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Designing Double-Tree Intermediate Supports for Multispan Skyline Logging

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OREGON STATE UNIVERSITY EXTENSION SERVICE

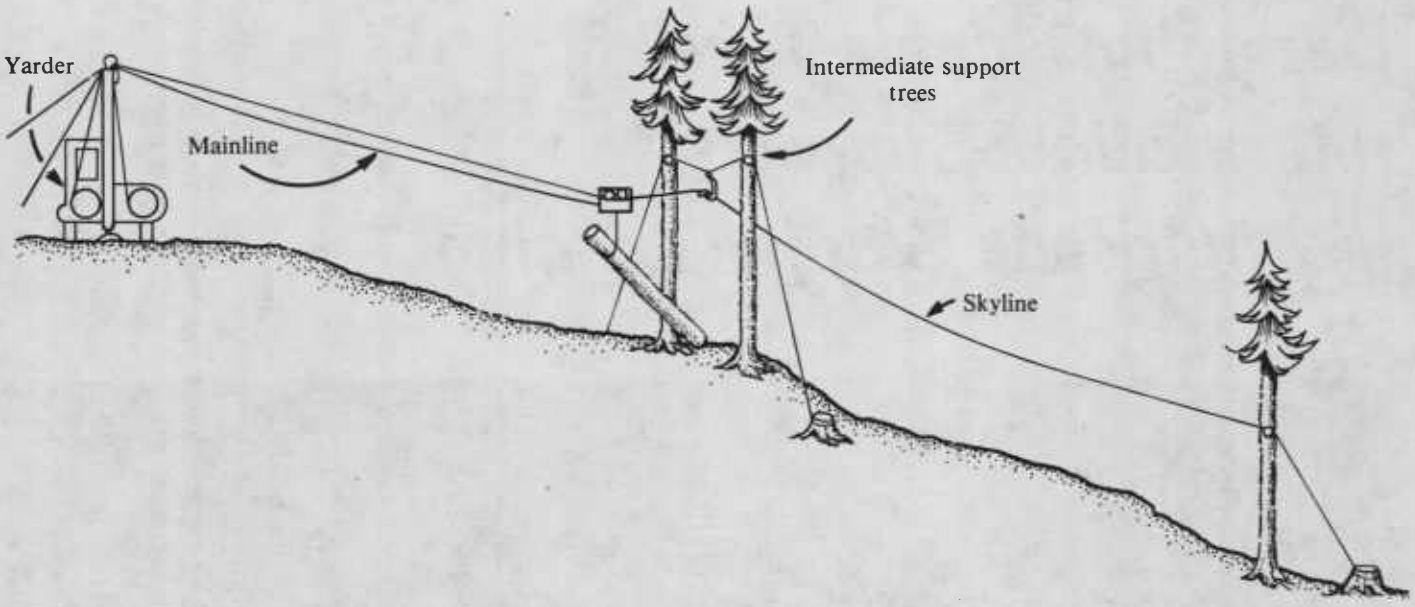


Figure 1.—*Typical multispan skyline yarding configuration*

Multispan skyline logging is becoming increasingly important in the Pacific Northwest as a way to reach timber where more conventional systems won't do.

In terrain with convex slopes, long and continuous slopes, or extremely broken ground, single-span skylines encounter difficult— often insurmountable—problems: They simply can't achieve the deflection loggers need to carry adequate payloads.

In these situations, multispan skyline systems use intermediate supports to keep the skyline elevated well above ground level, increasing deflection and improving the system's load-carrying capacity.

Intermediate supports may also eliminate the need for costly and often unstable midslope truck roads.

Multispan logging produces relatively low levels of ground disturbance, so this system competes favorably with aerial systems in areas sensitive to logging impacts.

When loggers use intermediate supports, individual span lengths are shortened, reducing lateral skyline movement and increasing skyline elevation.

These two factors help to reduce stand damage in partial-cut situations (see "Skyline Deflection: How Much Is Enough?" in the "For further reading" section, page 8). Figure 1 shows a typical multispan setup.

The setting design and rigging requirements for multispan skylines are somewhat more complex than those for single-span systems. When you compare the yarding expenses by themselves, costs are typically higher.

However, when you consider potential savings in road construction costs and other benefits, multispan systems can provide significantly lower overall harvesting costs.

On a recent multispan project in southwestern Oregon, the logger's estimate of intermediate support rigging cost was $600. This would have quickly been offset by the cost of chokers he would have broken, trying to log over the blind lead that was present without using intermediate supports.

A road needed to reach this same area for successful logging with a single-span skyline would have cost about $10,000. So the logger and the landowner both saved money.

Often the most critical elements in successful multispan logging are the location, design, and rigging of the intermediate supports. The advantages of using a multispan are greatly reduced if intermediate supports are not properly located on the skyline road.

The skyline must be supported at the correct height to allow for carriage passage and the right deflection.

Anchors for the intermediate support line and the rigging angles of this line must be planned to insure a safe and efficient operation.

These few but important complications have made some Northwest loggers hesitant about accepting this system, despite its many advantages.

A better understanding of intermediate supports, and some clearly defined guidelines and procedures to use when locating and rigging supports, should be helpful to foresters and loggers when planning multispan projects.

This publication will give some background information about the multispan skyline and will explain a step-by-step procedure for designing and rigging intermediate supports.

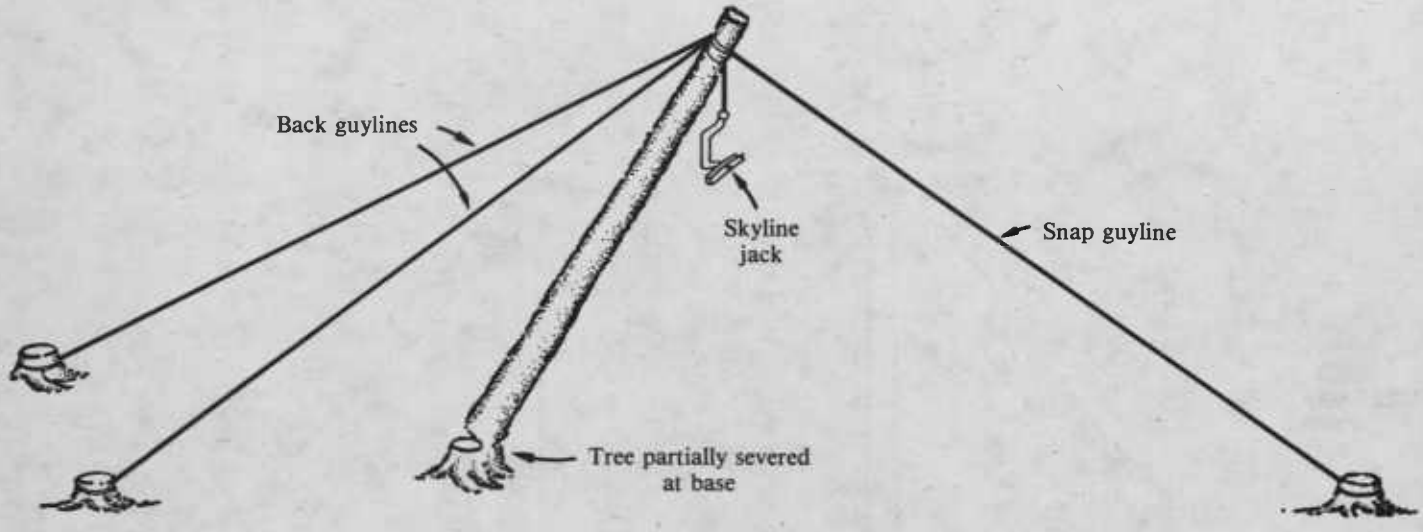


Figure 2.—*Single, leaning tree intermediate support*

Geometric and mechanical factors

Intermediate supports for a multispan skyline system typically fall into one of three categories:

- the single, leaning tree, partially severed at the stump (figure 2);
- the single, vertical tree (figure 3); and
- the double tree (figure 4).

Other ways of rigging supports—such as stringing line between two ridgetops or in the crotch of a large hardwood tree—are sometimes used, but these methods are not common.

European multispan loggers favor the single, leaning-tree support, but American loggers don't often use it because of the rigging problems involved.

In large, old-growth timber, the support type that is often used in this country is the single, vertical tree.

In young-growth stands, and in some of the denser old-growth areas, the double-tree support is quite common. It is the easiest to understand and the least difficult to rig of the three types of intermediate supports. For more information on the other types, see FRL Research Note 74 ("For further reading," page 8).

The double-tree intermediate support consists of a single intermediate support line passing through two blocks hung in separate trees with an open-sided skyline jack suspended from the line between the two trees (figure 4).

The skyline is placed in the groove of the jack before the intermediate support line is raised and anchored. While the jack is being raised, the skyline is held in place by a

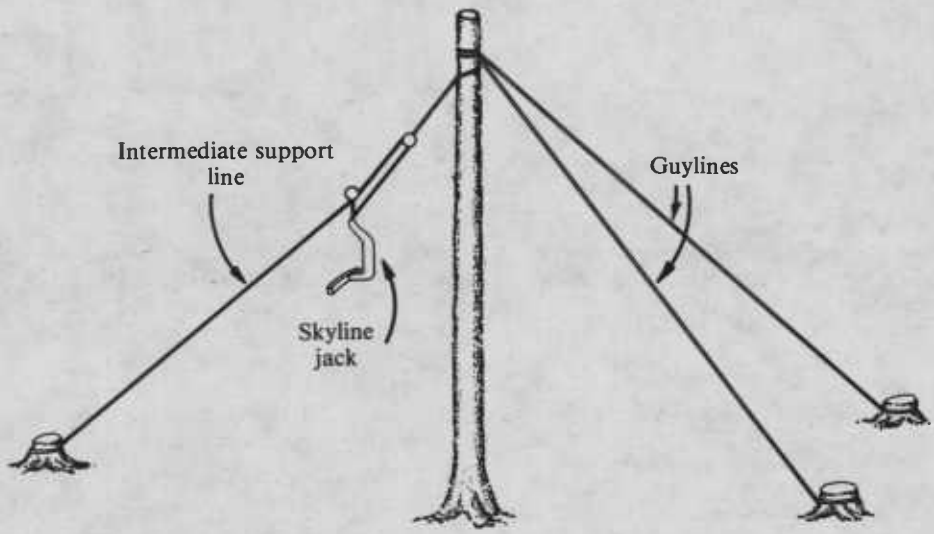


Figure 3.—*Single, vertical tree intermediate support*

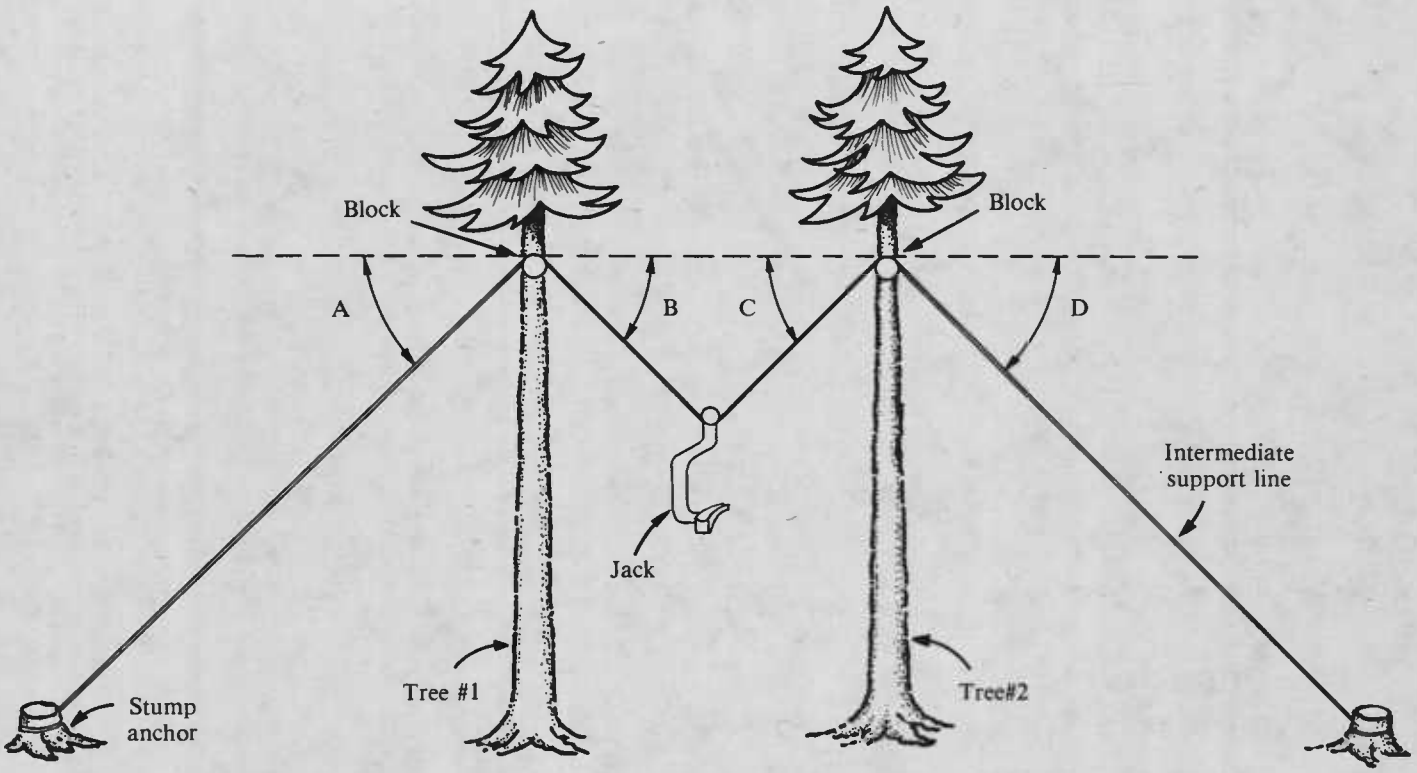


Figure 4.—*Double-tree intermediate support—front view*

metal clip. (This clip is normally not necessary during the logging operation because the load on the skyline is enough to maintain the position of the line in the jack groove.)

Since the metal clip can cause some carriage sheave wear and is not really needed once the skyline is in logging position, some loggers use a piece of soft wire wrapped around the jack shoe and skyline. This will be cut after the first two or three turns by the action of the carriage crossing the jack.

An idealized diagram of a double-tree intermediate support is shown in figure 4. When you view this frontal perspective, the point is to equalize the angles that the intermediate support line makes with the block in each tree.

As figure 4 indicates, angles A and B should be approximately equal to insure a balanced vertical force on the support tree. This also is true for angles C and D.

If the angles are not equal, horizontal forces will not be in balance, and the tree will be forced to bend into or away from the skyline corridor. For trees #1 and #2 in figure 4:

- If A is greater than B, tree #1 will tend to bend *toward* the skyline corridor.
- If D is greater than C, tree #2 will tend to bend *toward* the skyline corridor.
- If A is less than B, tree #1 will tend to bend *away* from the skyline corridor.
- If D is less than C, tree #2 will tend to bend *away* from the skyline corridor.

As the Oregon State Safety Code (1981) suggests, a reasonable range of angles to plan for in this rigging situation is from 25 to 50°.

When the skyline in the jack is under tension, the jack and its supporting line will swing slightly in the uphill direction. From a side view, the system would then appear as in figure 5.

The jack moves in the *uphill* direction because it acts as a frictionless pulley between the two separate spans of the skyline. In this situation, the section of intermediate support line between the jack and the support block must bisect (divide into two equal parts) the chord slopes of the two skyline spans.

To make a multispan system worth the effort, the lower span must be steeper than or equal in slope to the upper span. Therefore, the jack will always swing to the uphill side.

On long, continuous slopes where there is no steepening of terrain, this section of line between jack and block will appear perpendicular to the ground when viewed from the side. This phenomenon is true in both uphill and downhill yarding (see figure 6).

Since the jack will always swing uphill and since it is desirable to have a balanced vertical force on the support trees, it follows that anchors for the intermediate support line should be slightly downhill from the intermediate support trees.

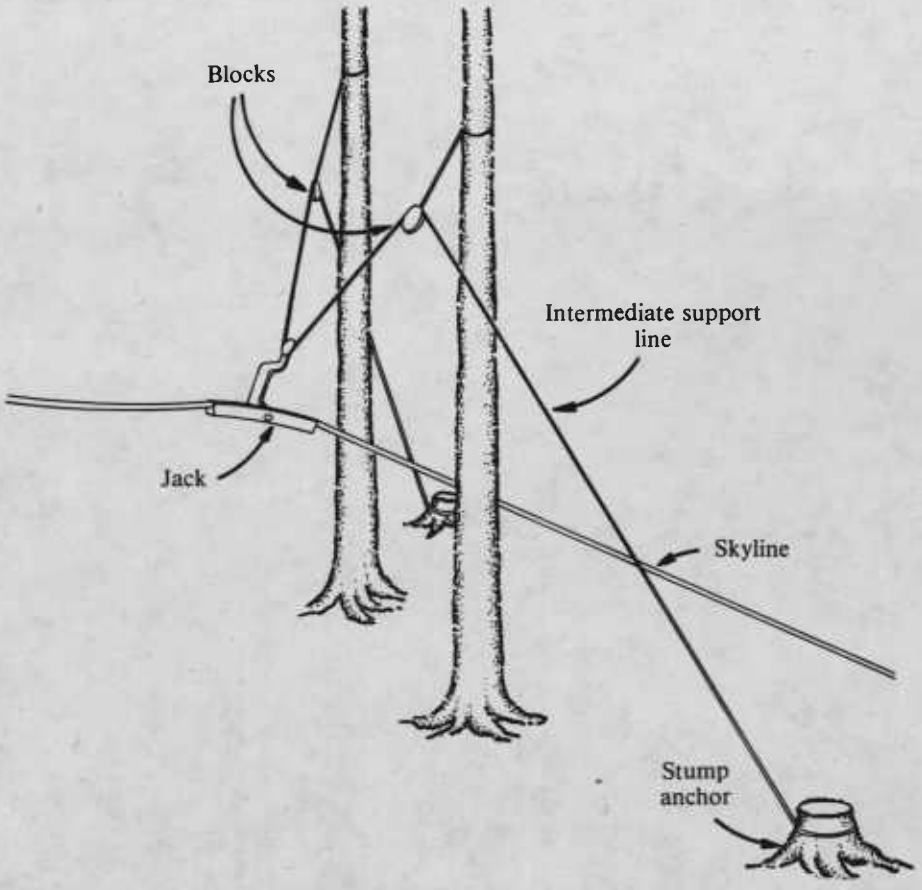
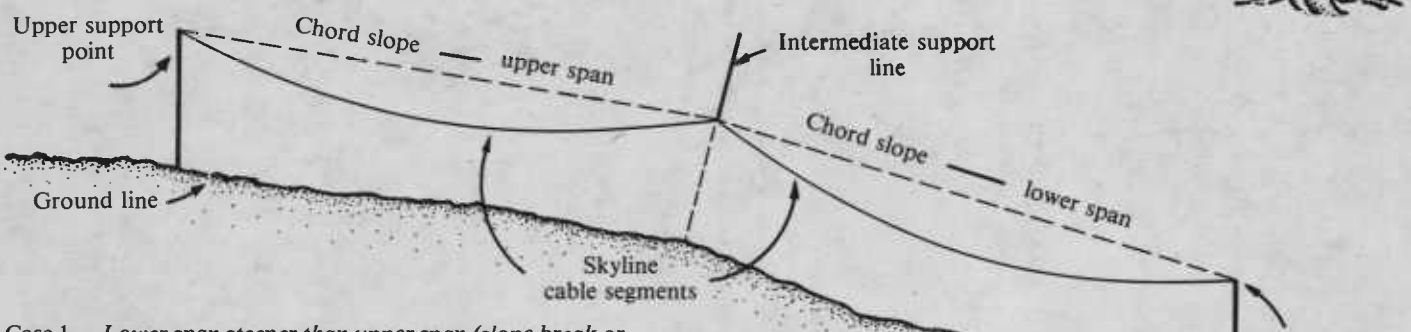
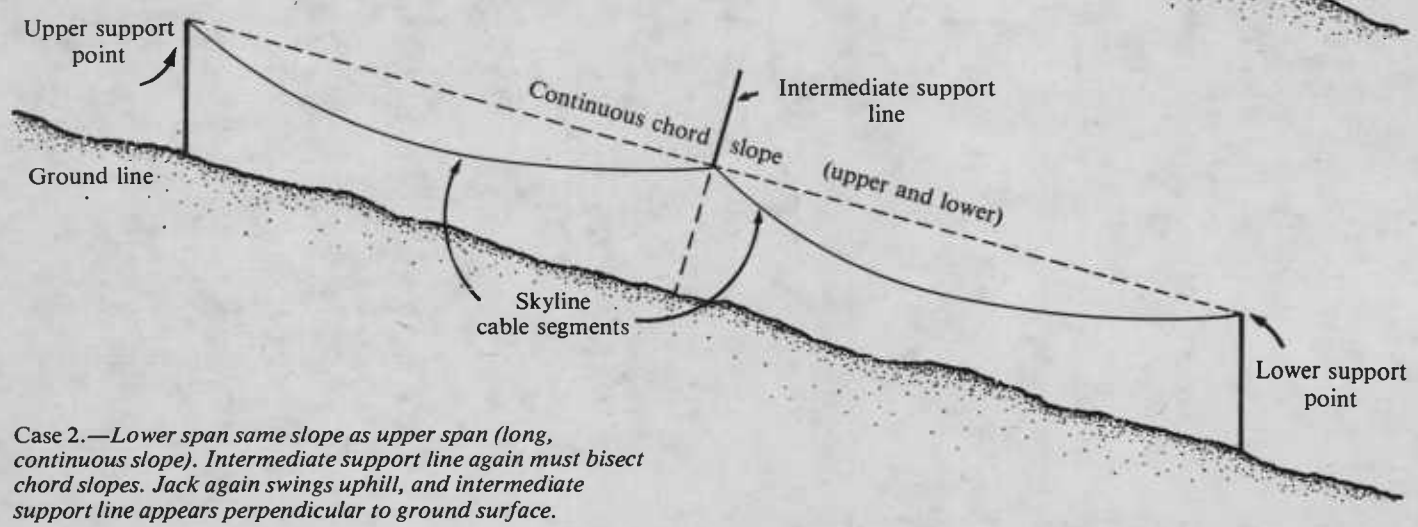


Figure 5 *(right).—Side view of double-tree intermediate support with skyline under tension*

Figure 6 *(below).—Why the intermediate support jack swings uphill in multispan logging*



Case 1.—*Lower span steeper than upper span (slope break or convex slope). Intermediate support line must* bisect *chord slopes in order for system to be in static equilibrium. Therefore, jack swings in uphill direction.*



Case 2.—*Lower span same slope as upper span (long, continuous slope). Intermediate support line again must bisect chord slopes. Jack again swings uphill, and intermediate support line appears perpendicular to ground surface.*

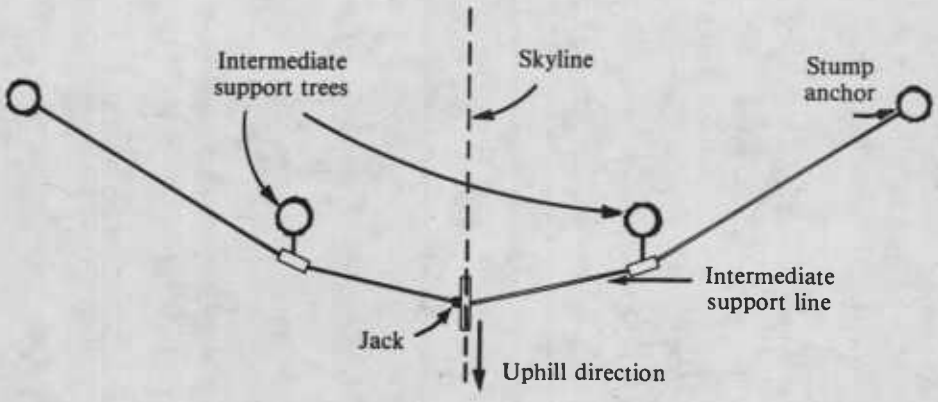


Figure 7.—*Overhead view of a double-tree intermediate support*

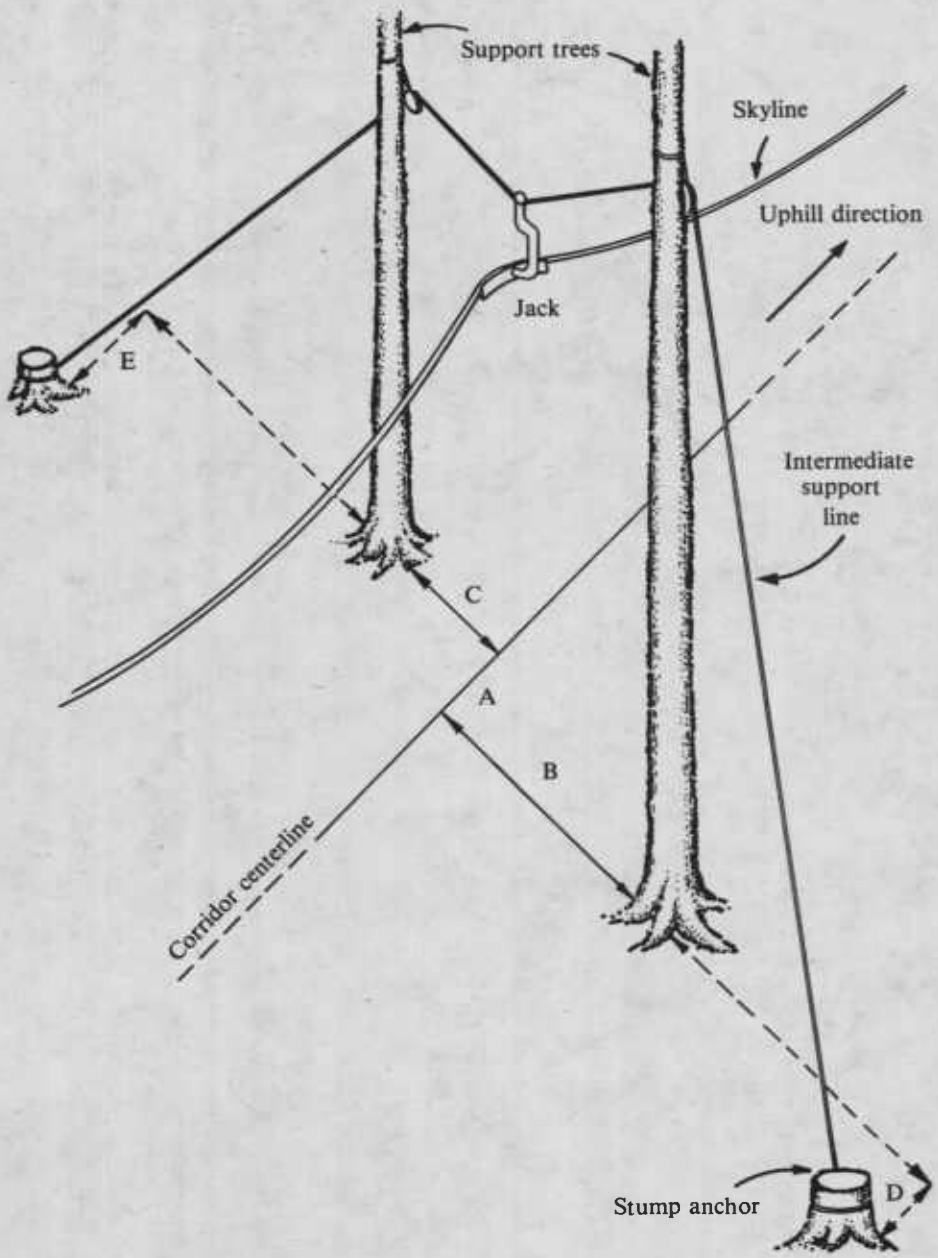


Figure 8.—*Double-tree intermediate support with trees at different locations along corridor and not equidistant from corridor centerline*

Looking at this from an overhead view (figure 7) may help you understand better how to position the trees and anchors to obtain this necessary force balance.

Support trees don't have to be perpendicular to and equidistant from the skyline. In fact, you will rarely find trees in such a convenient arrangement. Even so, do your rigging with the same objective: balanced vertical forces on the support trees, to avoid bending toward or away from the skyline corridor.

Figure 8 shows a double-tree intermediate support with two trees separated up and down the skyline corridor by distance A. The trees are not equidistant from the corridor centerline (distance B is greater then C). However, the intermediate support line anchors are still situated slightly downhill from the support trees, as shown by the distances D and E.

By diagraming the actual tree and anchor locations as in figures 4 and 7, you can solve this positioning problem and decide if the double tree support is the best alternative. If the available trees are separated too far from one another up or down the slope, then a single-tree or leaning-tree support may be more appropriate.

Field location procedures

An essential part of multispan planning is collecting accurate profile data for your terrain. Without knowing the shape and length of the slopes over which you'll need to move your logs, it is often not possible to determine whether or not an intermediate support is necessary—or where to locate the support for the most efficient yarding.

When you collect profile data, look for distinct breaks in a convex slope where an unsupported cable would likely be too close to the ground. These points are probable locations for intermediate supports and may sometimes be quite evident.

When you're working with extremely broken terrain or long and continuous slopes, however, good locations for intermediate supports may be less obvious.

In all situations, keep notes on trees along the skyline corridor that you could use as supports. This information is necessary when you analyze the profile to determine payload. This approach also holds true for locating tail spars at the outer end of the profile.

Your recorded information must include tree d.b.h., species, and location in reference to the terrain profile line. Remember: Try not to use trees with obvious defects.

The next step in multispan project planning is to return to your home or office and analyze your terrain profile(s) with a computer or chain and board model to determine skyline payload capabilities.

This analysis includes determining the location and heights of intermediate supports that you will need to carry an adequate payload. You'll need this information to do the final selection and rigging of intermediate supports.

The "Stick Trick" method

Now you return to the field and locate the position on the ground where you will rig the intermediate support. There are a number of ways to insure that the available intermediate support trees and anchors are correctly positioned to meet the objectives of any particular skyline setting.

The following directions will, however, present a simple and practical procedure, the "Stick Trick" method:

1. Starting at the intermediate support trees you selected, measure off a distance (100 feet is convenient) along the skyline profile in an uphill direction.
2. Using a clinometer or abney level, locate the point in space between these trees where the jack must hang. (You will have determined this height in the skyline analysis process.)
3. Once you locate the jack height you obtained from a payload analysis, try to fix this spot in space by using some reference point on the bole of an adjacent tree, or some feature in the background of crown canopy.
4. Keeping your eye trained on this spot, use the side scale of the clinometer to construct an angle between 25° to 50° (35° is a good starting point) *turned counterclockwise* from the horizontal.
5. Using a straightedge (a straight stick you might find in the woods will do nicely), extend this 35° line from the point where the jack must hang until it intersects with the bole of the right-hand intermediate support tree. This is the point where a block must hang. Mark this point by reference or measure its height with the clinometer (figure 9).

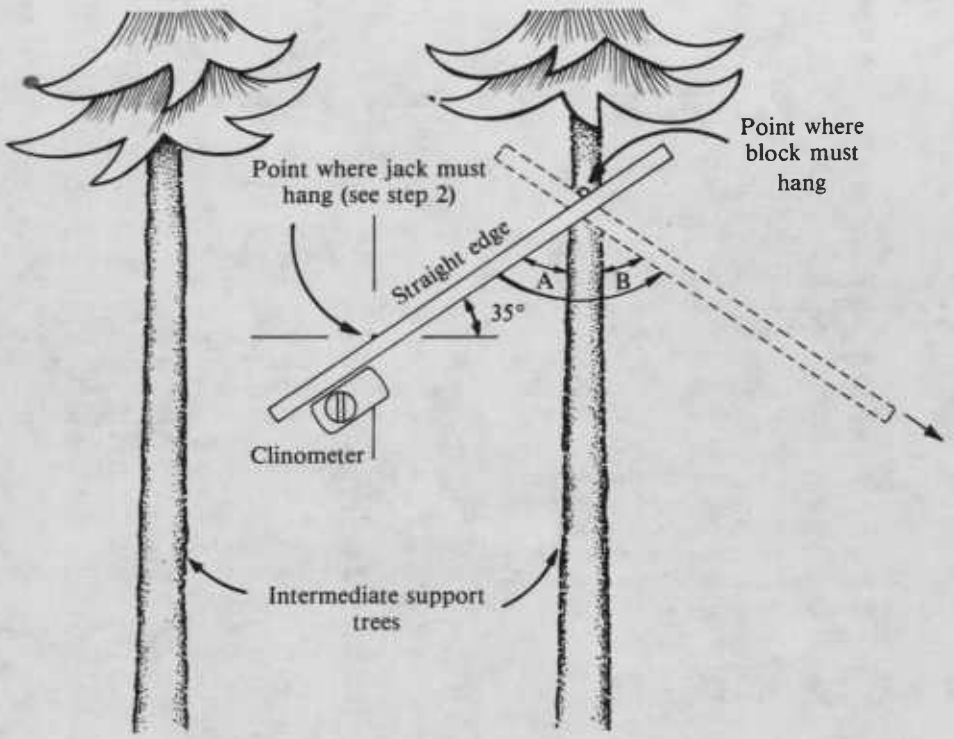


Figure 9.—*The Stick Trick: rotate the straightedge until the angle you constructed on the inside portion of the support tree is duplicated on the outside—that is, when angle A equals angle B.*

6. Because the intermediate support line on the outside of a tree should form approximtely the same angle as on the inside, fix in your mind the angle the straightedge is now making with the tree. Then turn the stick quickly, but carefully, *to the right* until the stick makes approximately the same angle to the *outside* portion of the support tree. You are using your eyes alone here, and no more clinometer measurements are necessary. The observer relies solely on his or her eye to successfully complete this rotation—with a little practice, it is quite easy to do it with adequate results.
7. The lower end of the stick is now pointing to the area on the ground where you must anchor the intermediate support line. Note some reference points, so that you can identify this area later. (One easy way to do this is to have an assistant walk to the area indicated by the stick while you direct the assistant's movements. Once in place, the assistant should mark the position with plastic flagging.)
8. Mark the ground position on the skyline profile from the location where you made the clinometer readings; you will use this position again.
9. In order to balance forces on the intermediate support trees, your anchoring points must be slightly downhill from the trees (figures 5, 7, and 8). Proceed down the skyline corridor to the right-side intermediate support tree and turn an angle 90° from the direction of the profile. Walking in this direction, go out to the anchoring area you determined in steps 6 and 7.
10. When you reach the anchoring area, move slightly downhill (5 to 10 feet) to look for anchoring opportunities. If acceptable anchors are available, mark the best one and return to the point marked on the ground profile in step 8. Repeat this process (steps 1 to 10) for the *left* side of the skyline jack.
11. If anchors are not available for either tree, you have four alternatives:
    - Change the angle that the intermediate support line makes at the jack. Try 40° and see how that changes the required anchor locations.
    - Move slightly higher in the intermediate support trees. If you use this alternative, try to move up *the same distance* in both trees. Changing the rigging height in only one tree displaces the jack sideways, toward the lower rigging point. This will cause a dogleg in the skyline that may present problems when the carriage must pass the jack. Minor doglegs at the intermediate support jack are

acceptable and also quite common. Recent research reported carriage passage of an intermediate support with an 8° dogleg; however, the same system couldn't handle a 12.25° dogleg successfully (see FRL Research Note 74, "For further reading," righthand column).

- Choose a different intermediate support location. It is generally better to move slightly *uphill* than it is to go downhill, to locate a new intermediate support.
- Try to design a single-tree intermediate support.

12. When you find acceptable anchors for both ends of the intermediate support line, remeasure the heights to the point where the blocks must hang in the trees. Add 3 to 5 feet to this height to allow for strap length. This will be the rigging height to pass along to the climber.
13. Measure the diameter outside bark at this point with a Relaskop or measure d.b.h. and modify that measurement according to the form class of the tree. Subtract an appropriate bark thickness and proceed with a buckling analysis to determine if the selected trees are large enough to withstand the forces they will be subjected to during yarding. Consult the Oregon State Safety Code, logging section, for tree-diameter guidelines.

This method is not a precise surveying procedure, and there are many opportunities for inaccuracy—but it works. Experienced logging engineers and multispan loggers use this "Stick Trick" regularly with satisfactory results.

Care in turning the various angles is important for acceptable results. With a little practice, this method can be a useful planning tool for project layout foresters and loggers.

Summary

Multispan skyline logging systems are being used throughout the Pacific Northwest with excellent results. Intermediate supports are often unnecessary on *every* skyline road in a project area. However, when terrain presents a problem for the single-span skyline, multispan rigging provides that extra lift to raise the skyline and payload over the obstruction.

Loggers who have used intermediate skyline supports have been favorably impressed by the increased ease of yarding and the improvements in productivity. Many skyline yarders and carriages can be easily and inexpensively adapted to log over intermediate supports.

Experts agree that as loggers and land managers become more familiar with this system, they will routinely rig intermediate supports to reach those difficult pieces of ground they have previously avoided or left for helicopter logging systems.

For further reading

Lysne, D. H., and S. E. Armitage, *Multispan Logging of Old-Growth Timber in Southwest Oregon,* Oregon State University, School of Forestry, Forest Research Laboratory Research Note 74 (Corvallis, 1983). No charge for single copies; order from OSU College of Forestry, Corvallis 97331.

Mann, John W., "Skyline Deflection: How Much Is Enough?" *Forestry Intensified Research Report,* vol. 5, no. 1, Oregon State University Extension Service (Medford, 1983). No charge for single copies; order from Forestry Intensified Research Program, 1301 Maple Grove Dr., Medford 97501.

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