climber's medical condition requires immediate care that can only be provided on the ground.
 - C. The incapacitated climber is physically and mentally able to assist the assisting climber.
 - D. The assisting climber's level of rescue preparation makes the current situation straightforward and low risk.
2. Protect the incapacitated climber from further injury before performing the rescue.
 - A. Provide emotional support to the injured, anxious incapacitated climber.
 - B. Continue checking the ABCs (airway, breathing, circulation).
 - C. Clear a path for lowering the incapacitated climber.
3. If the injury is not life threatening and the incapacitated climber can be secured safely in the tree, wait for help to bring the incapacitated climber down.

4. If the injury is life threatening, perform the rescue immediately.
5. Secure the injured climber in a comfortable upright position. An additional safety line or lanyard may be needed for the injured climber if the original support system was damaged by the accident.
 - A. A pulley system may be needed to raise the incapacitated climber to a position where they can be lowered. The Z-rig pulley system can be used to lift and lower the climber (Figure 8c). It consists of two pulleys, secured above the incapacitated climber, and a pulley on his harness. The working end of the rope is secured to the incapacitated climber's harness. Carabiners can be substituted for the pulleys, but will add friction to the system.
 - B. No person should be left hanging in their harness for an extended period of time. Care must always be taken to keep the incapacitated climber in a seated position with the legs bent to avoid suspension trauma.



Figure 8c: Z-rig pulley system

8.2 Rescue from Sectional Ladders

After assessing the situation and confirming that you feel confident with the rescue, check to see that you have the minimum equipment: rappel system, four locking carabiners, gloves, rescue rope with a Figure Eight on a Bight, two lanyards, and a pair of bolt cutters.

Determine best method of ascent to a point above the incapacitated climber. A separate set of ladders may be necessary if the incapacitated climber is immobilized directly over the ladder.

Two lanyards will be necessary to perform a limb-over around the incapacitated climber. Take care when swinging second lanyard around the tree bole not to strike incapacitated climber with lanyard.

Secure the tensionless hitch, friction saver/crotch lanyard, or anchor point high enough above the incapacitated climber to create enough space to rig the rappel system. (Figure 4e, Section 4.4: Specialty Knots, page 35). Position rope to ensure the incapacitated climber is lowered far enough away from the ladders not to become entangled during descent, but close enough for you to work with the incapacitated climber during the descent.

Position yourself next to the incapacitated climber. Rig the rappel system (two wraps for added friction if using rescue-8) and then secure it to the incapacitated climber with a locking carabiner. Take any slack out of the rope before locking off the rappel device. Once completely locked off, slowly let slack out of the incapacitated climber's lanyard(s) to transition weight from the lanyard to the rappel system.

Utilize a ground belay or friction hitch backup if available during the rescue (Section 7.4: Rappelling, page 72).

Once the incapacitated climber's weight is on the rappel system, disconnect or cut the lanyard and/or carabiner from the incapacitated climber. The incapacitated climber will now be solely supported by the rappel system with the assisting climber controlling the descent. Slowly lower the incapacitated climber to the ground maintaining control of the rope at all times. Move down the ladder with the incapacitated climber to be able to administer first aid and/or clear the descent route.

8.3 Rescue From Spurs

After assessing the situation and confirming that you feel confident with the rescue, check to see that you have the minimum equipment: a set of climbing spurs, rappel device, a minimum of four locking carabiners, one or two rescue ropes and two lanyards. A pair of bolt cutters or hacksaw may facilitate releasing a loaded cut-resistant lanyard.

Determine best method of ascent to a point above the incapacitated climber. If spur climbing, two lanyards will be necessary to perform a limb-over around the incapacitated climber. Take care when swinging the lanyards around the tree bole not to strike incapacitated climber with the lanyard. Take care not to spur the incapacitated climber while climbing to a position above the incapacitated climber.

Secure a tensionless hitch, friction saver/crotch lanyard, or anchor point high enough above the incapacitated climber to allow the assisting climber ample room to maneuver. Rig one or two ropes (depending on chosen method of rescue) for a single or doubled rope rappel. Any of the approved rappel systems may be used to lower an incapacitated climber.

Rappel to the incapacitated climber. Secure incapacitated climber to your chosen rappel device. Once the incapacitated climber is secured, slowly let slack out of the incapacitated climber's lanyard(s) to transition the incapacitated climber's weight from the lanyard to the rappel device. The assisting climber may need to secure themselves to the incapacitated climber to lift the incapacitated climber's weight off of their lanyard. Never attach the disabled climber directly to the assisting climber's harness for rappelling.

Utilize a ground belay if available during the rescue. If not, employ a self-belaying friction hitch below the rappel device.

Once the incapacitated climber's weight is on the rappel device, disconnect or cut the incapacitated climber's lanyard. The incapacitated climber will now be solely supported by the rappel device with the assisting climber controlling the descent. The assisting climber releases their own lanyard or rappel device, then slowly lowers himself and the incapacitated climber to the ground maintaining control of the rope at all times. The assisting climber rappels with the incapacitated climber to be able to administer first aid and/or clear the descent route. Great care must be exercised to avoid inadvertently spurring the incapacitated climber on the way down. Both the assisting climber's and incapacitated climber's spurs must be controlled as the two reach the ground. The assisting climber may remove their spurs and the incapacitated climber's spurs before the descent if practical.

8.4 Rescue from SRT

8.4.1 Pre-set Belay Rescue

The simplest way to rescue a climber on a single rope is to preset the rescue so that the climber can be lowered to the ground in the event of an emergency. This can be done in at least three ways. If the climbing rope is much longer than is needed for the climb, it can be rigged to a locked off belay point with a Rappel Rack or Figure 8 (Figure 8d). If the climbing rope is not long enough to do this then there are two other options. You can join an extra rope to the climbing rope and rig the extra rope to a locked off belay point just below the joining knot. If you do not have an extra rope you can join the two ends of the climbing rope to form a continuous loop and fix the rope to a locked off belay point just below the joining knot (Figure 8e). To rescue with these methods, you unlock the belay and lower the climber to the ground. Always keep at least one hand on the belay rope as you unlock the belay. If two people are available, one person operates the belay while the other person unlocks the tied off belay/lowering device. Regardless of whether an extra rope or continuous loop is used, a strong reliable knot, such as the double-fisherman (grapevine), is critical for joining the ropes.



Figure 8d: Rescue-8 Descender with 3X rope

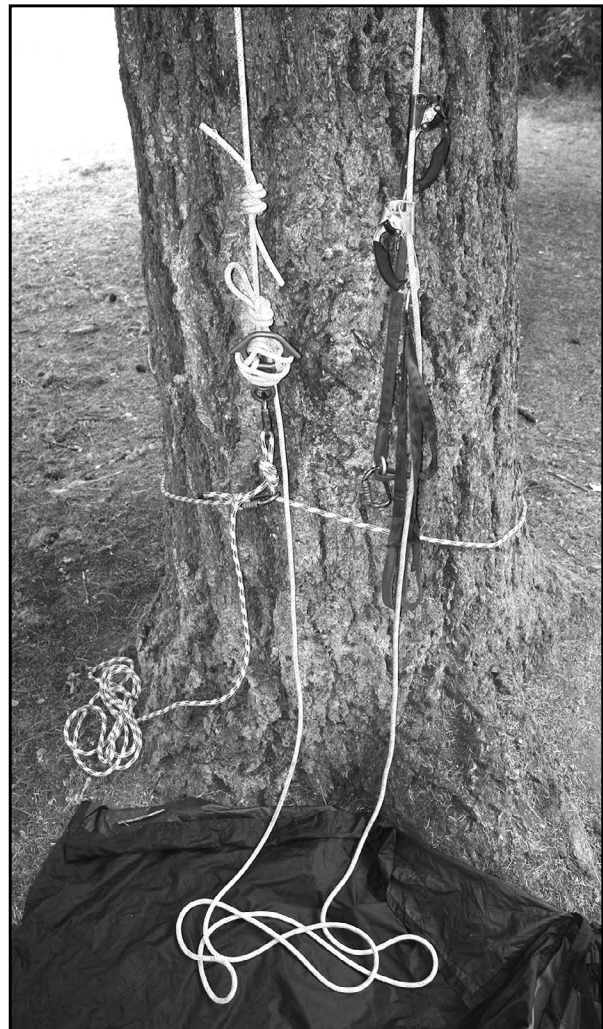


Figure 8e: Rescue-8 Descender using continuous loop

8.4.2 Rescue Without Preset Belay

If the climber used a fixed tie off (Figure 8f), they can still be lowered on their climbing rope by setting up an independent anchor with a belay/lowering device. Then, attach a prusik above the original anchor point on the climber's weighted rope. Next attach a new rope or the unweighted tail of the climbers' rope to the prusik. Run this rope through the belay/lowering device and take up the slack (Figure 8g). Once the belay is set untie or cut the original tie-off and lower the climber (Figure 8h). The only difference between this method and the methods described above is that a prusik or other secure friction device is used to attach the belay rope to the climbing line. A stopper knot shall be tied below the prusik to ensure it cannot slide off the rope.

Although it is permissible to cut a rope in the event of a real rescue, this can usually be avoided by clipping a friction device or knot to the climbing rope just above the tie-off. By hanging or standing on the friction device a small amount of slack can usually be created in the mainline allowing the original anchor to be untied without cutting anything. If time is not a factor, such as in practice sessions, a pulley system (Figure 8c, page 78) between the prusik and the new anchor point can be set up to pull slack in the climbing line so you can release the tie-off.

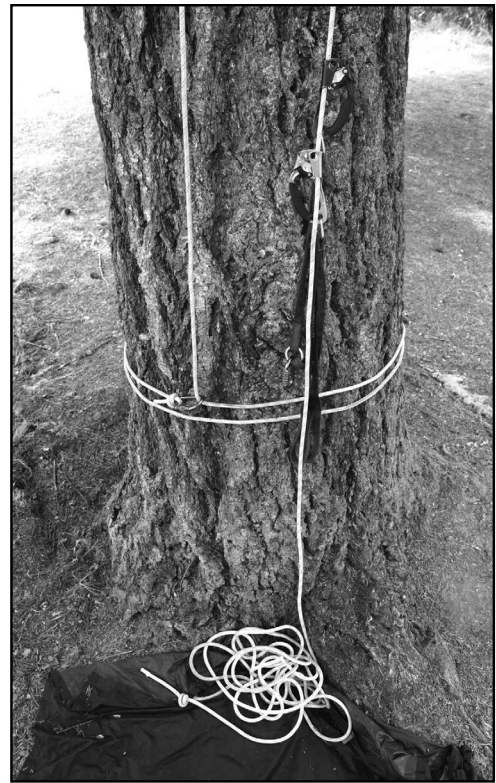


Figure 8f

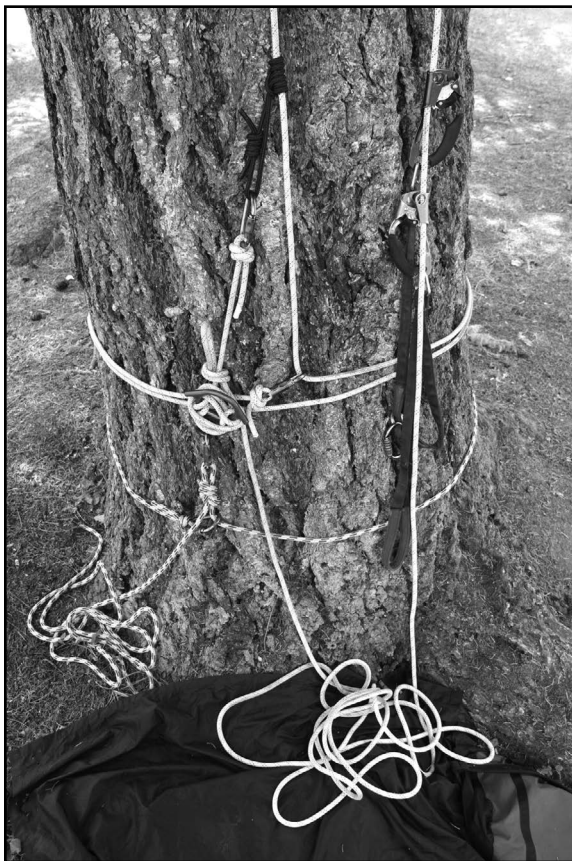


Figure 8g

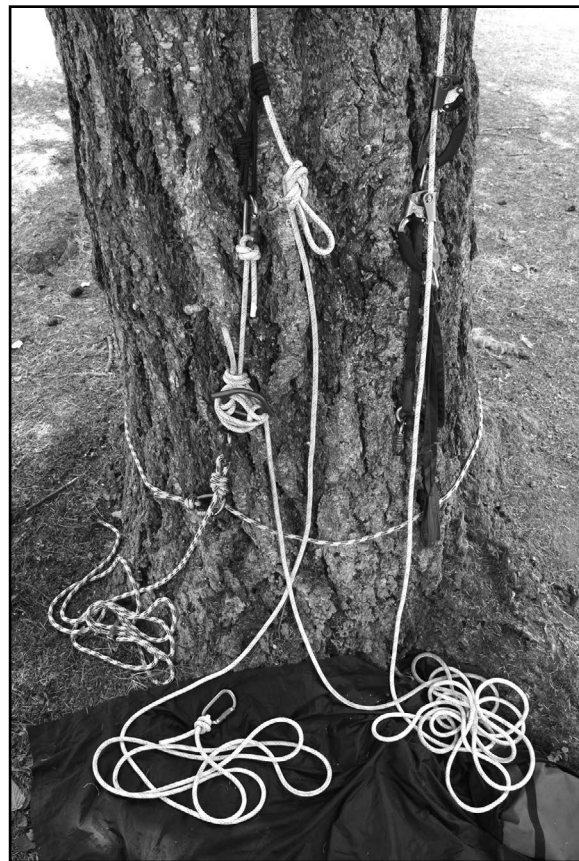


Figure 8h

8.4.3 Pick-Off Rescue

If the climber's rope cannot be freed to lower the climber to the ground, the assisting climber ascends to the climber and either lowers them to the ground on a different rope, or picks them off the rope and descends with them to the ground.

The quickest and easiest way to accomplish this is for the assisting climber to ascend the climber's rope until above the injured climber. A secondary mechanical ascender or friction knot can be useful when unclipping ascenders to get past the injured climber. Once above the injured climber, a prusik or secondary mechanical ascender can be attached to the climbing rope to create a 3:1 or 5:1 pulley system (Figure 8c z-rig pulley system, page 78) between the prusik and the main attachment point of the injured climber's harness. Then, the assisting climber moves back down the rope by alternately stepping down with their ascenders until their main attachment point is just below the main attachment point of the injured climber. The assisting climber then transitions from ascenders to descending device, locks the descending device, and uses a sling or carabiner to attach the climber to the assisting climber's lowering device. Then the assisting climber stands on the pulley rope to lift climber's weight off the incapacitated climber's ascenders, removes the incapacitated climber's ascenders from the rope, and gently lowers them until they are hanging from the lowering device. Finally, both descend to the ground together, under the assisting climber's control of the descent device.

It is also possible to do a pick-off rescue by rigging a separate rope in the tree and using this rope to ascend to the climber. While theoretically safer and easier than ascending the same rope that the climber is on, it will usually be extremely difficult and time consuming to get a second rope in place for a rescue, and if the two ropes become entangled, the situation can quickly go from bad to worse. In general, it is better to work with the rope that is already in the tree, unless there is some good reason for doing otherwise (e.g. the rope supporting the climber has become unstable because a support limb has broken).

8.5 Rescue from DRT

In the event of an incident requiring aerial rescue of a climber working in the tree on a DRT system, some special considerations are in order. As with any aerial rescue, the assisting climber should assess the specific situation and select a method that provides both quick and safe access to the incapacitated climber.

Unless the DRT system the incapacitated climber is climbing on has been damaged in the incident, it provides the easiest method for extraction. The assisting climber would install a separate DRT climbing system. Extraction can be accomplished by simultaneously controlling both the incapacitated climber's and the assisting climber's friction hitches for descent.

The assisting climber must carefully evaluate the location for his tie-in. The general area of the tie-in used by the incapacitated climber may not be sufficiently sturdy to support the additional loads of the assisting climber. Use of a redirect to place the assisting climber in the proper position to assist the incapacitated climber while utilizing a safe tie-in that is somewhat distant from the incapacitated climber may well be necessary.

Should the incapacitated climber's DRT system not be safe to use, the assisting climber should be cautious of placing both himself and the incapacitated climber on the assisting climber's single DRT system, as the double load may render the friction hitch either insufficient in ability to hold or cause it to grab so tightly as to make descent impossible. In this case, single or doubled rope rappel using a rescue 8, rappel rack, or other mechanical descender may be the best option, with both assisting climber and incapacitated climber independently attached to the single descent device, controlled by the assisting climber.

8.6 Rescue from Upper Reaches of the Tree Crown/Canopy

Should an aerial rescue become necessary where the incapacitated climber is in a portion of the tree that is deemed insufficiently strong to safely support the additional load of an assisting climber, mitigations must be employed in order to evacuate the incapacitated climber.

Some measures one might consider in a rescue that takes the assisting climber into the small wood, be it the top of a conifer or outer edges of the crown of a hardwood, could include keeping body weights on opposite sides of an upright stem, use of multiple overhead anchor points to share loading for ascent and lowering, use of alternative high tie-ins from an adjacent tree or trees, or bracing a fragile upper stem with multiple lines, as one might rig a high lead spar pole.

As in all aerial rescue scenarios, the assisting climber must assess the risks inherent in undertaking a course of action. No one is well-served if the outcome produces a second serious injury, compounding an already unfortunate situation. The assisting climber must be able to provide for their own safety before attempting a rescue.

Chapter 9 Using Chainsaws in Trees

9.1 Determining Whether a Chainsaw is Needed

In addition to the normal risks of personal injury from a chainsaw, a climber has the risk of severing climbing lines or lanyards. Because of this danger, any use of chainsaws in trees must be thoroughly justified and documented in the job hazard analysis. The work shall be done with the smallest saw that can do the job efficiently.

9.2 Chainsaw Endorsement Categories (EC)

1. Each of the following categories requires a separate endorsement (certification), in addition to the sawyer certification required by all categories.

EC-1. Cavity creation (including artificial cavities for red-cockaded woodpeckers or other cavity-nesting birds)

EC-2. Pruning and/or limbing in hardwoods (includes basic limb lowering)

EC-3. Pruning and/or limbing in conifers (includes basic limb lowering)

EC-4. Advanced rigging and heavy wood removal (topping/tree removal). EC-4 encompasses advanced rigging techniques used in the pruning of large limbs, topping of trees and rigging trees for removal. Climbers can be expected to be trained in the use of larger diameter ropes (larger than ½ inch), Hobbs lowering devices, Port-A-Wraps, and other heavy rigging equipment used to safely gain mechanical advantage over large limbs, tree tops, and whole trees.

2. Specific endorsements are valid for 3 years.

9.3 Requirements for Chainsaw Operators EC 1, 2, and 3

1. Must be certified as a Tree Climber or Tree Climbing Instructor.
2. Must hold a valid 2 or 1 sawyer certification.
3. Must receive training from a qualified EC 1, 2, or 3 instructor.

9.4 Requirements for Chainsaw Operators EC 4

1. Must be certified as a Tree Climber or Tree Climbing Instructor.
2. Must hold a valid 1 sawyer certification.
3. Must receive training from a qualified EC 4 instructor.

9.5 Requirements for Chainsaw Instructors

1. EC 1
 - A. Must be certified as a Tree Climbing Instructor.
 - B. Must hold a valid 2 sawyer certification.
 - C. Must successfully complete an EC 1 instructor training and meet the approval of the evaluating facilitator.
2. EC 2 and 3
 - A. Must be certified as a Tree Climbing Instructor.
 - B. Must hold a valid 1 sawyer certification.
 - C. Must successfully complete an EC 2 or 3 instructor training and meet the approval of the evaluating facilitator.

3. EC 4

A. Must be approved by the national tree climbing program manager.

B. Must hold a valid 1 sawyer certification and must obtain relevant training and certification from a nationally recognized arborist training organization.

OR

Must be an industry professional with a minimum of 10 years' experience in the tree service industry.

9.6 Equipment

1. Chainsaws shall be clean and in good operating condition with at least the following safety features: chain brake, chain catch, spark arrester, and throttle lockout. A low-kickback chain is recommended.
2. The following personal protective equipment shall be worn while operating a chainsaw in a tree.
 - A. Eye protection meeting requirement of ANSI Z 87.1.
 - B. Hearing protection.
 - C. Climbing helmet meeting requirement of ANSI Z 89.1 Type II or UIAA.
 - D. Gloves.
 - E. Boots made of heavy leather or other cut-resistant material.
 - F. Long sleeve shirt.
 - G. Leg protection meeting requirement of current version of Forest Service Specification 6170-4 or ASTM F-1897. Chainsaw protective pants or protective inserts for the legs are also acceptable alternatives.

9.7 Working in the Tree with a Chainsaw

Climbers shall adhere to the following safe work practices:

1. Secure your footing and engage the chain brake when you are starting the chainsaw.
2. While you are working in a tree, the chainsaw shall be tethered to the tree or to yourself at all times to prevent it from falling (except for RCW artificial cavity installation). Breakaway chainsaw lanyards are available commercially for saws weighing 15 pounds or less. Saws weighing more than 15 pounds should not hang from the breakaway lanyard while climbing but should be secured by the chainsaw lanyard ring. These lanyards break when 200 to 250 pounds of force is applied, such as when the lanyard is snagged by a falling branch.
3. When using a chainsaw in a tree, secure yourself to the tree with a minimum of two systems. One of the systems shall be cut resistant (steel-core lanyard or chain); the other system should be an attached safety, climbing, or rappel line. Care should be taken to keep slack out of lanyards and the climbing system, and to keep all lines clear of falling limbs or tops
4. When topping or trimming a large section of a tree, or in tree species that will readily "barber chair," a securing system (log chain, ratchet strap, etc.) should be used around the bole of the tree, just above and below the point where the cut is to be made.
5. Engage the chain brake and take your hand off the throttle while moving between work locations in the tree. Stop the engine when you are making long moves in a tree, such as when you must release the lanyard.

6. Maintain a firm grip on the chainsaw with both hands when you are sawing. Keep your thumbs encircling both handles to avoid losing control in the event of a kickback.
7. Keep ropes, lanyards, and your body out of the cutting or kickback zone—especially when you are making plunge cuts.
8. Always be fully aware of the cutting zone, and never make “blind cuts,” where the saw can come in contact with the climbing line or work-positioning lanyard.
9. When carrying a rappel line and a chainsaw up a tree, attach the saw on the opposite side of your belt from the rappel line to avoid damaging the rope.
10. When repositioning the saw, or when the saw may contact a lanyard or climbing line, the chain brake shall be engaged.

Chapter 10 Recommended Publications

Much of the technical information in this field guide is derived from the following sources. Climbers and Climbing Instructors are strongly encouraged to refer to these references for additional information about equipment, procedures, and safety.

ANSI Z133.1

Ashley, Clifford W. 1944. *The Ashley book of knots*. Garden City, New York: Doubleday & Co. 620 p.

Beranek, G.F. *The fundamentals of general tree work*. Ft. Bragg, CA: Beranek Publications. 512 p.

Denison, W.C.; Tracy, D.M.; Rhoades, F.M. 1972. Direct, nondestructive measurements of biomass and structure in living, old-growth Douglas-fir. Proceedings—Research on coniferous forest ecosystems—a symposium. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 147–158.

Frank, James A.; Smith, Jerry. 1983. Figure eight descenders. Nylon Highway. Huntsville, AL: National Speleological Society Vertical Section. 16:1–4; June.

Frank, James A.; Smith, Jerrold B. 1987. *Rope rescue manual*. Santa Barbara, CA: California Mountain Co., Ltd. 138 p.

Graumont, Raoul. 1945. *Handbook of knots*. Cambridge, MD: Cornell Maritime Press, Inc. 194 p.

Graydon, Don, ed. 1997. *Mountaineering: the freedom of the hills*. 6th ed. Seattle, WA: The Mountaineers. 544 p.

Hudson, Steve; Williams, Toni. 1983. Using the rappel rack. Nylon Highway. Huntsville, AL: National Speleological Society Vertical Section. 16: 5–14; June.

Jepson, Jeff. 2000. *The tree climber's companion*. Longville, MN: Beaver Tree Publishing. 104 p.

Lilly, Sharon. 1998. *Tree climber's guide*. International Society of Arboriculture. Hagerstown, IN: Exponent Publishers, Inc. 143 p.

Martin, Tom. 1988. *Rappelling edition II*. Mt. Sterling, KY: Search. 295 p.

National Fire Protection Association (NFPA) 1983. 2001. Standard on fire service life safety rope and system components. Quincy, MA: National Fire Protection Association. 34 p.

OSHA Standards Handbook H6109.13.

Padgett, Allen; Smith, Bruce. 1996. On rope: North American vertical rope techniques. Huntsville, AL: National Speleological Society. 382 p.

Seal, D.T.; Matthews, J.D.; Wheeler, T.T. 1962. Collection of cones from standing trees. Forest Record No. 39. England: Forestry Commission. 45 p.

Setnicka, Tim J. 1980. *Wilderness search and rescue*. Boston, MA: Appalachian Mountain Club. 640 p.

Snyder, E.B.; Rossoll, H. 1958. Climbing southern pines safely. U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. Occasional Pap 159. 17 p.

- Vines, Tom; Hudson, Steve. 1989. *High angle rescue techniques: a student guide for rope rescue classes*. National Association for Search and Rescue. Dubuque, IA: Kendall/Hunt Publishing. 250 p.
- Wellington-Puritan, Inc. 1980. *The splicing book*. Madison, GA: Wellington-Puritan, Inc. 18 p.
- Wheelock, W. 1967. *Ropes, knots, and slings for climbers*. Glendale, CA: La Siesta Press. 36 p.
- Yeatman, C.W.; Nieman, T.C. 1978. Safe tree climbing in forest management. Forestry Tech. Rep. 24. Fisheries and Environment Canada, Forestry Service. 34 p.