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SAFE TREE CLIMBING IN FOREST MANAGEMENT

by

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DANIDA FOREST SEED CENTRE

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Danida Forest Seed Centre (DFSC) is a Danish non-profit institute which has been working with development and transfer of know-how in management of tree genetic resources since 1969. The development objective of DFSC is to contribute to improve the benefits ofgrowing treesfor the well-being ofpeople in developing countries. DFSC's programme isfinanced by Danish International Development Assistance (Danida).

Abstract

Reforestation of commercial forests has a high priority in Canadian forest management. More and more tree seed must be collected from standing trees as the importance of seed origin and genetic quality is recognized, and as seed-producing stands and trees become scarce in preferred source areas. Climbing, properly executed, is a safe and economic method, and is frequently the only practical way to collect seed in quantity from standing trees. It is also necessary in applied breeding programs that call for the collection of seed and branches from plus trees selected in natural stands. Trained personnel are needed to climb and to lead seasonal crews for collection of seed and branches from selected stands or trees wherever they may be found in the forest. This manual is designed to assist in training crew leaders and tree climbers.

The tree climbing equipment and methods used in the genetics program at Petawawa Forest Experiment Station are described and illustrated in detail. Emphasis is placed on safety and effectiveness. The procedures described include the use of ropes, ladders, climbing devices, and safety equipment suitable in a wide range of situations, from young planted orchards to mature, forest-grown stands. The principles of long-term planning for operational seed collection are outlined, together with guidelines for organizing collection crews. Known suppliers of equipment suitable for tree climbing are listed.

Résumé

Le reboisement des forêts commerciales est hautement prioritaire dans l'aménagement des forêts du Canada. Il faut récolter toujours plus de graines des arbres sur pied à mesure que l'importance de l'origine des graines et la génétique prennent de l'ampleur et que se raréfient les peuplements semenciers dans les régions sources préférées. Si elle est bien exécutée, l'escalade constitue une méthode sûre et pratique en plus d'être souvent le seul hoyen pratique de récolter les graines en quantité dans les arbres sur pied. Elle est aussi nécessaire dans les programmes d'hybridation, qui exigent la récolte de branches et de graines provenant d'arbres plus, choisis en peuplements naturels. Des équipes bien formées doivent grimper et guider les saisonniers dans la récolte de branches et de graines provenant d'arbres et de peuplements choisis n'importe où en forêt. Ce manuel est concu pour aider à former des chefs d'équipes et des grimpeurs d'arbres.

L'équipement et les méthodes employés lors d'études génétiques à la Station d'expérimention forestière de Petawawa y sont décrits et illustrés en détail. On a mis l'accent sur la sécurité et l'efficacité. Les méthodes décrites comprennent l'utilisation de câbles, d'échelles, d'accessoires d'escalade et d'un équipement de sûreté s'adaptant à un large éventail de situations, allant des jeunes plantations de vergers aux peuplements naturels matures. Le manuel souligne les principes de la planification à long terme, ainsi que des directives pour organiser des équipes de récolte. On fournit un répertoire de vendeurs connus d'équipement utilisé pour grimper dans les arbres.

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INTRODUCTION

Tree climbing methods and equipment used in the genetics program at the Petawawa Forest Experiment Station are described in the belief they will find application for mass collection of seed for reforestation in northern and eastern Canada. The same methods may be used for collecting scions from plus trees, for controlled breeding and seed collection in seed orchards, and in detailed mensurational exercises involving tall trees. However, most of this discussion refers to seed collection, which provides the more general application.

Large volumes of tree seed are required for reforestation of cutover and burned land that fails to regenerate satisfactorily by natural means (Dobbs et al. 1976). Ontario and Quebec each collect between 10,000 and 15,000 hl (hectoliters) of cones and rough seed annually to meet their current demands for seed[1]. Species are chosen for seeding or planting on the basis of site, probability of success, and potential for commercial use. Spruce, pine, and larch commonly meet these criteria in the extensive forests of eastern Canada. Seed of some hardwood species is needed in smaller quantities for timber production and for amenity and specialty planting. Increasingly, emphasis is being placed on collecting seed from designated stands, seed production areas, seed orchards, and selected trees (Morgenstern 1975, Yeatman 1976).

Such control of seed collection is needed to identify and maintain genetically superior populations, to upgrade genetic and physiological quality of tree seed, and to permit proper distribution of seed and plants with regard to seed origin and location of seeding or planting. In many areas of intensive forest utilization, scarcity of natural stands precludes tree felling for seed production only, and seed must be collected from standing trees to ensure continuity of supply. Even in stands scheduled to be cut, climbing and topping may be more effective than felling and permit greater flexibility in harvesting both seed and wood. This applies particularly to species with small cones or seed that have a brief period between maturation and seed fall (D.A. Skeates, pers. comm.).

Mechanization for gathering tree seed from standing trees has attracted much attention and is being applied in the planted seed orchards of southern pines and in some areas of Canada (Calvert 1974). Such equipment includes trailed and self-propelled raised platforms and extension ladders, boom buckets (cherry pickers), tree shakers, and seed sweepers. To ensure safe and effective operation, mechanization demands relatively flat land that is free of obstruction and where there is easy access to trees (Perry 1954). Mechanical aids to seed collection also require large capital outlays in equipment and stand improvement or development. A single unit such as a bucket hoist is only able to put one or two pickers into a tree crown at a time. Repeated operation of heavy vehicles compacts soil and limits root development. Deep, boulder-free soils are necessary to permit loosening the compacted lanes by subsoiling. These constraints on mechanization that call for easy access, generous financing, and intensive management would severely limit the choice of seed source of most commercial species in Canada if emphasis were to be placed on harvesting seed with machines.

In some species, e.g. jack pine and black spruce, bulk seed collection is best integrated with commercial harvest operations in designated seed collection areas. Seedling seed orchards of these species can logically be designed for collection by clear felling when collection from the ground becomes impractical owing to increasing tree height (Yeatman 1974). For other species, e.g. white spruce and white pine, late sexual maturity precludes ground collection and high-picking is a necessity. Infrequent and irregular seed crops combined with a brief period of maturation before release of seed require periodic collection from standing trees as opportunities occur. These silvical constraints also dictate a preference for planting clonal seed orchards designed for harvesting seed from standing trees of white spruce and white pine.

[1] Provincial submissions to the Canadian Forestry Service workshop, Tree Seed Production and improvement in Canada, 1978.

Climbing- Why Not?

Collecting seed by climbing is fast, efficient, and flexible, and most tree species can be climbed with safety and confidence if attention is given to organization, equipment, training, and planning (Snyder and Rossoll 1958).

For many reasons climbing is often felt to be a serious and even insurmountable obstacle. Fear of height, or acrophobia, is a real and limiting factor and must not be brushed aside lightly. It is absolute in few individuals and, when encountered, it must be respected. Many people consider climbing trees to be dangerous or childish. This may be contrasted with the general acceptance of climbing man-made structures to paint, repair, or build. An innate apprehension of natural structures such as trees, cliffs, and caves commonly engenders mistrust in climbing and exploration. Such fears are reinforced at an early age by protective parental attitudes. It has been our experience that, as long as an individual is physically fit, a normal reluctance to climb can be overcome by example, training, and experience.

Because of commonly held negative attitudes toward operational tree climbing and in the face of increasing demands for larger quantities of tree seed at lower costs, large amounts of money can be generated for construction or purchase of mechanical aids for seed collection, and there is no difficulty in finding men who will operate elaborate machines. Also large numbers of trees have been felled for seed collection, whereas climbing would have done the job without loss and waste of trees for timber or future seed collection. Valuable seed crops have been lost because the seed or cones were considered inaccessible. Arguments for greater efficiency and reduction in cost through mechanization may be unfounded if subjected to critical economic analysis. The fact is that under present circumstances, including administrative attitudes and lack of staff with training or experience, it is difficult to recruit personnel willing and able to pick seed and cones from standing trees.

Many of these problems can be overcome if foresters and forest technicians will accept tree climbing as a normal and necessary activity in forest management. Trained men are needed to organize and lead seasonally employed seed collection crews. Since young people generally are more responsive to learning the job than older people, they should be recruited for seasonal positions whenever possible. Although not available for fall or winter collections, high school and college students are usually free in the latter half of August for collecting cones from white spruce and white pine, for which climbing is often essential. When safe climbing techniques have been demonstrated and are followed, it takes most individuals only a day or two to gain confidence and become good climbers and efficient seed collectors.

Seed Collection Crews- Seed Control

Crews for climbing can be organized in many ways according to the type of stand, species, size of trees, and equipment needed, but it is essential to work in groups, with at least one person on the ground at all times. He is the anchor man, tending safety lines, picking up bags of cones, branches, or seeds dropped by the climbers, labelling collections, and doing the bookkeeping.

Incentive pay is appropriate for demonstrated skill and performance in tree climbing; it should not be referred to as danger pay because tree climbing is not a particularly dangerous activity. Hazardous, perhaps, but only if safety is not respected, as in many forest operations. The work has an element of glamour that could be used to advantage in generating a positive spirit among cone and seed pickers, giving rise to the same élan as ”smoke jumpers” had in western Canada. So long as established employment practices and regulations are followed, Canadian workers are covered by health and income insurance in the event of injury due to an accident.

Organization of seed collection by trained crews gives the forest manager complete control over where, when and how seed will be collected, and includes felling when this is appropriate. Tree populations may be designated for cone collection, and particular stands or select trees distributed within a defined area may be marked for collection in advance of seed maturity. Young natural stands and plantations of preferred origin can be managed for seed production, e.g. by thinning, pruning, fertilizing, and protection from insects and fire.

Good planning avoids collections (1) from widely scattered, open-grown trees that yield seed of low viability and poor quality due to inbreeding (self-pollination), (2) from trees that are overmature or growing on infertile sites that yield seed of small size and variable quality, and (3) in poor crop years, when seed may be found only on a few scattered trees with consequent low yield and poor quality. A high quality and large quantity of seed can be assured by collecting mature seed or cones in good crop years from vigorous trees growing in well-spaced, uniformly stocked stands (Seal et al. 1962). Accurate information concerning seed source identity, i.e. place of origin, characteristics of stand and site, seed crop maturity, incidence of pests, date of collection, and other relevant factors, is easily gathered by a trained, supervised crew.

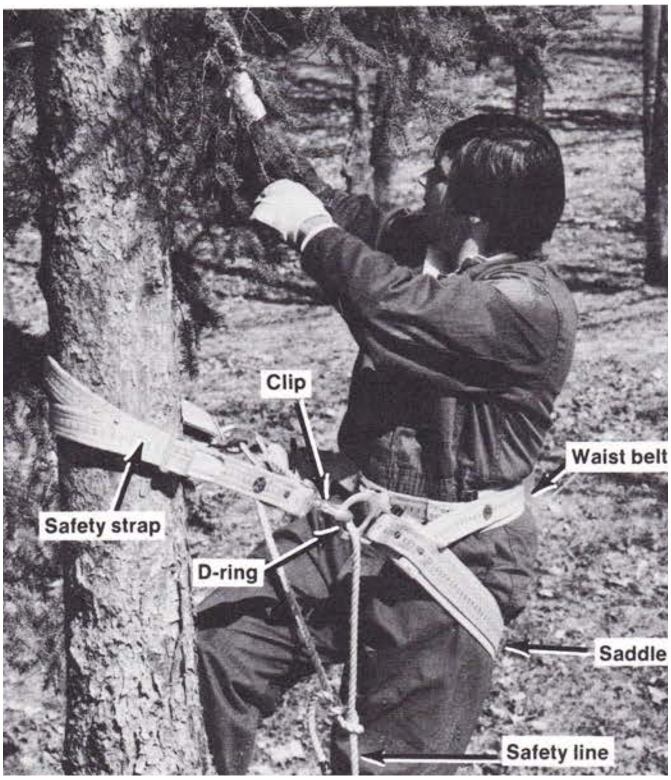
Collections of cones or seed by trained crews requires more administrative and organizational effort than a simple purchase of cones at the forest ranger’s office. Sufficient equipment for climbing (harnesses, ropes, ladders, etc.) must be on hand to meet the anticipated needs. This equipment must be stored properly and maintained in good order in the interests of safety and economy.

Casual pickers know little and care less about the criteria and importance of selecting populations, stands, and trees for seed collection. The unit cost of seed may be increased somewhat by adopting higher standards, but in the long run there can be little doubt that seed of uniformly high quality and of certified origin will pay high dividends in the nursery and forest and that continued supplies of source-identified seed will be assured.

Equipment, Skills and Safety

Efficiency and safety in climbing trees depend on using the right equipment for the job at hand, knowing how to use it correctly, and ensuring that it remains in top condition. A harness consisting of body belt and safety strap is used by climbers at all times. Ropes are needed as safety lines and for descent from tall trees, for raising and lowering tools, cones, etc. and as guy ropes for ladders. It is essential that climbers know how to tie simple knots correctly and when to use them.

Carabiners are used with rope slings or strops to secure the safety line on clear boles and at the tree top. Other climbing aids, including tree spurs, tree ladders and free-standing ladders, poles and the "tree-bicycle," are used to reach the seed-bearing crown. Accessory equipment needed to complete the work includes a variety of tools, containers, and recording forms that must be chosen to suit the circumstances.



HARNESS

The climbing belt and safety strap, or harness (Fig. 1), is the climber's insurance against serious accident and provides the necessary security to eliminate tension and minimize fatigue in climbing. The best design for working in trees combines a webbing saddle with a body or waist belt combined with one or two clip-on safety straps. The waist belt simply keeps the harness in place, and the climber's weight is supported by the saddle with a safety strap passed around the tree and clipped to the saddle D-rings. Simple waist belts have been found to be very tiring after an hour or so of working in a tree top, as is frequently called for in seed collection.

Before use, belts should be checked to ensure that webbing, stitching, and rivets are in good condition and secure. A belt or strap with deep fraying or cuts should be discarded. Leather belts should be cleaned with saddle soap and dressed with dubbin after use. When belts and straps are not in use, they should be kept in compartments or suitable boxes in the vehicles when on the road and stored between climbing operations by hanging on hooks or pegs in a dry place away from excessive heat or strong light.

Figure 1. Safety harness.
Forestry worker's climbing belt with webbing saddle and waist belt together with the safety strap, which is passed around the tree and clipped to D-rings.

ROPES

Nylon stranded rope has been found to be most serviceable for working in trees. Ropes of natural fibers are not as strong at equal diameter and are subject to weathering and rot. Half-inch (12.7 mm) or 7/16 in. (11.1 mm) diameter ropes are used as climber's safety lines; 3/8 in. (9.5 mm) and 1/4 in. (6.4 mm) ropes are used as equipment and guy lines. Specifications of weight, length, and strength for nylon rope of these dimensions are set out in Table 1. More detailed comparisons with ropes of other natural and synthetic fibers are to be found in the Rigging Manual published by the Construction Safety Association of Ontario (Dickie 1975).

Polypropylene fiber ropes are commonly available and relatively cheap but are not suitable for climbing. Polypropylene ropes are weakened by a rise in temperature and will melt at a relatively low temperature (154°C). This rise in temperature can easily result from abrasion and friction, e.g. when the rope is used to descend. The polypropylene also tends to be stiff and is difficult to fasten securely. Because of these disadvantages, polypropylene fiber ropes must not be used as safety ropes.

Nylon ropes become fuzzy on the surface in use, but this is no cause for alarm, as the nap protects the rope, thereby reducing further wear. Deep fraying and cuts are dangerous, and the rope must be shortened to eliminate the defects or be discarded. Never use knots or splices to repair safety ropes. Ropes purchased for climbing should never be used for general purposes such as tying down ladders, loads of cones, etc. Any rope subjected to excessive strain, e.g. a tow rope, must not be used for climbing. After use, ropes should be coiled and hung in a cool, dry place away from direct light and not stored by being laid on the floor. Ropes can be cleaned in clear water to remove surface dirt and grit, which acts as an abrasive, causing excessive wear after a period of time. Never dry nylon rope by heating. The ends of nylon rope are, however, most easily and effectively sealed to prevent unravelling by melting the cut ends with a soldering iron or smallflame. The rope can be held intact when cut and before sealing if it is first wrapped with adhesive tape and a sharp blade is used to cut through the tape and the rope.

Table 1. Nylon rope specifications CWC stabilized 707 nylon, three-strand regular lay[1]

Diameter		Weight/length ratios			Breaking Strength		Working load[2]	
in	mm	lb/100 ft	ft/lb	m/kg	lb	kg	lb	kg
1/4	6.4	1.8	55.6	37.4	1.500	680	165	75
3/8	9.5	4.1	24.4	16.4	3.400	1540	374	169
7/16	11.1	5.0	20.0	13.4	4.800	2180	528	240
1/2	12.7	6.7	14.9	10.0	6.200	2810	682	309

[1]Canada Western Cordage Co. Ltd., Vancouver, B.C.

[2]Based on factor of safety = 9

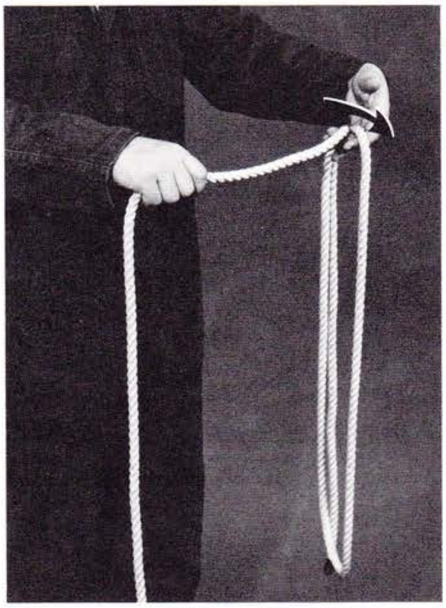


Fig. 2,a

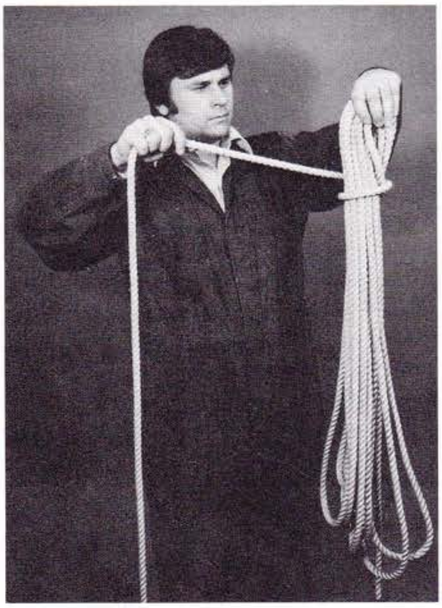


Fig. 2,b

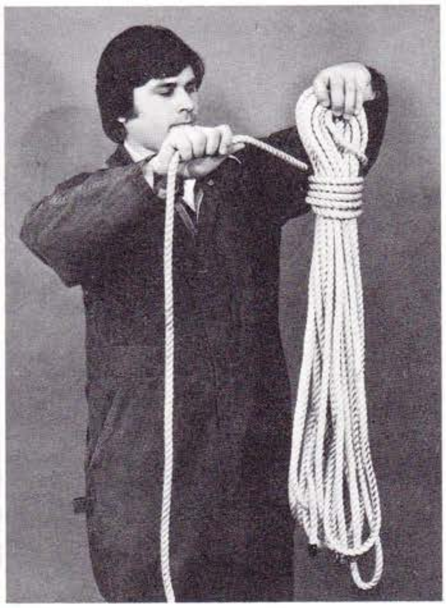


Fig. 2,c

Fig. 2,d

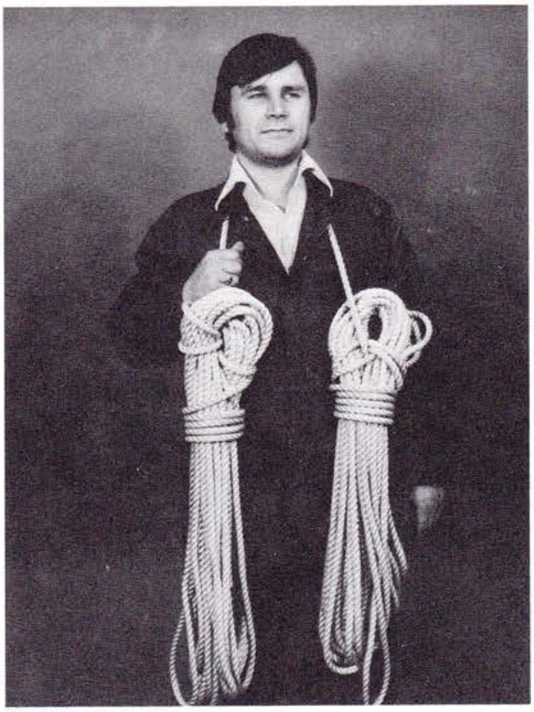


Fig. 2,f

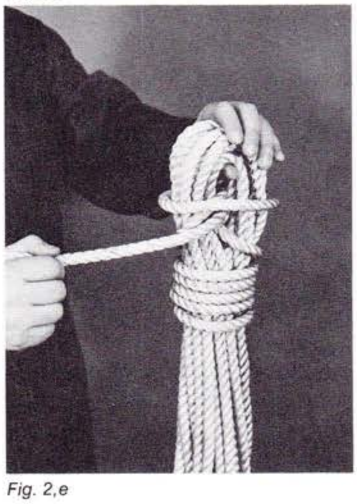


Fig. 2,e

Figure 2. Coiling a rope.

(a) Coil clockwise (left to right).
(b,c) Wrapping turns.
(d,e) Secure with a bight.
(f) Long rope coiled in two parts from the center.

To prevent tangling and ensure free running, stranded rope should always be coiled clockwise, with the lay of the rope. Twists and kinks are worked to the free end as the rope is gathered. The coiled rope is conveniently secured by wrapping a few turns towards the top of the coil with the standing part, finishing with a bight through the coil over the top and tightening to secure (Fig. 2). A long rope, too bulky to be held conveniently in one hand, is coiled in two parts, starting from the middle towards each end, wrapping, and securing with the mid part of the rope (Fig. 2,f).

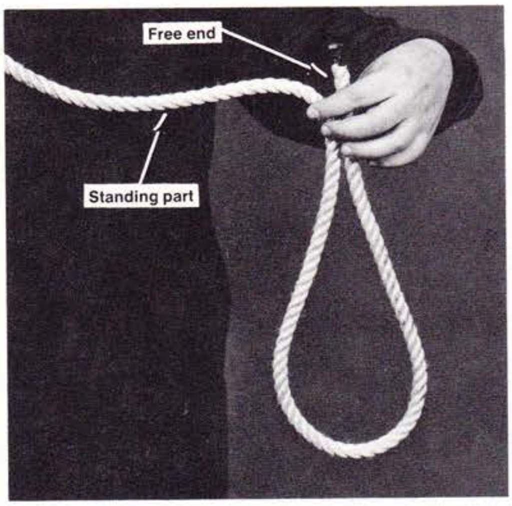


Figure 3. Bight.

KNOTS

Within the limits of its breaking strength, a rope is only as strong as the knot used to fasten it. Knots must be simple, easily tied, and, equally important, readily untied.

They must be used correctly and confidently to ensure safety and efficiency. The same knots must be used by all climbers and ground personnel to avoid confusion and unnecessary, possibly hazardous, delay.

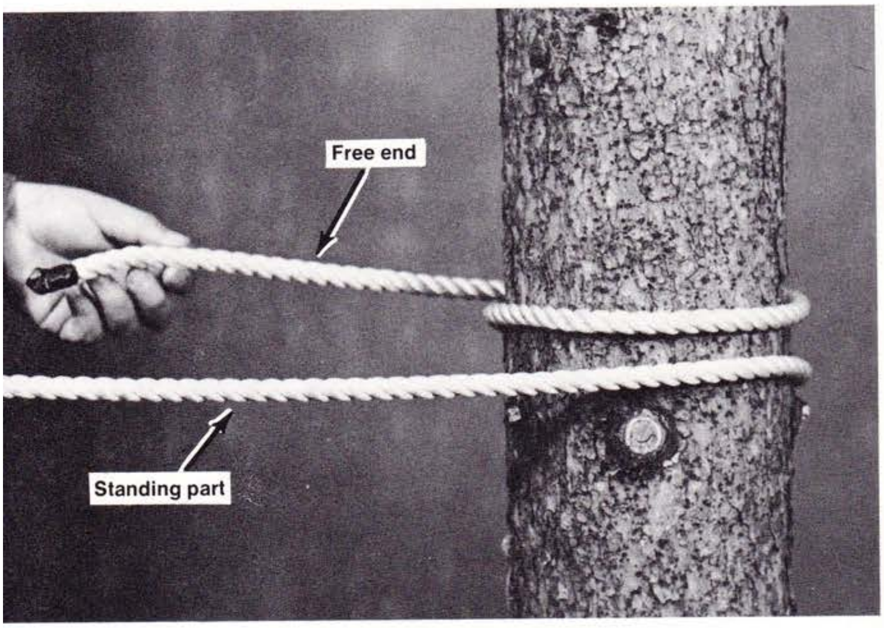


Figure 4. Round turn.

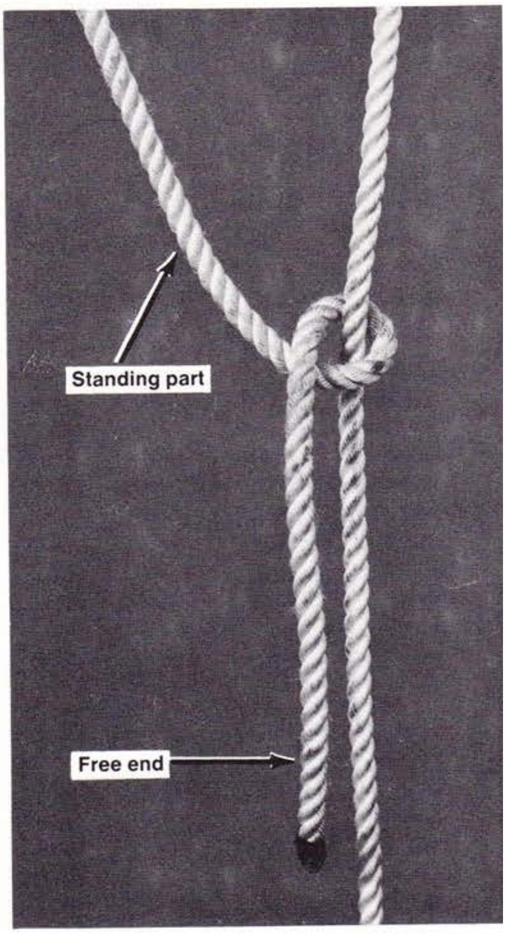


Figure 5. Half hitch.

The following terms are commonly used in knotting and rope-handling:

Hitch-a knot used to tie a rope to an object
Bend-a knot used to fasten two ropes together
Bight-a loop formed in a rope (Fig. 3)
Round turn-a complete turn (x 1½) of a rope around an object (Fig. 4)
Half hitch-single turn to secure a free end around a rope or an object (Fig. 5)

Thumb, or overhand, knot--a rope turned once about itself or another rope (Figs. 6 and 7)
Standing part--the end of a rope fixed to an object and the direction expected to provide a strain
Free end--the end of the rope with which the knot is tied and to which normally no strain is to be applied.
Figure 6. Thumb knot.

The knots illustrated in this text are combinations of simple hitches, bights, and round turns, each combination best fitted for a particular function. The common element in all cases is that, under strain, the standing part jams the free end and prevents slippage, yet the knots are readily loosened when the strain is released. Most knots should be tightened by pulling the standing part(s), not the free end(s).

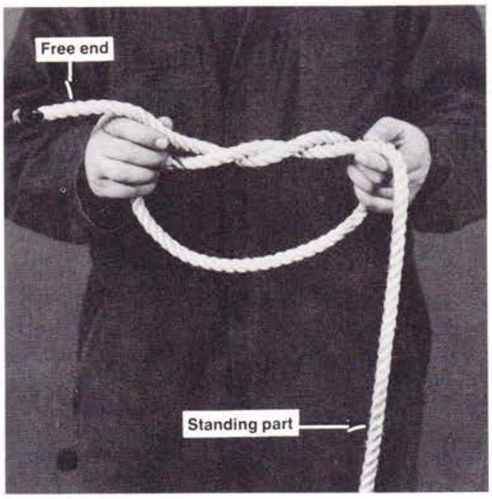


Figure 6. Thumb knot.

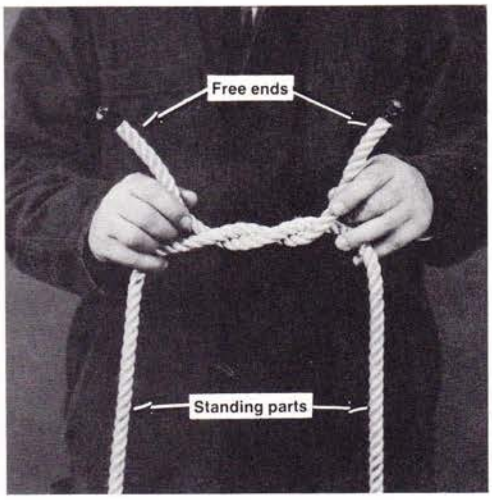


Figure 7. Overhand knot.

Bowline (Fig. 8). This knot is used to form a fixed bight in a rope, as in fastening the safety line through the D-rings of the climber's belt (Fig. 1). It is a combination of a half hitch in the standing part secured with a bight in the free end.

Fig. 8,a

Fig. 8,b

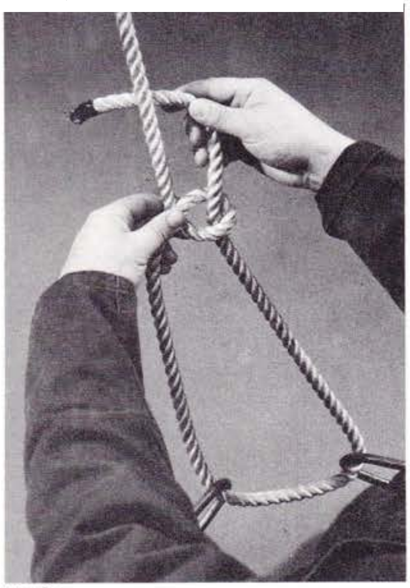


Fig. 8,c

Clove hitch (Fig. 9). This hitch is used to fasten the rope to an object larger in diameter than the rope, e.g. a tree. It is formed by combining two half hitches. A minimum of three half hitches should be used around the standing part to secure the free end and prevent the clove hitch from slipping under load (Fig. 9,c). When the pull is at an angle to the axis of the stem, the first hitch must be made in the direction of the strain (Fig. 9,a).

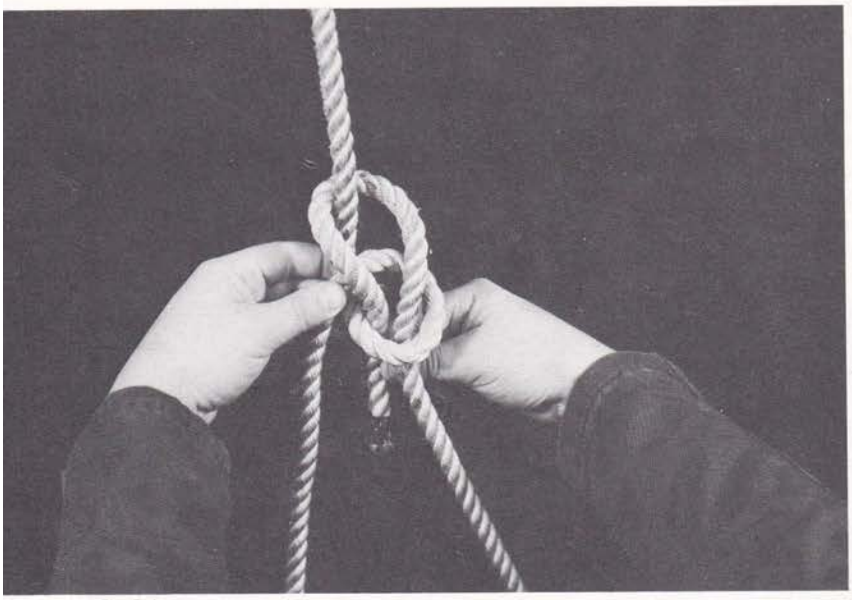


Fig. 8,d

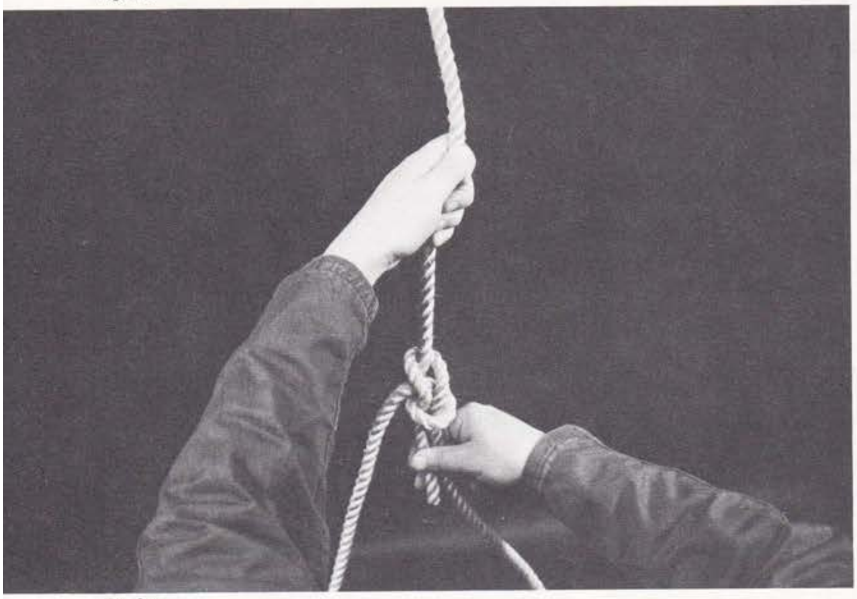


Fig. 8,e

Figure 8. Bowline.
(a,b) Forming the hitch.
(c,d) Securing the bight.
(e) Pulling the knot snug.

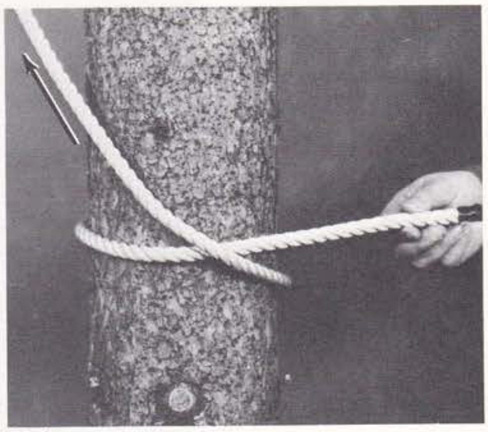


Fig. 9,a

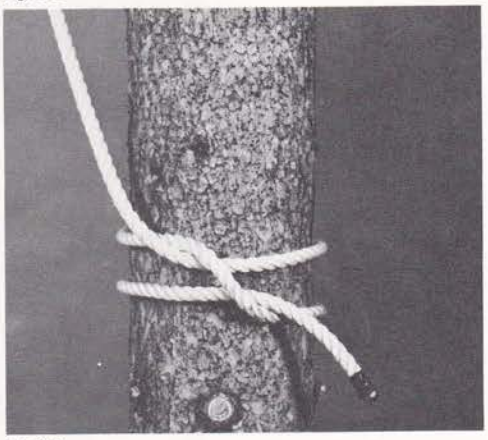


Fig. 9,b

Fig. 9,c

Figure 9. Clove hitch.
(a) First half hitch.
(b) Second half hitch.
(c) Secure hitch.

Fisherman's hitch (Fig. 10). This hitch is used to fasten a rope directly to an object of small diameter when security is of paramount importance. It is used in tree climbing to fasten a rope strop to a carabiner or a guy rope to the rail of a ladder. The hitch is a combination of a round turn and two half hitches, the first half hitch being passed through the round turn, the second around the standing part only.

Fig. 10,a

Fig. 10,b

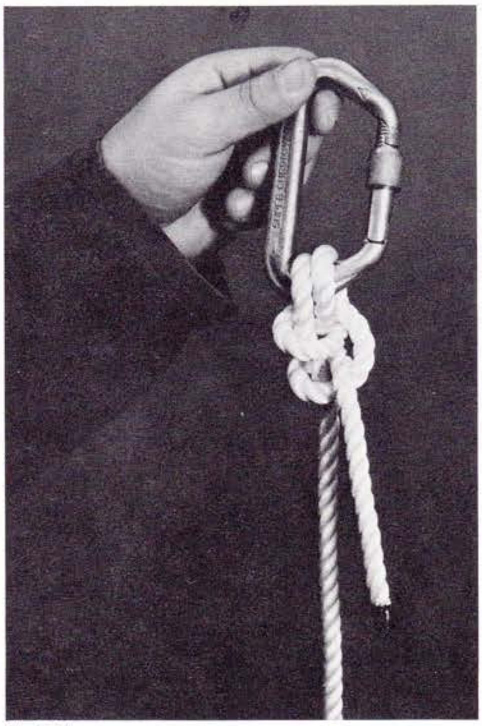


Fig. 10,d

Figure 10. Fisherman's hitch made on a carabiner.
(a) Round turn.
(b) Half hitch through the turn.
(c) Second half hitch.
(d) Completed hitch pulled snug.

Sheet bend (Fig. 11). This knot is used to join two ropes or to join the ends of a short length of rope to form a sling. It is a combination of half hitch through a bight. If the ropes are of unequal size, the bight is made in the rope of larger diameter. A double sheet bend is made by passing the end through the hitch a second time for additional security, and the double knot has less tendency to jam.

Fig. 11,a

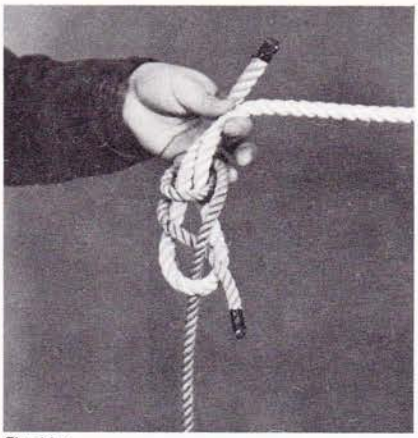


Fig. 11,c

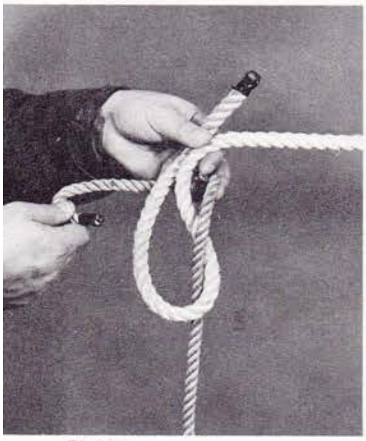


Fig. 11,b

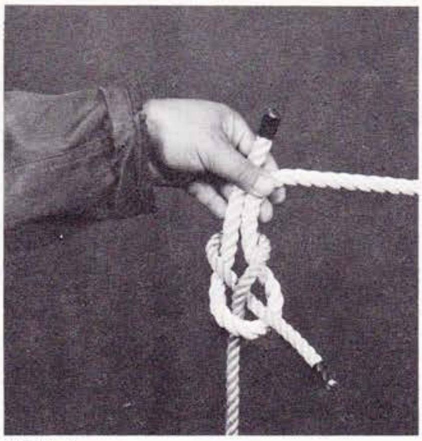


Fig. 11,d

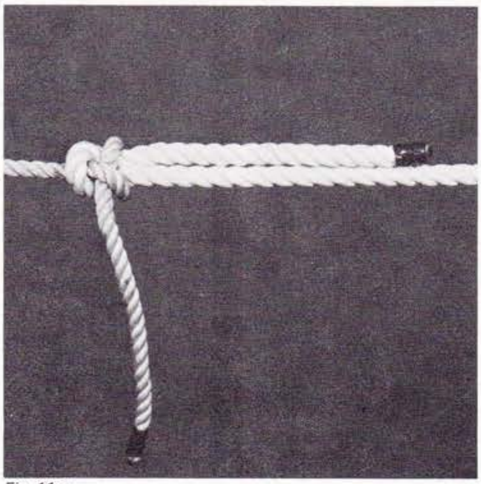


Fig. 11,e

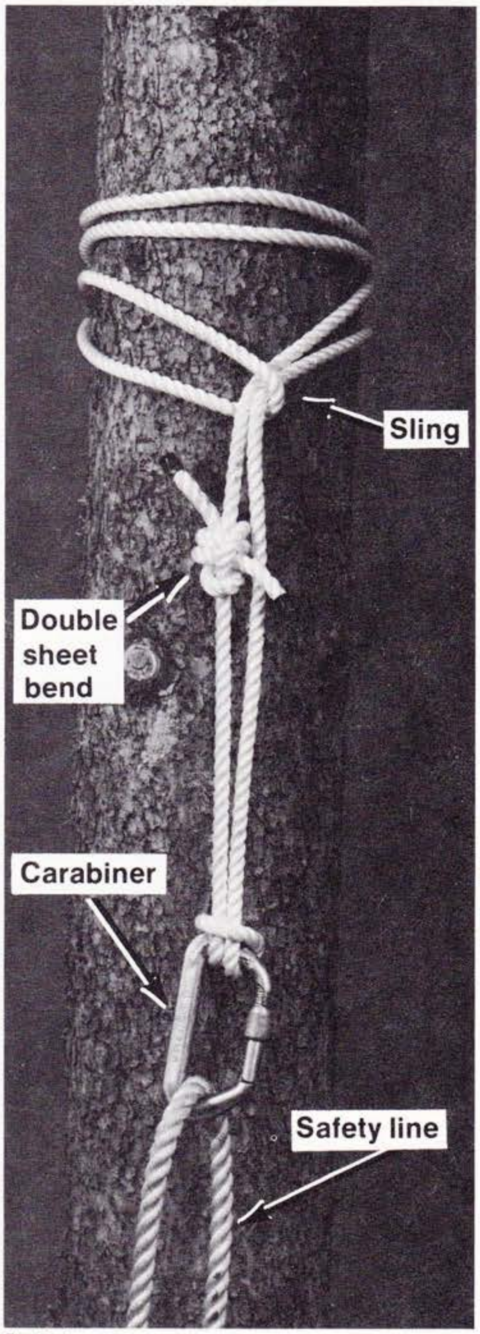


Fig. 11,f

Figure 11. Sheet bend.

- *(a,b) Half hitch, rope 1 through the bight of rope 2.*
- *(c) Single sheet bend.*
- *(d) Double sheet bend.*
- *(e) Snug sheet bend. Note that the free ends extend to opposite sides of the knot.*
- *(f) Double sheet bend in a sling.*

Rolling hitch (Fig. .12). This is a sliding knot used to create an adjustable loop in a line. It will not slip when under strain but can be adjusted easily by pulling directly on the knot. It is a combination of half hitch-round turn and a half hitch. The rolling hitch can be used to secure the safety line to a tree at ground level, yet the length of the line may be adjusted by the anchor man as the climber moves a few feet up or down in the crown. It is also useful to set adjustable guy lines for tall ladders (Figs. 20 and 21 ,c).

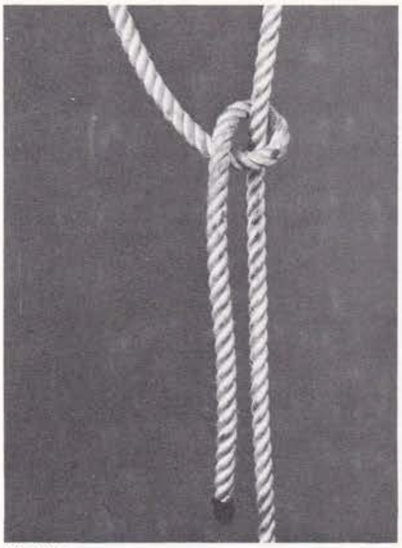


Fig. 12,a

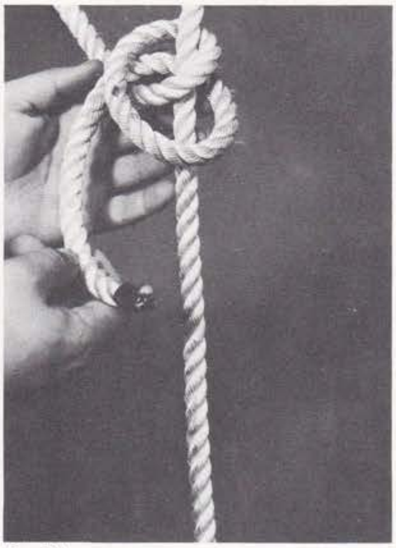


Fig. 12,b

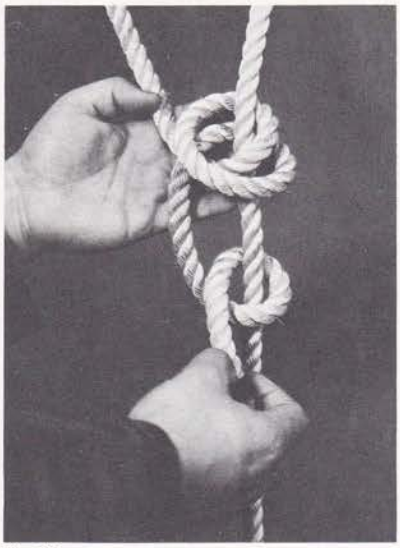


Fig. 12,c

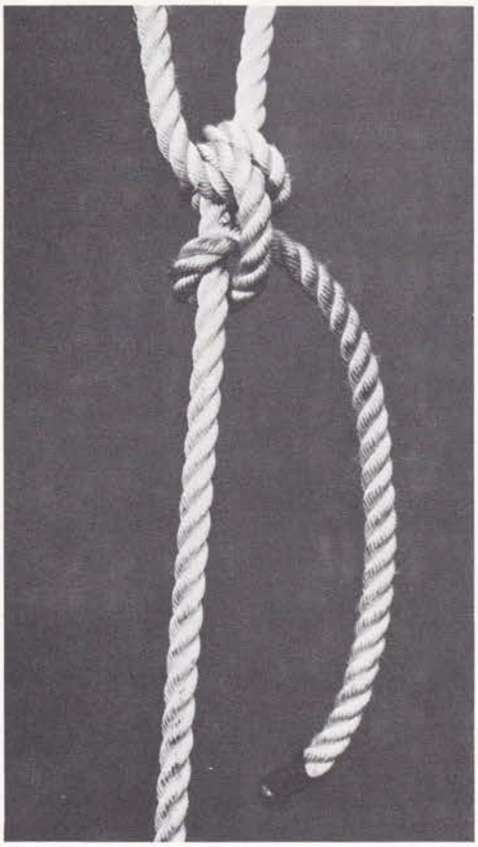


Fig. 12,d

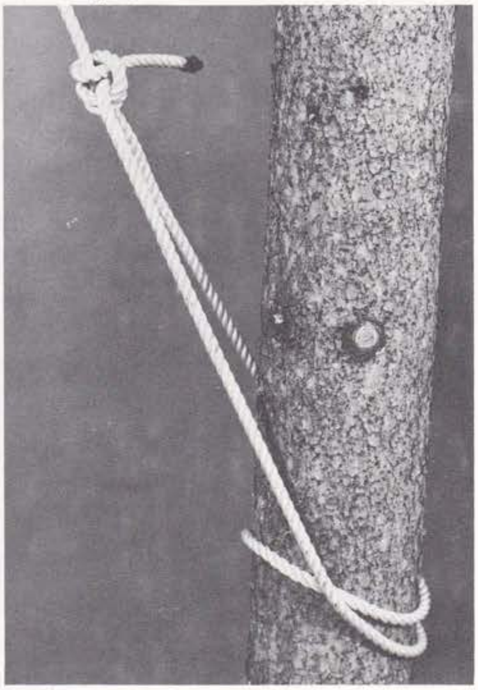


Fig. 12,e

Figure 12. Rolling hitch.

(a) Half hitch.
(b) Round turn jammed with the half hitch.
(c) Second securing half hitch.
(d) Knot pulled snug.
(e) Rolling hitch in a guy line.

Tautline hitch (Fig. 13). This may be used by a climber to adjust the length of his safety line while working or to control his descent from a tree. It is a combination of two round turns of one rope about another with the free end of the downhaul fastened to the taut uphaul side of the safety line. It will hold when the standing part from the knot is taut and slide when the knot is pulled by hand. The tautline hitch is not suitable for use either with very soft nylon rope (it tends to jam) or with hard, stiff rope (it may not hold).

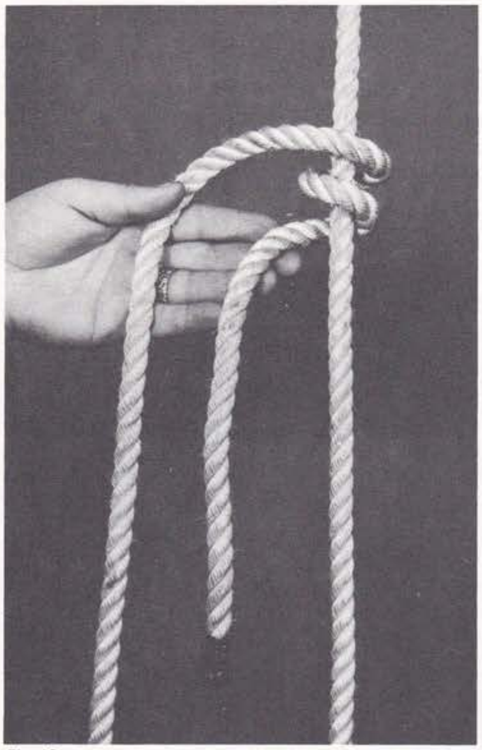


Fig. 13,a

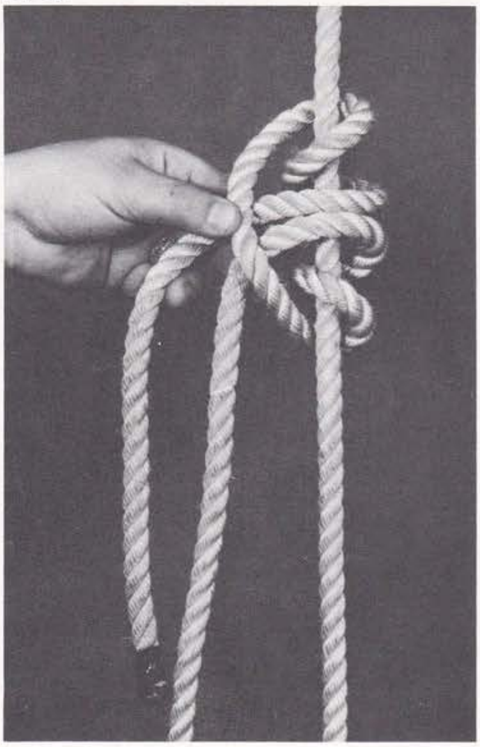


Fig. 13,b

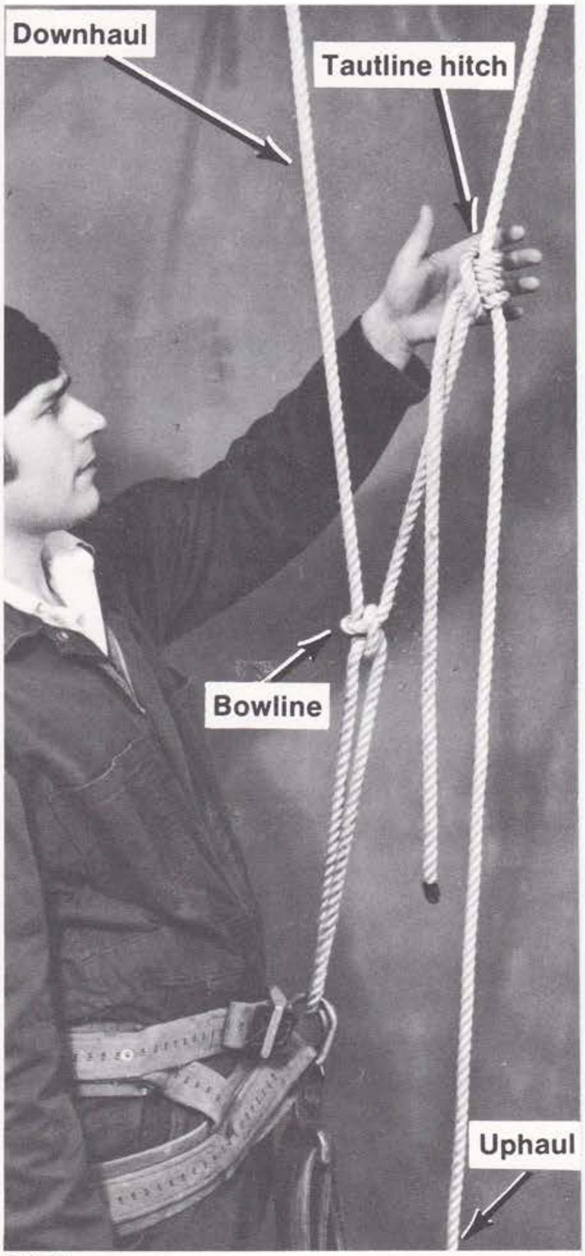


Fig. 13,c

Figure 13. Tautline hitch.
(a) First round turn.
(b) Second round turn.
(c) Set for descending.

Descent-control hitch, or Carabiner hitch (Fig. 14).

This hitch is made on a carabiner with the uphaul side of the safety line, i.e. the free end running to the ground from the crotch or carabiner supporting the line. With the hitch in place, the carabiner is clipped to a D-ring on the harness and the climber controls his descent by feeding the free end of the safety line through the carabiner. Slippage of the line through the carabiner is easily controlled by pulling up on the free end. A second turn about the shank of the carabiner increases friction if it is needed for greater control. The carabiner hitch is preferred to the tautline hitch for routine use with nylon rope. In a descent with either hitch, the rope should not be allowed to slip too rapidly, as friction at the hitch and crotch may burn and weaken the rope.

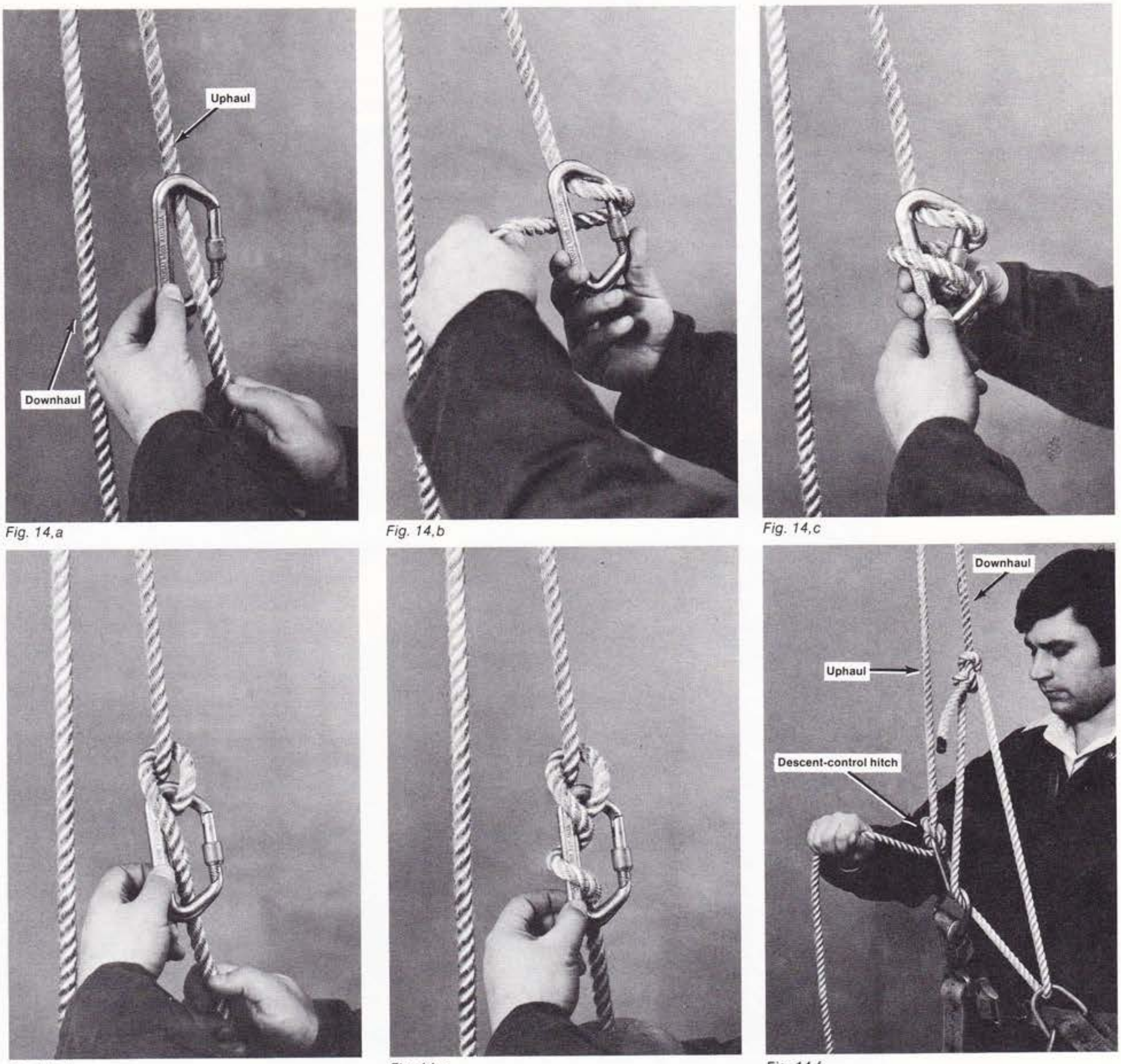


Figure 14. Descent-control hitch on a carabiner.
(a) Carabiner on the uphaul.
(b,c) Turn around the carabiner and through the gate.
(d) Completed hitch.
(e) Double turn for additional control (friction).
(f) Carabiner clipped to the D-ring preparatory to descent, which is controlled by releasing the lower end of the uphaul.

Figure eight (Fig. 15). This serves as a stop knot in the end of a rope to prevent it slipping through a fastening or carabiner. It may also be used to create a bight in a rope for raising or lowering equipment etc. It is formed by two opposed half hitches.

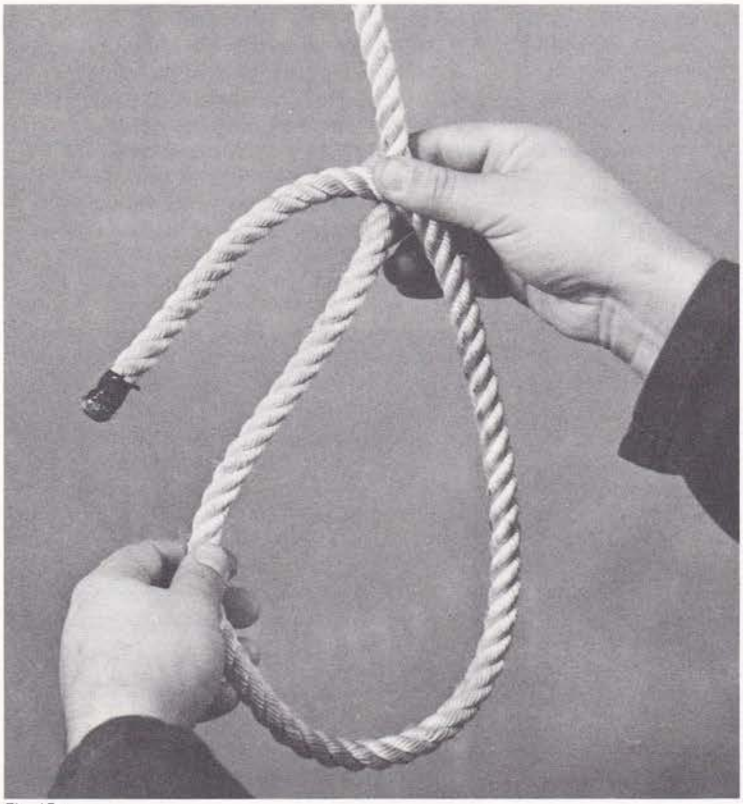


Fig. 15,a

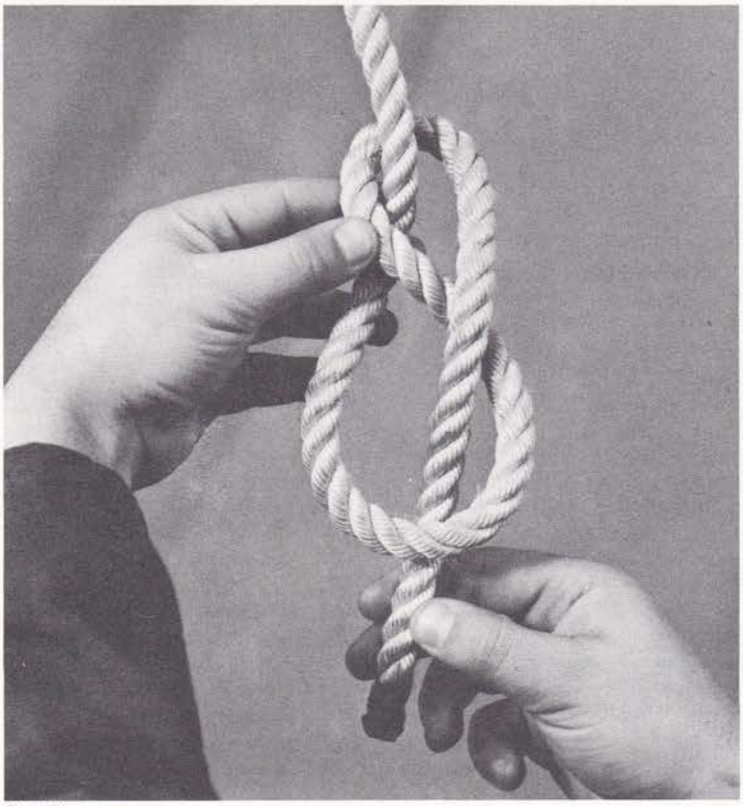


Fig. 15,b

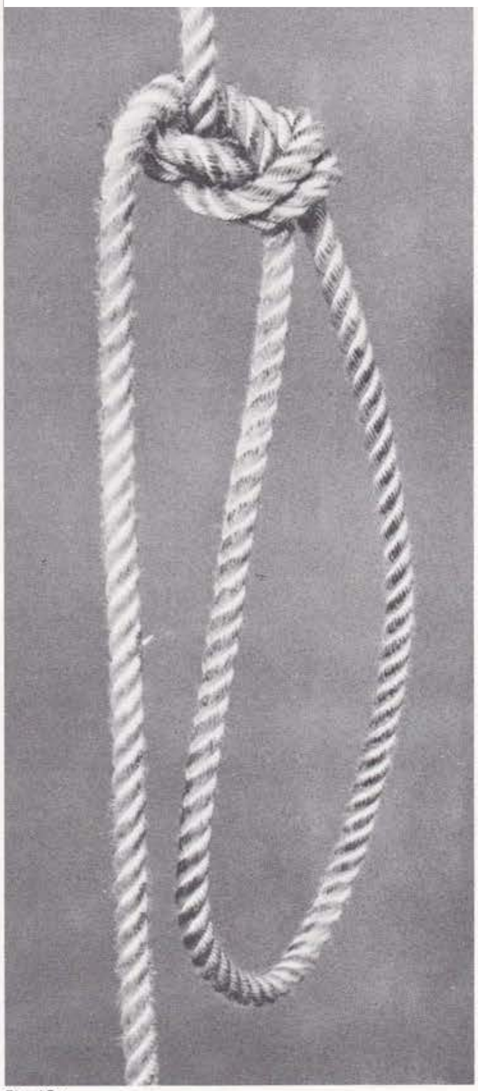


Fig. 15,c

Figure 15. Figure eight knot.
(a,b) Single knot for rope stop.
(c) Made with a bight.

Reef knot (Fig. 16). This knot is used for tying bundles and bags. It is made by combining two overhand knots, the second opposite in direction to the first. It is not suitable for rigging, as it has a tendency to jam or to shake loose, especially with nylon rope. Cone- and seed-bags can be closed with string by means of a round turn finished with a reef knot in a bow followed by an overhand knot to secure the bights.

Fig. 16,a

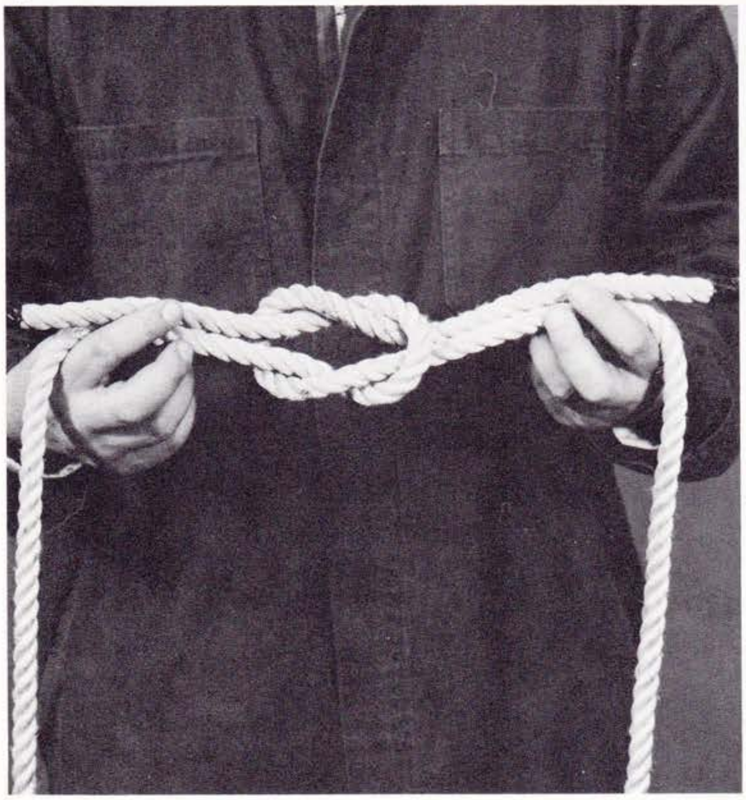


Fig. 16,b

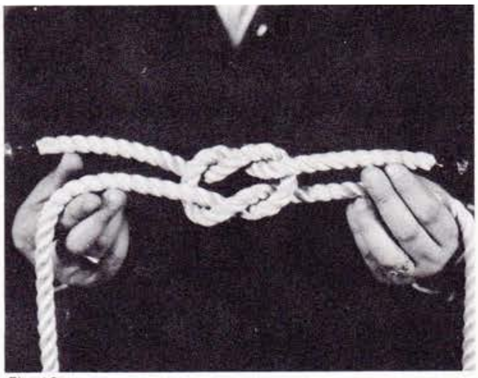


Fig. 16,c

Fig. 16,d

Figure 16. Reef knot.
(a) First overhand knot.
(b) Reef knot.
(c) Granny knot (likely to slip or jam).
(d) Cone bag fastened with a reef knot in a bow.

Round Lashing (Fig. 17). The round lashing is used to secure an accessory pole to a tree to provide additional strength and purchase for climbing. The lashing is applied with six-ply jute twine, a heavy cord of rough texture that may be considered expendable.

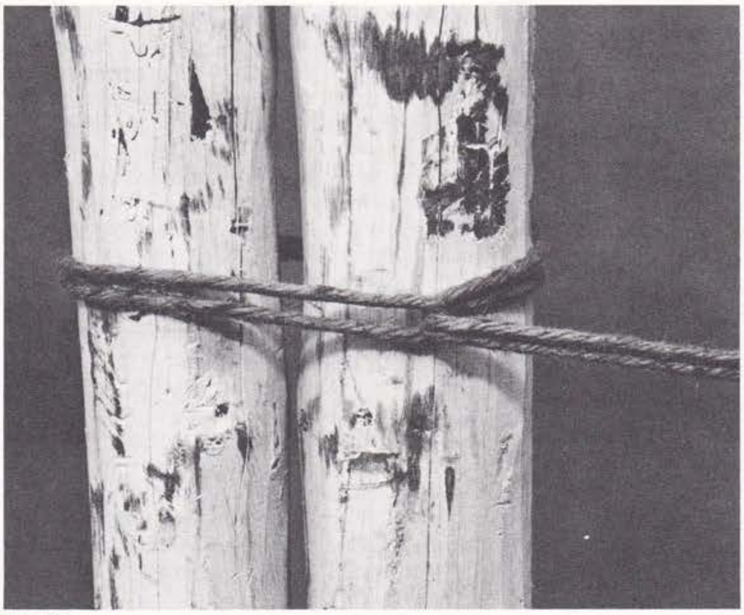


Fig. 17,a

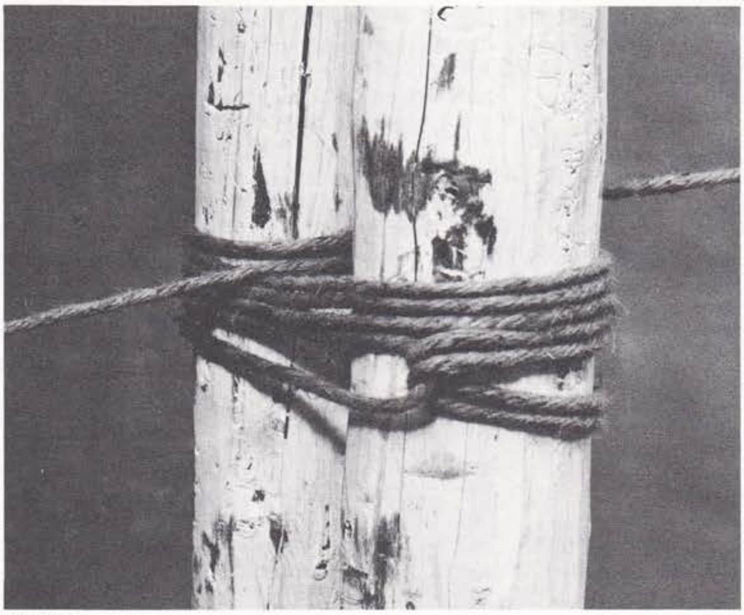


Fig. 17,b

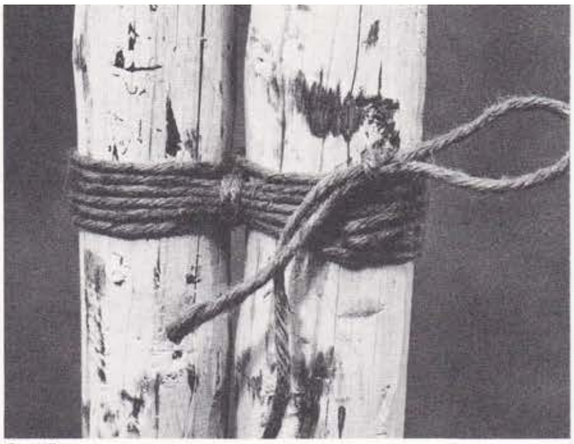


Fig. 17,c

Figure 17. Round lashing.

(a) Double the lashing cord through the bight to start. Leave space between the spars.

(b) Round turns wound firmly, ends brought between the spars in opposite directions.

(c) Lashing turns drawn tight with frapping turns between the spars, the free ends secured with a reef knot.

CLIMBING AIDS

Mature, forest-grown trees have a length of clear stem with dead, brittle branches to be surmounted before the lowermost sound branches of the live crown are reached. Light-weight portable equipment commonly used to climb the lower stem includes tree climbing spurs, sectional and extension ladders, and the tree bicycle.

A different problem is presented by sapling- to pole-stage trees that are too weak and limber to support climbers safely for seed collection. This is frequently the case in immature seed orchards and young stands managed for seed production. It is also important that damage to stems and branches be minimized if seed productron is to be sustained over many years. Free-standing step ladders and guyed extension ladders are useful in accessible stands. Accessory poles, with or without steps attached, may be lashed to seed trees to provide additional strength and purchase for climbing.

Tree climbing spurs (Fig. 19). Spurs are compact, portable, and effective in terms of time saved, ease of operation, and safety. Occasional use, for instance in climbing a tree once in a season for seed collection, does little damage to a healthy tree and is unlikely to result in infection by rot or damage by insects. Spurs are not suitable when repeated climbing is called for, as in controlled poflination, or if the stemwood is potentially of high value for veneer or clear lumber.

Before each use spurs should be inspected for: (1) fractures or hairline cracks on gaffs, shanks, or slides, (2) dull, nicked, bent, misshapen, or loose gaffs, (3) straps that are worn or cut or have pulled rivets, (4) broken, deformed, or otherwise damaged buckles, rings, or pins. Such damage must be corrected before the spurs can be used safely. The points of the gaffs need to be maintained with a sharp, single-cut file. Usually all that is required is to remove the burr. Filing should be done in such a way as to retain the original contour and angles of the surfaces of the gaff. The inner surface of the gaff is filed lengthwise from tip to base. It should not be cross-filed, as this creates marks that may weaken the gaff under load. Only the outer surface at the tip area should be filed to maintain slightly rounded lower edges leading to the point. A needle point should be avoided. Never file the ridge of the gaff, as this reduces the cross-sectional area and will cause the spur to "cut out" of the tree in climbing.

Climbing spurs are classified by the length of the gaff measured from the point along the lower surface to the shank. Tree spurs are equipped with 3½ in. (9 cm) gaffs to hold in soft, thick bark, and pole spurs commonly have 2 in. (5 cm) gaffs. The long-gaff spurs should not be used for working on accessory poles or thin-barked trees, as the boot is held too distant from the stem and has a tendency to rotate excessively about the point of the gaff, causing it to gouge or slip. The 2 in. gaff is recommended for general climbing of eastern Canadian and boreal forest tree species. Spurs should be discarded or the gaffs replaced when worn to 1½ in. (4 cm).

Climbing spurs should be secured in pairs by the straps when not in use. The gaffs must be covered with guards or short lengths of thick-walled rubber tubing to prevent damage to the points and to avoid injury in handling. They must be transported and stored separately to avoid any possibility of abrasion or cuts to safety belts and ropes from the metal edges and points of the climbers. The leather straps and pads require regular cleaning with saddle soap followed by an application of dubbin to keep them soft and pliable. Surface grime can be removed with mild soap and water.

Ladders (Figs. 20, 21 , and 22). The types of ladder used for controlled pollination and seed collection at Petawawa F.E.S. include stepladders 6 to 10 ft (2 to 3 m), tripod ladders 12, 16, and 20 ft (4, 5, and 6 m), extension ladders to 40 ft (12 m), and sectional tree ladders to 60 ft (18 m). All are constructed of light metal alloys. They are durable and almost maintenance-free but must not be handled roughly. Metal ladders must never be used close to power-transmission lines.

Ladders should be inspected regularly for signs of wear. Ropes and pulleys on extension ladders should be kept in proper working condition. Side rails, ground shoes, rungs, and hinge bolts must be checked, and any damaged ladder should be clearly identified and removed from service until repaired. Ladders should not be dropped when being removed from vehicles or trees, as this may cause fatigue in the side rails with subsequent failure when they are in service. When ladders are stored in a horizontal position, they should be well supported to avoid sagging. Ladders are best secured for transport with coil springs or heavy rubber straps attached to rope tie-downs, which are there-by kept in tension and prevent rattling and abrasion of the load.

Poles (Figs. 23 and 24). Wood poles, stepped and nonstepped, have been used at Petawawa F.E.S. for climbing tall saplings for controlled pollination and for seed collection in spruce, fir, and larch. The poles are natural dry black spruce or tamarack trees as commonly found in flooded swamps. Sound trees with minimum taper and no stem defects are selected, felled, limbed, and cut to 2 in. (5 cm) top diameter inside bark. The tower cut is made to length as required. The bark is stripped from poles intended for reuse. Debarked poles are stored under cover when not in service. The stepped pole is equipped with aluminum steps, 6 in. (15 cm) in length, bolted to the pole at 18-in. (45-cm) intervals. The steps face the large end of the pole to give the greater strength at the top when the pole is in place. Poles can be used from the ground in climbing trees up to 20 ft (6 m) (Fig. 23), depending on the length of the pole. They may also be used effectively to give additional rigidity and purchase to reach and work in the upper crowns of taller trees (Fig. 24). They are used when the tree stem is too small or the limbs are too brittle or limber to support the weight of a climber within reach of the cone-bearing crown.

Tree bicycle (Fig. 25). The tree bicycle is designed for climbing trees without damaging the bark or wood. It is suitable for use on clear stems with diameters ranging trom 12 to 32 in. (30 to 80 cm) and may be preferred to long ladders because it is easier to transport and can readily be carried by one man from tree to tree. Little maintenance is required beyond cleaning and occasional lubrication of pinions and springs. Care must be taken not to bend the steel bands because kinks prevent free adjustment for tree diameter. Regular checks should be made of the leather straps, foot-release catches, the screws securing the rubber bearing pads to the cast aluminum frame, and the band-locking screws.

ACCESSORIES TO CLIMBING AND SEED COLLECTION

Clothing. Strong coveralls (Fig. 18,a) are comfortable, permit unrestricted movement, protect body and limbs from scratches and abrasion by twigs and branches, and prevent debris working its way between skin and clothing. A well-fitting shirt or jacket and trousers are also satisfactory for climbing (Fig. 18,b). Loose clothing, unfastened jackets, and short-sleeved shirts are hazardous and should not be worn. Sturdy leather gloves offer protection for the hands and normal work boots without hobnails or steel plates provide suitable footwear.

It is advisable to have climbing helmets and safety glasses (Figs. 18,a, and 21,b) available in case of need, but their use is not mandatory for safe tree climbing. A helmet protects the head from scratches and abrasion, particularly in climbing in a densely branched crown of mature white spruce. Safety glasses provide protection from resin, pieces of bark, needles, etc. and prevent injury from twigs and branches poking the eyes.

It is mandatory that hard hats be worn at all times by personnel when working on the ground (Fig. 18,b).

Carabiners and ties (Figs. 10 and 11). Carabiners equipped with 10 ft (3 m) nylon rope strops or slings are used to secure the safety line and to support equipment and haul lines. A carabiner may also be used to assist in descending by rope (Fig. 14). Carabiners need to be kept clean, and hinges and locking screws should be oiled occasionally to ensure their free operation.

Six-ply jute twine serves well for lashing supplementary poles to trees and as temporary ties to secure ladders for transport. Strong rubber-strap hooks and nylon rope provide secure, adjustable, and quick-release tie-downs for fastening ladders, poles, etc. to vehicle-carrying racks.

Tools and containers. The particular circumstances of climbing operations dictate the variety and type of equipment best suited to the job. Lengths of heavy, flexible wire (soft iron or copper) are useful to hold in long branches for easier picking of cones or seed. Cone hooks may be devised for dislodging large cones such as those of white pine. A pruning saw, secateurs, and a pole pruner find particular application in removing unwanted branches, cutting seed-laden branch ends, and collecting scions (twigs) with minimum damage to the tree crown.

Woven bags are needed for transporting cones and seed safely. Collection bags for use in the trees are best designed for the type of material being picked, but they should leave the hands free to pick and the opening must be readily accessible. Cones and seed are living material and must be well ventilated during transport and storage to prevent fermentation and heating. Nylon-mesh laundry bags are strong and airy and have proven ideal for gathering cones and drying them in the same bag (R.R. Silen, pers. comm.). Strong, water-resistant string or plastic-coated tie wire is needed for closing the shipping bags.

Scions must be kept fresh and cool and away from direct sun or drying winds. Insulated cooler chests are readily available and are suitable for use in the field at the time of collection and for transportation of the scions. In winter, branch sections of both conifers and hardwoods may be placed in plastic bags, sealed, packed in snow, and kept frozen for transport and storage. Before grafting or setting for rooting, they must be removed from the snow pack and thawed slowly in a cold room at 0-4°C.

An axe and a bucksaw are often needed to clear brush that may interfere with tree climbing. In some cases, e.g. working with plus trees, a small power saw is useful for cutting trees to release the crowns or to clear a path for access or photography. A sharp knife will have many uses and should always be available. A flat file is required for touching up climbing spurs and maintaining the edges of cutting tools. Hand cleaner or waterless soap and paper towels are needed to combat the grime, resin, and stain commonly associated with tree climbing and seed collection.

Labels and records. All material should be identified at the time of collection according to an established procedure. This will normally require forms for recording place, time, conditions of collection, etc., and wetproof labels for placing inside and tying outside shipping bags. Waterproof grease pencils or ink markers are needed to complete the labels.

CLIMBING THE CROWN

Climbing in the branches of the crown is similar for all conifers and most hardwoods and will be discussed first, as it is independent of the means used to reach the lowest branches, whether directly from the ground or by ladder, spurs, etc.

A climbing belt, safety strap, and safety line are essential for safe climbing and working in tree tops. The safety line is tied with a bowline knot through the D-rings on the climbing belt (Figs. 1, 8, and 18,a). The climber ascends the tree by climbing in a slow spiral or in a zig-zag fashion to ensure that the safety line will catch in a crotch of a branch should he slip or fall. The distance between catch points should not exceed 5 ft (1.5 m), but the turns must not cause excessive friction and impede the ascent of the climber. In climbing on the branches of a tree, as on the rungs of a ladder, handholds are used mainly for guidance and balance and the feet and legs are used for thrust. Only one limb, a hand or a foot - is moved at a time, gripping

Fig. 18,a

Fig. 18,b

Figure 18. Climbing team.
(a) The climber, dressed for climbing and equipped with helmet and climbing belt with safety line attached.
(b) Anchor man, set to control the safety line leading to the climber.

or standing on branches where they are strongest, close to the main stem. Doubtful branches should be tested by being pulled sharply before being trusted to carry the weight of the climber.

The climber is primarily responsible for his own safety at all times. He must direct his own progress up the tree and communicate clearly and frequently with the anchor man on the ground to keep him informed of the situation. An experienced worker may safely climb alone, independent of a ground man and tending his own safety line (W. Jenkins, Ontario Hydro, pers. comm.).

The anchor man must stand well clear of the fall line from the tree being climbed to avoid possible injury from falling branches that may be broken off as the climber ascends. The anchor man must be ready at any time to support the weight of the climber on the rope as he feeds the safety line under one arm, around his back, and over the other shoulder, releasing the rope alternately with one hand while gripping it with the other (Fig. 18,b). A half turn of the rope should be made around the lower trunk of a neighboring tree to provide additional friction and greater security should the climber slip or fall. However, the friction should be minimal during the ascent to ensure that the climber is not held back by the safety line. It is important that the unused part of the safety line remain coiled on the ground and free of obstruction so that tangles are avoided as the rope is paid out. The safety rope is of particular advantage when it is necessary to take rapid evasive action from wasps or bees that are sometimes encountered in tree climbing.

When the climber reaches the working level in the crown, the safety strap is passed around the stem above a major branch or whorl and clipped to the belt (cover photo). The strap may be shortened by being wrapped once or twice around the stem and thereby keep the climber in an upright position with his center of gravity near the stem and most of his weight on his feet. A carabiner may be tied to the stem (clove hitch or sling), especially if the branches are small and flexible. The safety line is snapped into the carabiner for added security in working and may be used to support the climber's weight when he is working lower in the crown. One must remember always to lock the carabiner by tightening the safety screw once the rope is secured. It is unsafe to fasten a carabiner or safety strap to a stem less than 3 in. (8 cm) in diameter. If there is any doubt, a first carabiner should be fastened below before the climb to the working level. When the climber is set, he may ask the anchor man to hitch the safety rope to a neighboring tree, leaving enough slack to permit free movement while he is working. The anchor man is then free to attend other climbers, catch up with bagging and labelling cones, recording, picking up cut branches, etc.

On spruce, the cones are concentrated near the top of the tree and the climber does not usually have to move about very much, either vertically or laterally. In white and red pine and most hardwoods, however, the cones and seed are borne on ends of branches over a greater width and depth of crown and considerable freedom of movement is necessary. A safety-rope-locking method can be used to give greater flexibility than is possible when the climber is attached to the tree by the safety strap. With this technique, the anchor man does not fasten the safety line at the ground and the climber attends to it himself to enable him to move safely and independently up and down the crown. A control hitch is applied before releasing the safety strap, use being made of a second carabiner clipped to a D-ring on the belt (Fig. 14,f). Alternatively, the climber may tie a long free end from the bowline with a tautline hitch (Fig. 13,c) to the opposing (uphaul) side of the safety line (Eversole 1954).

His hands now free, the climber is able to get on with the job of seed collection. Techniques for picking cones or seed vary with species, depending on their accessibility, abundance, size, manner and firmness of attachment, and aerial distribution. Direct collection into an open-mouthed bag hooked to the climber's belt is preferred, although in some cases it is more practical to dislodge large cones, fruit, nuts, etc. to be picked up from the ground. Equipment such as a pole pruner or a cone hook should be raised to the climber on a separate line passed through a second carabiner attached to the tree. Extreme caution must be exercised to ensure that such cutting tools do not slip and fall. Ground personnelshould keep well clear when the tools are in use. It is sound practice to tie a lanyard from the tool to the tree while work is in progress.

Since the objective of climbing for seed collection is to save the trees to produce subsequent crops, climbers should avoid damaging the live crowns as much as possible. Any appreciable loss of green branches and foliage will reduce the productive capacity of the tree. Branches should not carelessly be broken and reasonable care should be exercised in picking to leave the fine branches intact. Excessive twisting or stamping of boots on the upper branches is liable to strip the thin bark from them. Some injury is unavoidable, but minor bruises heal without killing the branches.

When picking is completed, the closed bags of cones or seed may be dropped to the ground after making sure all is clear below. Large items of equipment should be lowered by rope. The carabiner is untied from the tree stem and clipped to the D-ring preparatory to descending. The anchor man is called to release the safety line and stand by to take in slack. It is often helpful before descending to select by observation a neighboring tree with a good crop for the next climb. At the request of the climber, the anchor man takes in the slack of the safety line and prepares to pay out the line as the climber descends (Fig. 18,b). The safety strap is released and the climber descends with care, following the same route down as the one he ascended by so as not to foul his safety line on the small branches of the upper crown. When his feet reach branches that will support all his weight on the safety line and are large enough in diameter to withstand rope abrasion, he moves laterally to catch the safety line on the crotch of a branch. The climber continues down so that the trailing safety line passes up and around the stem, over a stout branch, and on around and down to the climber. Alternatively, in trees with dense crowns, it is often easier to stop, belt to the tree, untie the safety line, pass it up on one side of the trunk over a branch on the opposite side and down the other side, and retie it to the body belt. With the safety line securely caught on a branch (crotched), the climber may be let down by the anchor man paying out the rope, or the climber may control his own descent (rappel) by using the carabiner or tautline hitch. It is critical that the descent by rope should begin at a height less than half the full length of the rope! Safety lines should always have a figure eight knot tied in the end of the uphaul to avoid running out. Descending by rope (Fig. 22,b)is rapid and less fatiguing than climbing down the branches of a tall tree.

Confidence and muscular coordination are keys to safe climbing. A sustained state of tension and reliance on strength alone can be both exhausting and hazardous. Most of the work should be borne by the legs, the arms and hands being used mainly for balance and guidance.

TREE CLIMBING SPURS

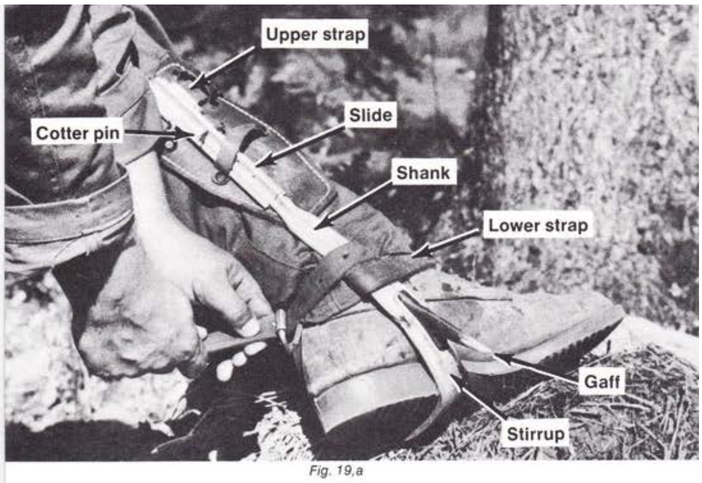


Fig. 19,a

Tree climbing spurs are used to reach secure limbs high above the ground quickly and with a minimum of preparation time.

The spurs are firmly strapped to the climber's feet and legs (Fig. 19,a). The top of the shank should fit comfortably to the calf just below the knee. The climber ascends the tree using a safety belt, with the safety strap passed around the stem and hooked to the belt (Fig. 19,b). A safety line is tied to the belt and two or more carabiners are clipped onto one of the belt rings. When climbing the stem, the climber must ensure that the spikes are well into the wood of the tree by keeping the knees out from the stem when setting the spur. The lower leg and ankle must be kept at a fair angle to the stem to prevent slipping and gouging the bark. The weight is kept on the feet spaced 6-8 in. (15-20 cm) apart and the center of gravity away from the stem. The hands and arms are used to balance by holding the safety strap firmly in both hands, rhythmically pulling the body towards the tree, moving the strap as the weight on it is lifted, and tightening it in the new position as the body moves back. The pull on the safety strap is on the arms in ascending and it should not be transferred to the body belt except when the climber is in a resting position. When the safety strap is tight, each foot is moved in turn and the weight transferred to the other foot.

In accordance with the length of the stem and the experience of the climber, carabiners may be tied to the tree as needed and the safety line passed through them. The climber should not climb higher than one-third the distance between the first carabiner and the ground before securing a second carabiner to the tree. However, so long as the safety strap is fastened around the tree trunk, the climber is in no danger of falling freely. The safety strap is never unclipped except to bypass branches too heavy to break off. A second safety strap or carabiner with safety line should be fastened above the obstructive branch before the first strap is unclipped.

Figure 19. Tree climbing spurs.
(a) Strapping on.
(b) Climbing.


Fig. 19,b

When sound branches are reached, preferably at the bottom of the live crown, the safety line is secured in a carabiner fastened above the first branch, the safety strap is unclipped, and the climber works his way into the live branches. Once the climber is supported on strong limbs, the safety strap is secured around the stem and the spurs are removed to avoid injury to the climber and the tree while the crown is being climbed. Ground crews must be warned to keep well clear in case a spur should fall when unfastened. The spurs are lowered to the ground on a rope to avoid damage to the gaffs. With the anchor man in control of the safety line, the climber unclips the safety strap and ascends as already described. The climber descends on the rope with the aid of the anchor man or by rappelling as mentioned earlier. During descent, the climber must pause to remove carabiners tied to the tree.

Climbing spurs should be worn only when needed and must not be worn in working on the ground, walking, or riding in motor vehicles.

LADDERS

Ladders provide simple, safe, and effective means for operating at low-to-moderate heights and for reaching the live crowns of tall trees. Little training is needed for their use and safe operation. The use of ladders prevents damage to the crowns of young trees and requires minimum pruning on tall trees. No special provisions for vehicular access are called for as in the case of truck-mounted ladders or lifts. The most suitable ladder for a particular job can be chosen from the wide variety of designs and sizes readily available. Light-metal construction, of either aluminum or magnesium alloy, provides strength, corrosion resistance, and portability. Metal ladders must never be used in the vicinity of electric power lines.

The main objection to ladders in general is that they are awkward to handle in brush and can be tiring to carry if seed trees are far from a road.

Free-standing step and tripod ladders are suitable for collecting seed in young plantations or natural stands where trees are widely spaced for seed production. Two men are needed to handle the 20 ft (6 m) ladder safely. For work from the top 6 ft (2 m) or so it must be guyed with ropes to each side for stability (Fig. 20). The use of guy ropes is also advisable on the 16 ft (5 m) ladder.

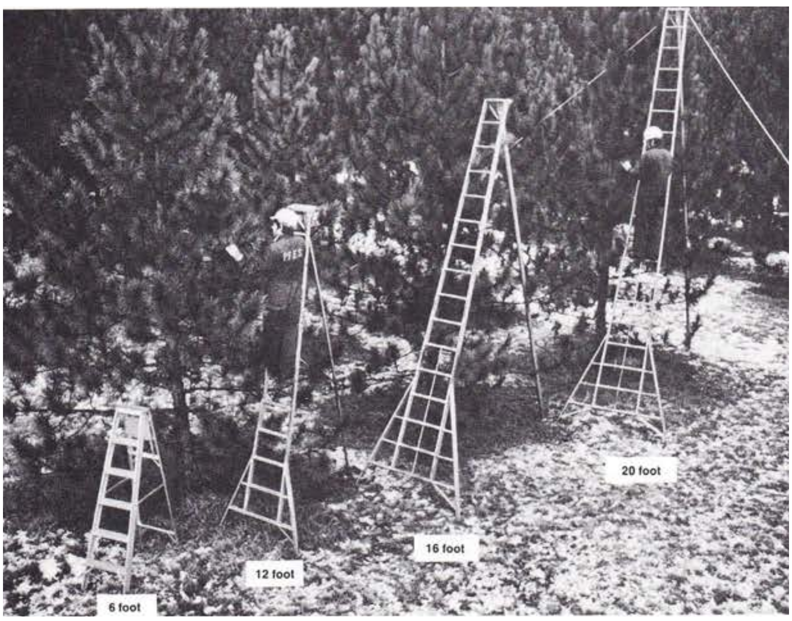


Figure 20. Step and tripod ladders. Twenty foot (6 m) ladder guyed for added security.


Fig. 21,a

An extension ladder may also be used for direct access to the tree crown as shown in Fig.21,b and c (Calvert 1974). With a three-man crew, two men control guy ropes tied to the rails at the top of the upper section as a third man raises the ladder. The guy ropes are tied securely after they have been adjusted to position the ladder alongside the seed-bearing crown. A third guy rope running forward from the middle of the ladder, round the tree and back to the foot of the ladder, provides added security against the ladder falling backwards or the foot slipping away from the tree. It is important to avoid sharp angles and bends in fastening the guy ropes. When a rope is under strain over a sharp corner the inner strands are crushed while the outer strands are stretched and could be broken. If a vehicle is used to anchor a guy rope, the ignition key should be removed, the brakes set, and the cab locked to prevent accidental movement.


Fig. 21,b

Figure 21. Guyed extension ladder.
(a) Vertical setup to reach the bottom of the live crown.
(b,c) Supported by guy ropes to reach the treetop.

Extension ladders with parallel sides and in two or more sections are made in a wide range of sizes. They are readily adjustable for variations in tree height and length of stem below live crown. According to circumstances, the ladder may be leaned against the tree to reach the live crown, or it may be set upright against the stem and secured with guy ropes as shown in Fig. 21,a. Extension ladders to 30 ft (10 m) are easily handled by one man; larger ladders require two men for safe carrying and erection.


Fig. 21,c

The sectional tree ladder (Fig.22) is a safe and convenient means of reaching the live crowns of trees with short or long distance below sound branches. It is especially worthwhile if a tree is to be climbed repeatedly in a season, as in controlled pollination. The ladder is light and easy to erect and does not damage the tree. Sections 6 8, or 10 ft (1.8, 2.4, or 3 m) long are available, depending on make and model. The side of the tree that has the lightest branches and is clear of heavy obstruction is chosen for climbing. The first section is set up parallel to the tree stem with the bracket at the top against the trunk. The climber ascends with his safety strap around both the tree and the ladder until his shoulders are even with the top of the ladder (Fig.22,a). A fastening device (rope or chain incorporating a spring to maintain tension [Miles and Hoekstra 1954]) attached to one side of the ladder is wrapped around the stem and fastened to a hook on the other side of the ladder. If the stem is clear of heavy branches, two sections may be set up initially from the ground. Subsequent sections are pulled up by an equipment rope and fitted into the section below. Each section is climbed and fastened to the tree in turn. Obstructive branches must be broken off or pruned to permit the ladder to fit closely to the tree. Once at the live crown, a carabiner is tied to the stem, the safety line is clipped into it, and the climber proceeds into the crown after releasing his safety strap.

The ladder is dismantled by reversing the procedure, except that it is convenient for the climber to be suspended on his safety line as he descends (Fig. 22,b).The ladders should not be dropped or subjected to lateral stress, e.g. by lowering more than two sections together, to avoid the risk of warping the rails or twisting the fittings of one ladder into another.

Fig. 22,a

Fig. 22,b

Figure 22. Sectional tree ladder.
(a) Preparing to pass the chain around the tree to secure the top of the first section.
(b) Dismantling the ladder. Climber suspended on a safety line

POLES

The stepped pole is climbed in the same manner as a sectional ladder. Pole lengths may range from 12 to 25 ft (4 to 8 m) but may be of any length to suit the purpose. For shorter trees, the pole is placed against the tree, the small end resting on the ground. It is pushed into the branches close to the stem of the tree and a round lashing is fastened securely at breast height to keep it in place (Fig. 23,a). The pole is then climbed and two more lashings are fastened -- half way up and again about 3 to 5 ft (1 to 1.5 m) from the top. The climber fastens his safety strap around the stem and the pole and, once it is secured, cone collection or pollination can proceed (Fig. 23,b).

The same method can be used with a pole without the alloy steps, but such a pole is climbed with spurs. The advantage is that the pole may be cut on site, limbed, and used in the same manner as just described.

Fig. 23,a

Fig. 23,b

For taller trees the pole method can be used to reach the peak of the crown of slender trees, e.g. black spruce, balsam fir, and immature white spruce (Fig.24). The tree is climbed to a safe point where the branches provide adequate support but below the seed-bearing crown. The climber straps himself onto the tree and a second rope, the equipment line, is passed through a carabiner attached to the stem. The ends of this rope are dropped to the ground. One end is attached to the pole with clove hitches, first to the larger butt end, then to the smaller end, with the rope taut between the hitches. The pole is pulled into the crown by the ground crew (Fig.24,a) until the large end of the pole reaches the carabiner (Fig.24,b). The climber straddles the pole and slips the clove hitch off the top of the pole, and the pole, guided by the climber, is pulled the remaining distance to the top of the tree by the haul line tied to the bottom (small end) of the pole. The pole is secured to the tree by a round lashing, the first of three or four (Fig.24,c). A lower lashing is then fastened at the base of the pole and the haul line is removed. The pole is climbed with spurs, one or two more lashings being tied as needed (Fig. 24,d). The pole is removed by untieing or cutting the lashings as the climber descends, leaving the next-to-bottom lashing until last. After ensuring all is clear below, the final lashing is released and the pole is allowed to slide between the climber's legs and drop to the ground.

This technique was developed for the erection of full-crown isolation tents, e.g. in white spruce (Yeatman and Venkatesh 1974), and has been used to climb slender trees for cone collection and for controlled pollinations in spruce and fir. It is similar to a method of bracing described for controlled pollination in southern pines (Dorman et al. 1944).

Figure 23. Stepped pole resting on the ground.
(a) Lashing a pole to a tree.
(b) Pole in use.

Fig. 24,a

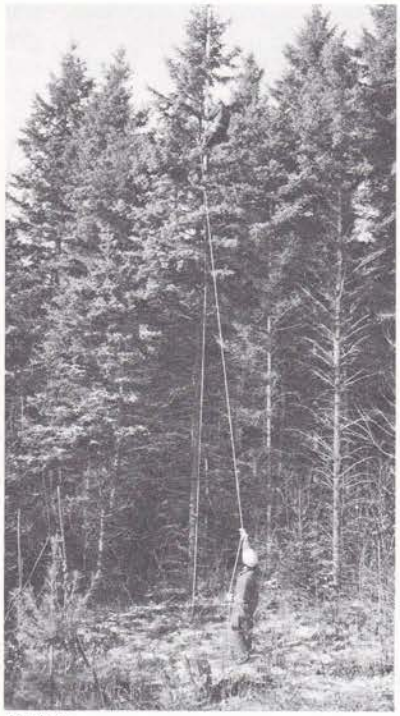


Fig. 24,b

Fig. 24,c

Fig. 24,d

Figure 24. Climbing a pole lashed to the top of a tree.

(a) Raising the pole to the climber.
(b) Pole is hauled to the top of the tree, guided by the climber.
(c) Tieing the first lashing to the lower end of the pole.
(d) Tieing a high lashing, the climber supported on the pole by spurs.
(e) Working at the top.

Fig. 24,e

TREE BICYCLE

The tree bicycle is used by two men working together, one a climber and one an anchor man. The climber wears a harness belt with safety line, two safety straps, and two carabiners attached.

The steel bands of the bicycle must not fit too tightly around the stem. They will grip properly as long as the climber's feet do not touch the tree trunk when his full weight is on the stirrup. The climber fits his feet into the stirrups of the bicycle, checking that the toe straps fit his boots, and closes the quick-release clips attached to the ankle straps (Fig. 25,a). The safety strap from the climbing belt is passed around the stem of the tree (Fig. 25,b).

Fig. 25,a


Fig. 25,b

The climber ascends, putting his weight alternately on one and the other stirrup and lifting in turn the free foot to raise the loosened band. He pauses to adjust the bands, one at a time, to allow for the taper of the tree (Fig. 25,c). This adjustment must be made before the toe of the boot touches the stem. Branches are pruned flush with the stem as necessary. On reaching sound limbs, the spare safety strap is passed above the first limb and secured before the first strap, below the limb, is released.

Once the steel bands of the bicycle reach the first limb, the climber attaches a carabiner to the stem as high as he can reach and passes his safety line through it. The anchor man now holds the safety line, leaving enough slack in the safety line to enable the climber to bend down to release the bicycle. The lower band is tightened and the ankle clips opened on both stirrups. The climber frees his feet from the foot straps, unhooks his safety strap, and climbs into the crown. The tightened lower band stops both parts of the bicycle from slipping freely down the stem.

With the procedure reversed, the bicycle may be used to climb down the stem or the climber may descend the tree more rapidly by his safety line. In the latter case he must pause to release the carabiner and open the bands of the bicycle before guiding the bicycle down the stem as he is lowered by the anchor man.

Figure 25. Tree bicycle.
(a) Stepping in.
(b) Climbing.
(c) Adjusting the band to the tree


Fig. 25,c

Safety Tips

The equipment described here for climbing, when properly maintained, ensures efficiency and safety for working within the crowns of standing trees. Climbers must be thoroughly familiar with the equipment and procedures for its use and take full advantage of the maximum safety provided.

The following safety hints should be known and practiced by all members of the climbing crews:

(1) Tree climbers must be physically fit.
(2) All equipment should be carefully stowed for transportation, with suitable racks and ties for ladders, poles, and pruners and compartmented boxes for spurs, ropes, belts, and miscellaneous equipment.
(3) Clothing should be strong, well fitting, and suited to the weather expected.
(4) All equipment should be checked before it is used and, if there is doubt about its condition, it must not be used until repaired or replaced.
(5) Climbing should not be attempted if weather conditions are unsafe. Climbing should be suspended in a strong wind, especially if it is very gusty, and in poor light, as at dusk. Extra caution is needed in wet weather, when thunderstorms threaten, and in winter temperatures below freezing.
(6) Do not climb trees with obvious signs of stem rot, severe cankers or galls, split stems, double leaders, or other abnormalities indicative of mechanical weakness.
(7) Communication between the anchor man and the climber should continue from the time the climber begins his ascent until he again reaches the ground. Simple standard words and phrases need to be established to avoid any possibility of misunderstanding. The anchor man must know the status of the climber at all times.
(8) The safety rope should be coiled on the ground before the climber ascends to avoid tangling or snagging the rope in the underbrush.
(9) The anchor man should hold the safety line under one arm and over the other shoulder. It is wise to make a half turn around a neighboring tree. This gives control and prevents the safety line from being pulled from his hands. Pull in and pay out the safety rope by alternate hand grips. A sliding rope is difficult to control and can cause painful friction burns.
(10) Know the knots and when to use them, and be sure to tie them securely. The safety line must be tied to the climbing belt properly (bowline knot) and carabiners should be locked when in use.
(11) Never climb with anything tied or looped around the neck.
(12) Safety helmets and goggles should be worn to prevent injury to the head and eyes in climbing rough, densely branched trees.
(13) Stand and grip branches close to the point of attachment to the main stem.
(14) Different species of trees have different branching characteristics. Spruce limbs generally are safe, but larch and pine and fir branches are more brittle and should be tested before weight is put on them. Similarly, dead limbs should be treated with due caution. The climber should have three points of support at all times (one hand and two feet or two hands and one foot), moving one limb at a time, except when attached to the tree by a safety strap or when suspended on a safety line.
(15) Do not carry tools while climbing the crown. If there is need for a pole pruner or cone rake etc., use a light haul line to hoist the equipment to the working level. Leave the haul line attached to large tools as a lanyard while working. Return tools to the ground on the line; do not drop them or throw them down.
(16) Beware of sharp branch stubs: they can snag clothing and may cause painful cuts and bruises.
(17) Climb spirally or in a zigzag manner, or fasten carabiners to the stem so that you cannot fall more than 5 ft (1.5 m) before your weight comes onto the safety rope.

(18) The diameter of the main stem should not be less than 3 in. (8 cm) at waist level during climbing. If in doubt concerning security, do not hesitate to tie a carabiner to the stem at a safe level before climbing within reach of the seed-bearing crown.

(19) In attaching the safety strap, a firm grip should be kept by one arm around the stem until the strap is clipped to the ring of the belt. At smaller diameters the strap may have to be wrapped around the stem two or three times. Be sure the strap is not twisted.

(20) Before letting go of the tree with your hands, test your weight against the safety strap and foot holds.

(21) The safety strap should always be attached around the tree stem except while you are climbing or changing position or are suspended on the safety line.

(22) Before dropping bags of cones or other material, be sure that the personnel on the ground are notified and are well clear.

(23) Have a well-stocked first aid kit handy at the climbing site at all times.

(24) Avoid climbing trees in the vicinity of electrical utilities if at all possible. Special care must be exercised should it be necessary to work in close proximity to electrical conductors. Never use metal ladders near power lines and do not throw ropes or safety lines onto overhead wires. Only persons who are familiar with the dangers and the established standards of operation, set down, for example, by the Ontario Hydro Corporation, should be allowed to work near power lines.

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We wish particularly to acknowledge the contribution made by Ernest Gilchrist to the development and demonstration of methods of safe climbing at Petawawa. Through his enthusiasm and ability he has set an example that many have followed. We also wish to thank reviewers of the manuscript whose constructive criticism and positive suggestions have been most valuable.

The authors will welcome suggestions for further improvement of presentation, content, and safety aspects of tree climbing in forestry operations.

C.W. Yeatman
T.C. Nieman

Equipment Suppliers *

Climbing equipment and accessories used by the Petawawa Forest Experiment Station have been purchased from the companies listed below. No special endorsement of these manufacturers and suppliers is intended or implied.

Each supplier is coded by a number, which is used in the following list of items of equipment to indicate sources of supply. The list is doubtless incomplete, and many readers will find other suppliers of suitable equipment in their geographic area.

Supplier	**Address**	**Supplier Code**
Ben Meadows Company	http://www.benmeadows.com/	1
Canadian Forestry Equipment	http://www.canadian-forests.com/	2
Cordage Ltd.	http://www.cordages.com/	3
Forestry Suppliers, Inc.	http://www.forestry-suppliers.com/	4
Magline of Canada Ltd.	http://www.lkgoodwin.com/more_info/carts_all_types/hand_trucks/hand_trucks.shtml	5
Mine Safety Appliances*	https://mining.cat.com/	6
Recreational Equipment, Inc.	http://www.rei.com/	7
Safety Equipment Co Ltd. *	https://mining.cat.com/	8

*Distribution centers across Canada.

Climbing Equipment	**Supplier Code**
Forestry worker's belt and pole strap	1,2,4,6,8
Climbing spurs	1,2,4,6
Ladders: sectional	1,2,4
step and extension	8
tripod (made to local specifications)	5
Tree bicycle	1,4
Rope	1,3, 4,7,9
Carabiners	7,9
Helmets	7,9
Goggles	1,4,6,8
Pole pruner and pruning saws	1,2,4

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* Addresses updated as of January 2015