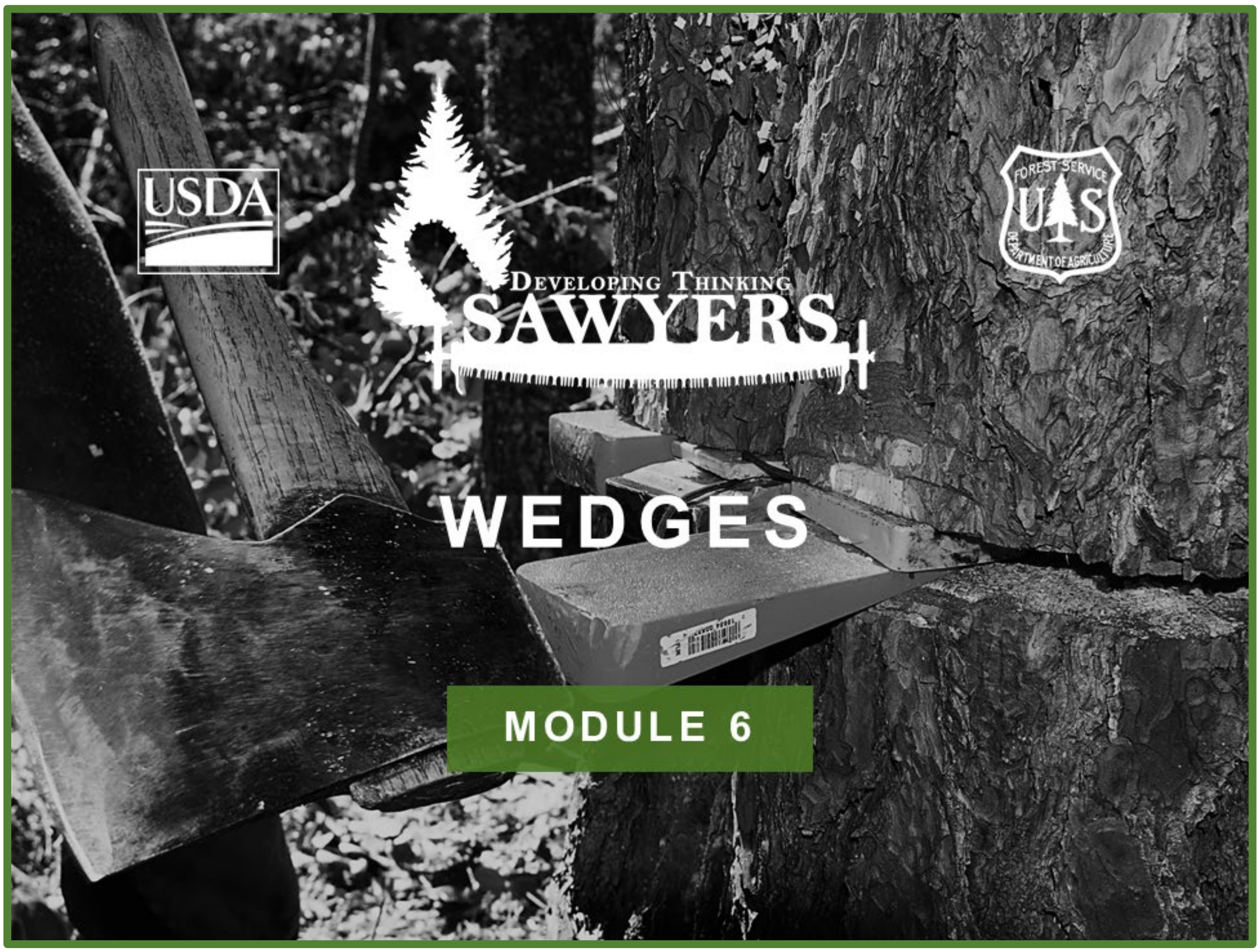
USDA Forest Service National Sawyer Training: Developing Thinking Sawyers



Student Guide

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Module 6: Wedges

Introduction

This module is designed to provide an introduction to selecting and using wedges. Wedges provide a mechanical advantage during felling and bucking operations. Understanding the use of wedges is a key component of being a "thinking sawyer".

Module Topics

In this module, we will discuss:

- Wedge Basics
- Types of Wedges
- Wedge Uses
- Wedges in Bucking and Felling Operations
- Tree Segments

Objectives

When you complete this module, you will be able to:

- Describe and discuss how wedges work.
- Describe the different types of wedges.
- Explain the different uses of wedges.
- Explain how sawyers use wedges in felling operations.
- Calculate the number of segments in a tree.

Wedge Basics

A wedge is an essential tool for bucking and felling operations. Sawyers use wedges during bucking operations to manage compression and prevent the saw from becoming pinched or stuck in the kerf. They use wedges during felling operations to lift the back of the tree and redistribute the center weight into the undercut, and can also use wedges to support the hinge on trees with heavy side leans.

How Wedges Work

A wedge is any material with a thick end tapering to a thin edge that is driven between two objects or parts of an object to secure, lift, or separate them. Wedges provide sawyers with a mechanical advantage for managing compressive forces.

Calculating Mechanical Advantage

Wedges come in many different types and sizes. It is important to know how to select the appropriate wedge for the task at hand. You can calculate the mechanical advantage of a wedge by dividing its height by its length (figure 6.0.1). Although a short wedge with a wide angle may do a job faster, it requires more force to drive than a long wedge with a narrow angle.

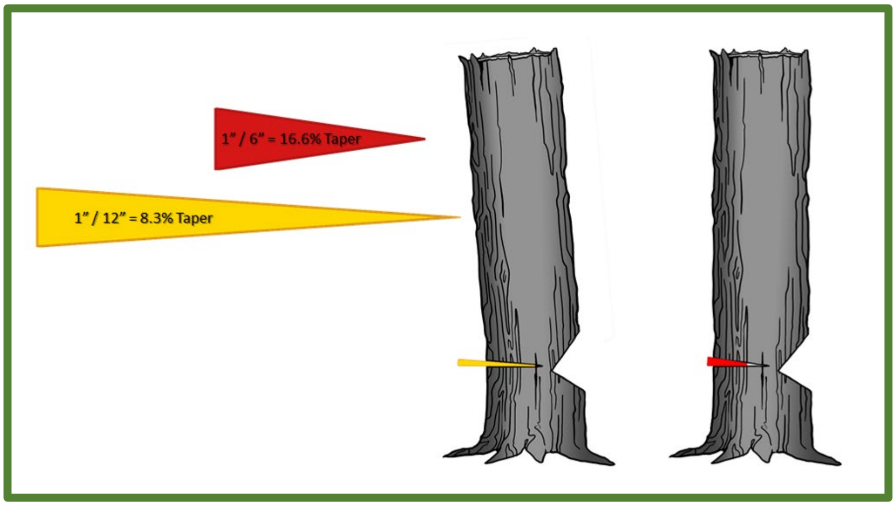

Figure 6.0.1—Calculating mechanical advantage.

Example:

A 1- by 12-inch wedge has a greater mechanical advantage than a 1- by 6-inch wedge. Therefore, a 1- by 12-inch wedge is easier to drive under a load than a 1- by 6-inch wedge.

The longer wedge with the thinner taper has a mechanical advantage over the wedge with the shorter, steeper taper. While the wedge with the shorter, steeper taper may open the saw kerf faster, it requires more effort to drive.

Types of Wedges

Modern wedges are often made of heavy-duty plastic blends. This helps minimize any damage if the cutting teeth of the saw contact the wedge.

Wedges come in several tapers and lengths, with various features that are specific to the intended use of the individual wedge.

We will discuss the following types of wedges:

- Single-taper
- Double-taper
- Triple-taper
- Hanging
- Rifled and hardhead wedges
- Shims

Figures 6.0.2 to 6.0.4 provide descriptions of single-, double-, and triple-taper wedges.

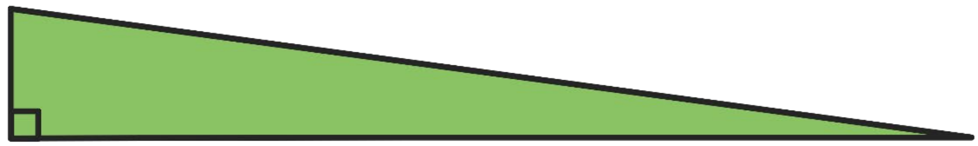

Figure 6.0.2—A single-taper wedge is a right triangle with a 90-degree angle on the back plate and three unequal sides.

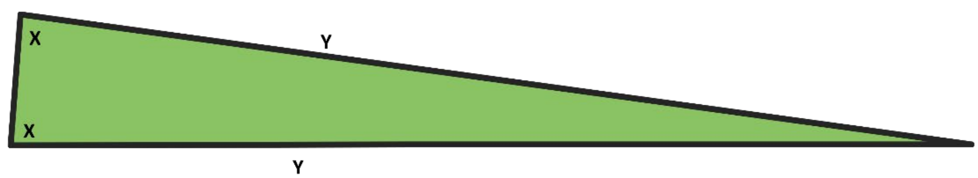

Figure 6.0.3—A double-taper wedge is an isosceles triangle with two equal sides.

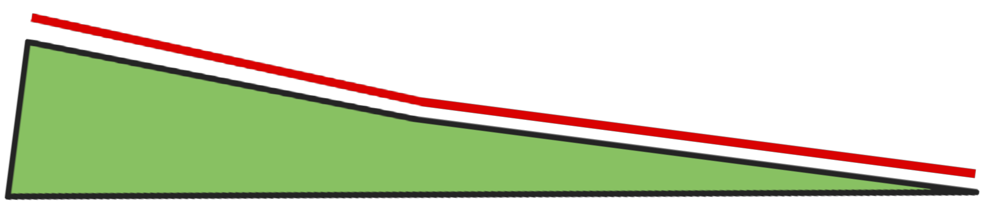

Figure 6.0.4—A triple-taper wedge starts similar to the single-taper wedge, but steps up the degree of incline about half-way into the taper.

Note: The triple-taper wedge works well for quicker lift on smaller trees. On heavier, larger trees, it lifts slowly to get the action started and then a quicker lift takes over. Because of the drastic change in taper, a triple-taper wedge is more difficult to drive toward the back of the wedge.

Hanging Wedges

Sawyers use hanging wedges for crosscut saw operations (figure 6.0.5). Hanging wedges are two wedges connected by a lanyard or cord and secured (e.g., over the head of an ax) to prevent them from dropping onto and damaging the crosscut saw. You can use hanging wedges as a pair and drive them across the kerf at the 10 o'clock and 2 o'clock positions. This prevents a log from rolling or twisting and unintentionally pinching the saw before you fully severe the log.

When hanging wedges are not available, you can use an ax or Pulaski across the kerf to prevent the log from rolling.

Figure 6.0.5—Hanging wedges.

Rifled Wedges

The grooves in rifled wedges are designed to help to keep them aligned when you stack the wedges (figure 6.0.6). You can damage the rifling if you use a rifled wedge singly, hampering your ability to stack two rifled wedges.

Figure 6.0.6—A rifled wedge.

Hardhead Wedges

Hardhead wedges have a plate of steel and metal inserted at the back of the wedge (figure 6.0.7). The purpose of the metal backing is to transfer energy more efficiently. Hardhead wedges are effective for lifting large trees.

Figure 6.0.7—A hardhead wedge.

Shims

Shims are made of short sections of old wedges and are used in combination with a standard wedge (figure 6.0.8). You can use them on small-diameter trees when you cannot insert two full-size wedges.

Figure 6.0.8—Shims.

Wedge Safety and Techniques

Safety is always a priority when conducting saw operations, and this includes the use of wedges.

When using wedges in felling operations, take special care to evaluate overhead hazards, including limbs, dead or unstable tops, or loose bark. Bark can become dislodged by the vibrations produced from driving a wedge.

General Safety

- Always wear eye protection when driving wedges.
- Check wedges for damage before beginning a job.
- Do not use cracked or damaged wedges.

Wedging Techniques

- Remove thick bark before wedging to help prevent the wedge from crushing the bark instead of providing lift.
- Drive the wedge by striking it squarely on the head to help prevent it from popping out. If the kerf is already under compression, drive the wedge carefully to prevent it from flying out of the kerf when struck.
- Place wedges adjacent to each other and strike them alternately. This is an efficient method that uses the least amount of effort.
- Carrying at least three wedges with you is recommended. The number of wedges you need will depend on saw operations and must be part of the wedging plan.
- If necessary, you can stack wedges to increase the amount of lift. It is a common practice to cross wedges to lessen the likelihood of a wedge **popping** out of the kerf when struck.
- Adding sawdust between stacked wedges will add friction and reduce the likelihood that a wedge will pop out of the kerf.
- Stacking more than two wedges makes them unstable. Do not stack more than two.
- Using an ax with the proper weight and handle length is imperative.
- Plastic wedges can break. If you can drive a long wedge only a short way into the saw kerf, most of the wedge’s length will be exposed, and a misplaced blow can break it.

Wedge Uses

Wedge placement is not a thoughtless process of just trying to keep the kerf opened. You carefully plan wedge use and placement during the objective, hazards, leans/binds, escape routes, cut plan (OHLEC) size-up process.

Common Wedge Uses

Sawyers most commonly use wedges to manage compressive forces in one form or another:

- While bucking, you can use wedges to counteract the effects of compression by maintaining an open saw kerf.

- During bucking operations, you can use hanging wedges to prevent the bole from twisting or rolling and damaging or pinching the saw.
- During felling operations, you can use wedges to prevent a tree from sitting back and pinching the saw bar.
- During felling operations, you can use wedges to lift the back of the tree and redistribute the center weight of the tree forward into the undercut.
- During felling operations, placing a wedge loosely in the back cut can help indicate movement in the tree.
- On side leaning trees, placing wedges behind and parallel to the hinge helps to stabilize the hinge and support the weight of the tree. Place these wedges snugly rather than driving them.

Wedges in Bucking Operations

When bucking, place the wedge into a saw kerf in the compression zone of a log. Placing the wedge correctly is important for maximizing the mechanical advantage.

You must cut deeply enough for the wedge to fit into the kerf without contacting the saw. **Set** and **drive** the wedge by striking it with the back of an ax head. Once you **set** the wedge, you can complete a bucking cut without pinching the saw because the wedge prevents compression from closing the kerf.

Bucking: Top Bind

In top bind situations, start a wedge as soon as you can and add more wedges as needed (figure 6.0.9). Additional wedges placed parallel to each other provide even more separating force.

Once you place these wedges, alternate striking each wedge. The kerf will open as you drive the wedges deeper, reducing the compressive forces on the other wedges. Alternating your strikes enables you to drive each wedge deeper into the kerf. You can overcome a lot of compression with this technique.

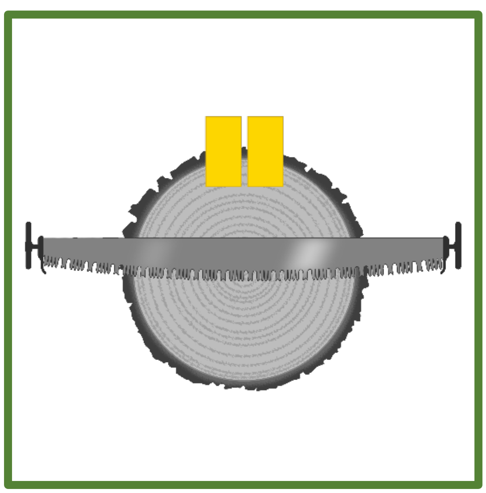

Figure 6.0.9—Wedging technique for top bind.

Bucking: Top and Side Bind

If a log has a top and side bind, place wedges at both compression points to prevent the kerf from closing at either bind (figure 6.0.10). Place multiple wedges in this compression area to provide the best mechanical advantage. Multiple wedges help spread the forces required to open the kerf instead of concentrating all the forces on one wedge.

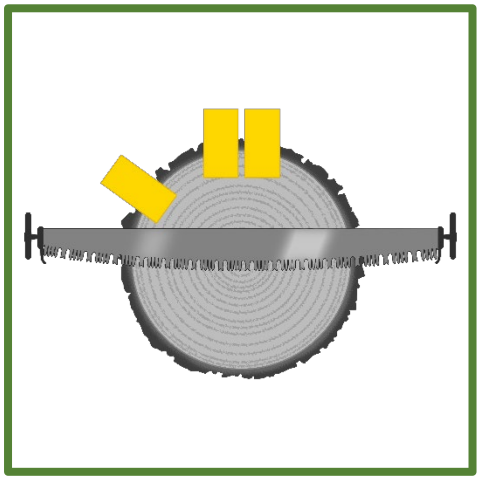

Figure 6.0.10—Wedging technique top bind and side bind.

Wedges in Felling Operations

A tree that does not have forward lean will require one or more wedges to move its center of weight past the front of the hinge, allowing the tree to fall into the lay. This is referred to as "overcoming the back lean."

Wedging a Tree

As you drive a wedge into the backcut during felling operations, the force developed effectively lifts the back of the tree and moves (rotates on the hinge) the top of the tree forward (figure 6.0.11). This redistributes the center weight of the tree forward into the undercut.

To facilitate this movement, time the cadence of your strike with the forward rocking of the tree. Take special care to watch for limbs, bark, or tops that may be knocked loose. Also, be particularly careful when driving wedges while standing under the **bad** side of the tree.

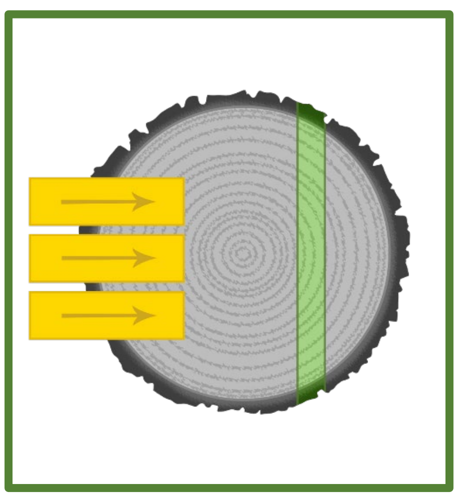

Figure 6.0.11—Wedging a tree.

Stabilizing Wedges

For trees with side lean, place a stabilizing wedge under the lean, parallel to and behind the hinge (figure 6.0.12). This can help prevent the hinge from failing due to the side weight of the tree. Do not drive this wedge too far in or it may break the hinge. The goal is to support the hinge and not **lift** the side of the tree. You may have to add more wedges, depending on the amount of side lean and the support needed.

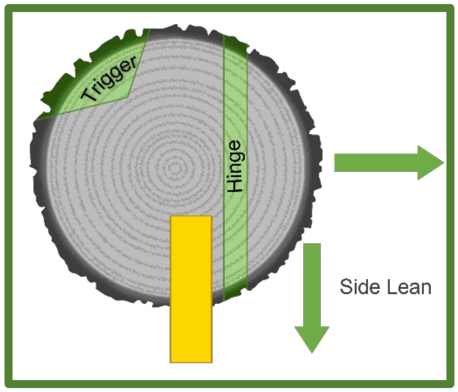

Figure 6.0.12—Stabilizing wedges.

Crossing/Stacking Wedges

You can stack wedges to increase the amount of lift. Crossing wedges is a common practice that lessens the likelihood of a wedge **popping** out when struck (figure 6.0.13). Do not stack more than two wedges together. The tree may sit back on itself if a wedge **pops** out of the kerf, and you may not be able to reinsert the wedge.

Adding sawdust between stacked wedges adds friction and reduces the likelihood that a wedge will **pop** out of the kerf.

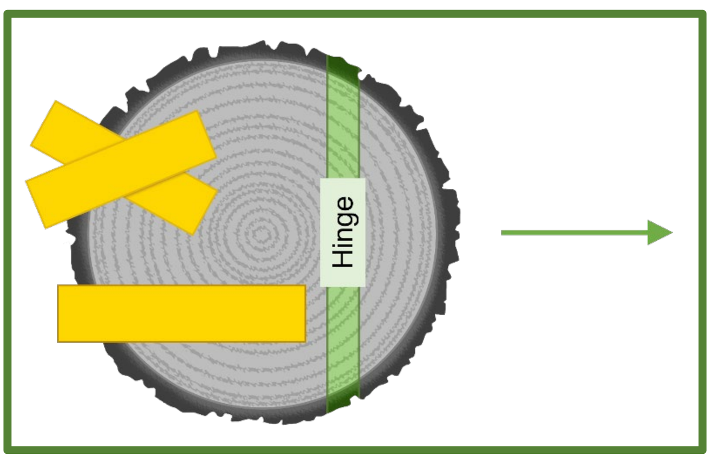

Figure 6.0.13—Crossing/stacking wedges.

Shims

When choosing to wedge over a back leaning tree, it is important to plan ahead and ensure that you have the right equipment on hand to tackle the job. Combining shims made of short sections of old wedges with a standard wedge can be an effective way to get additional lift (figure 6.0.14).

You can use shims on small-diameter trees when you cannot insert two full-size wedges.

With proper use, you can use wedging to overcome back lean if the amount of back lean does not exceed basic limits, there is a solid wedging platform, and the fiber in the hinge is sound and not too thick. Remember the hinge must be able to bend.

Figure 6.0.14—Combining shims with a standard wedge.

Factors Involved in Wedging Back Leans

Some important factors to consider when wedging a tree with back lean include:

- Tensile strength of a hinge
- Elasticity of the hinge
- Number and types of wedges needed
- Your ability to direct power into the wedges
- Wedging platform of the tree

Tensile Strength

Tensile strength is a measurement of the force required to pull something (such as rope, wire, or a structural beam) until it breaks (figure 6.0.15). When driving a wedge into a tree with significant back lean, the extreme tension on the hinge may cause it to fail. If the hinge fails, the tree may not fall in the intended direction, potentially compromising your escape path.

The tensile strength of fiber contained in the hinge is highly variable, depending on the species of tree, presence of decay, time of year, etc. The tensile strength of the hinge plays an important role in how much lean you can overcome.

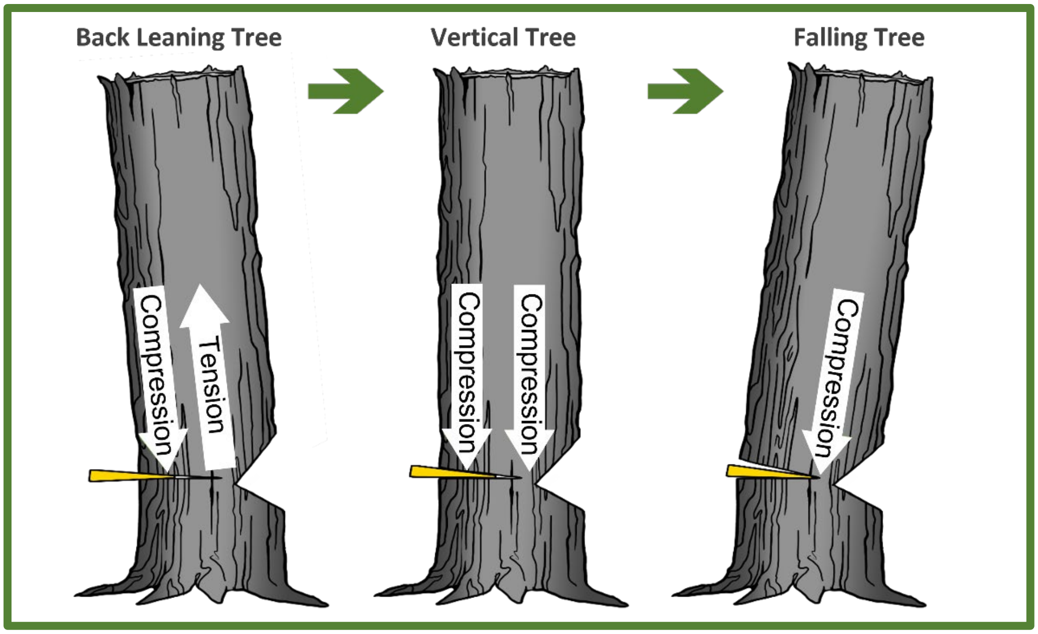

Figure 6.0.15—Tensile strength.

Elasticity of the Hinge

When we talk about the elasticity of the hinge, we are really saying “will the hinge bend and allow you to guide the tree into the objective?”

Sawyers use the **80+/10-** guideline to construct hinges. The hinge should be 10 percent (the 10-) or less of the tree’s diameter. You will often find it difficult to bend a hinge if it is thicker than 10 percent. If you constructed the hinge correctly and it is sound, it will bend and allow the tree to fall into the intended lay.

The hinge must bend for the weight in the top of the tree to move. Figure 6.0.16 shows that the hinge in an 18-inch diameter tree is about 16 by 1.8 inches and has more wood remaining than four 2 by 4s butted up against each other. As the diameter of the tree increases, the size of the hinge must increase as well. For example, a 40-inch tree would have a 32- by 4-inch hinge. This would be equivalent to bending eight 4 by 4s.

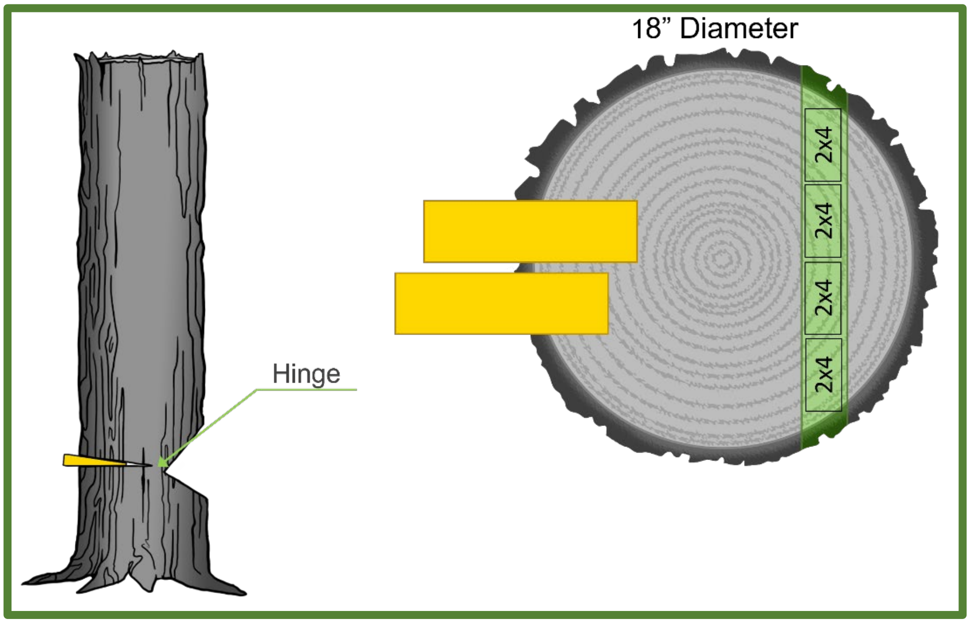

Figure 6.0.16—Elasticity of a hinge.

Wedging Platform

The wedging platform must be solid during wedging operations (figure 6.0.17). If rot or thick bark are present where you intend to insert a wedge, the fibers will compress and the wedge will not be able to lift the tree.

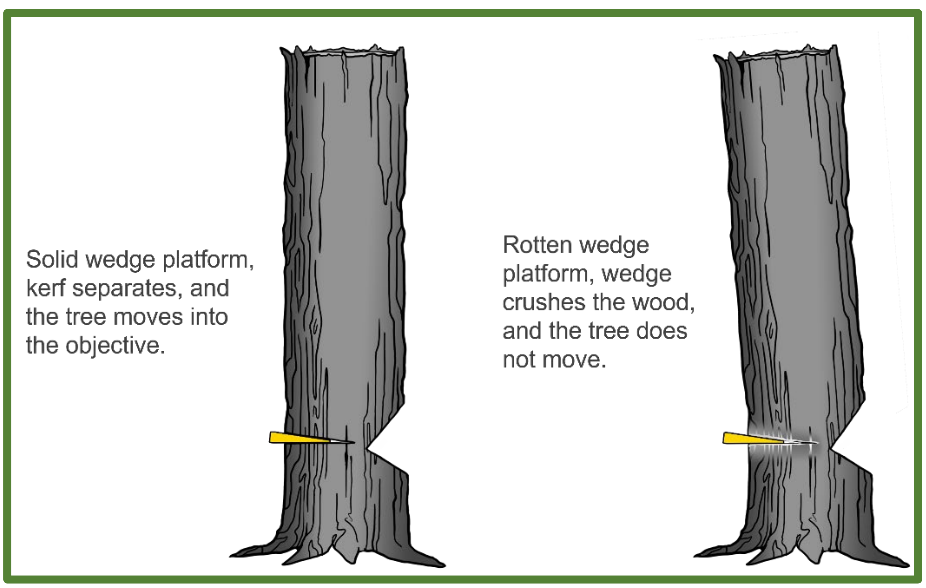

Figure 6.0.17—The wedging platform.

Driving Force

Which ax do you think will drive a wedge with the most force, a 3-pound single-bit head on a 16-inch handle or a 4½-pound single-bit head on a 30-inch handle?

A heavier ax with a full-size handle will deliver more power to the wedge and more lifting power into the kerf (figure 6.0.18). The energy transfer from your swing with the ax, to the wedge, and into the kerf, will vary.

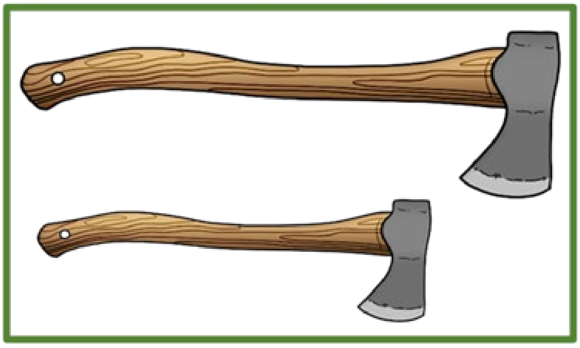

Figure 6.0.18—Different sized axes.

Tree Segments

Back-leaning trees can present unique challenges. Remember, for a tree to fall in the direction opposite its lean, the weighted center must move past the front of the hinge (i.e., the fulcrum point).

To accomplish this, you drive wedges into the backcut to open the kerf and lift the tree, which results in corresponding forward movement in the top of the tree toward the intended lay.

Calculating the number of segments in a tree is important because it allows you to know how much lift you will need to redistribute the tree's center weight.

What Are Tree Segments?

Think of segments as blocks stacked on top of each other. When you drive a wedge under the bottom corner of the block (segment), as shown in the left image of figure 6.0.19, the segment lifts and the opposite corner of the first segment moves forward an equal distance. The more segments in a tree, the more movement you can achieve at the top of the tree.

The right image of figure 6.0.19 shows us that using a wedge to lift a stack of blocks (segments) 1 inch moves the bottom segment 1 inch forward, the second segment 2 inches forward, the third segment 3 inches forward, and so on.

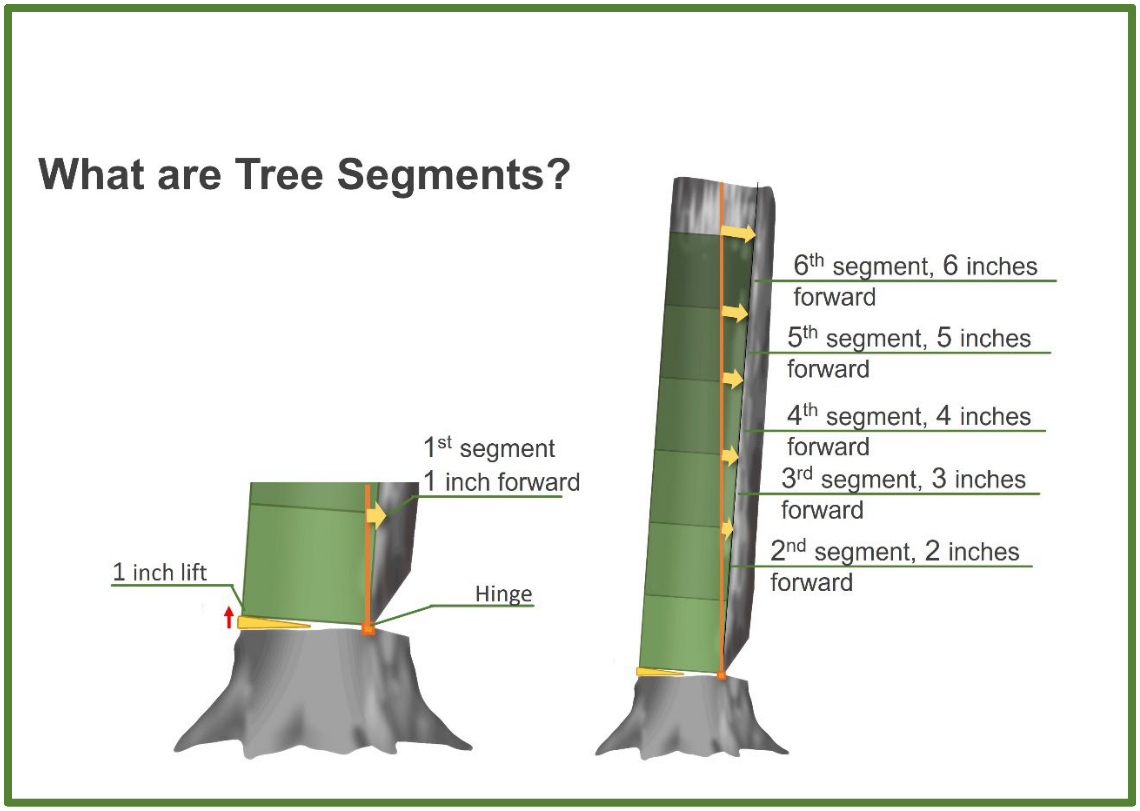

Figure 6.0.19—Tree segments.

Calculating Segments

When felling a tree against its lean, you must develop a wedging plan that includes some key pieces of information, including:

- Tree height in feet
- Amount of back lean in feet
- Distance from the back of the tree to the front of the hinge in feet (converted from inches)
- Amount of lift needed to redistribute the tree's center weight
- Condition of the hinge fiber

You will use this information to answer the question, "Will I be able to overcome the lean with wedges alone?"

Calculations

When calculating segments, dimensions are based on the distance from the lifting point, or back of the tree, to the front of the hinge.

You can change the number of segments by cutting either a deeper or shallower undercut, thus changing the distance from the back of the tree to the front of the hinge. However, as you shorten the length of the wedging platform, you will require greater force to drive the wedge.

You need two factors to calculate how much movement you can achieve:

- Height of the tree in feet
- Distance from the lifting point to the front of hinge **in inches**
    - Convert inches to feet

Example

1. Convert inches to feet

A tree with a segment length of 12 inches converts to how many feet? Divide the distance (in inches) by 12 to get feet.

- 12 inches ÷ 12 = 1 foot

2. Calculate the number of segments

Determine the number of segments by dividing the height of the tree (in feet) by the segment length (in feet).

Tree height: 60 feet

- 60 feet (height) divided by 1 foot (segment length) = 60 segments

3. Determine the forward movement of the tree

Calculate forward movement by multiplying the amount of lift (normally 1 inch per wedge) by the number of segments and dividing by 12.

- 1 inch x 60 segments = 60 inches
- 60 inches ÷ 12 = 5 feet of movement

Calculation Exercises

Use the formulas above to work through the questions below in the space provided.

Exercise 1: A tree that is 125 feet tall and has a segment length of 36 inches contains how many segments?

Exercise 2: How much forward movement will result with 1 inch of lift in a tree with 50 segments?

Exercise 3: How much forward movement will result with 1.5 inches of lift in a tree with 42 segments?

Using Charts

Charts have been developed to simplify this process. Remember, the number of segments in a tree tells you how much forward movement you can expect to get with one fully inserted wedge. The charts assume a ⅜-inch kerf and a 1-inch-tall wedge.

Appendix C of the guide contains two charts: “Number of Segments” and “Expected Movement.” Turn to the charts as we work through the examples below.

Number of Segments

Once you know the height of the tree in feet and segment length in inches, you can use this chart to determine how many segments a specific tree has.

Question 1: A tree with a segment length of 16 inches that is 65 feet tall has how many segments?

Question 2: A tree with a segment length of 20 inches that is 80 feet tall has how many segments?

Question 3: A tree with a segment length of 26 inches that is 110 feet tall has how many segments?

Expected Movement

Segment size can vary depending on the depth of the undercut you use. The simplified chart in figure 6.0.20 uses an average segment length based on tree diameter, compared to tree height, resulting in expected feet of motion toward the objective when using one wedge. This is the simplest chart created as it uses average segment length per diameter. If you are unsure if you will need to stack wedges, this is a good reference.

If the amount of back lean falls in the green color range on the chart, it is much easier for you to use wedges alone to overcome the lean than if it falls in the yellow or red range. The colors on the chart are not a go or no-go situation, but they work as a sawyer reference. There is always more to consider when felling trees than just the amount of back lean.

Segment Length in Inches

Height in Feet

	6	8	10	12	14	16	18	20	22	24	26	28	30
45	90	68	54	45	39	34	30	27	25	23	21	19	18
50	100	75	60	50	43	38	33	30	27	25	23	21	20
55	110	83	66	55	47	40	37	33	30	28	25	24	22
60	120	90	72	60	51	54	40	36	33	30	28	26	24
65	130	98	78	65	56	49	43	39	35	33	30	28	26
70	140	105	84	70	60	53	47	42	38	35	32	30	28
75	150	113	90	75	64	56	50	45	41	38	35	32	30
80	160	120	96	80	69	60	53	48	44	40	37	34	32
85	170	128	102	85	73	64	57	51	46	43	36	36	34
90	180	135	108	90	77	68	60	54	49	45	42	39	36
95	190	143	114	95	81	71	63	57	52	48	44	41	38
100	200	150	120	100	86	75	67	60	55	50	46	43	40
105	210	158	126	105	90	79	70	63	57	53	48	45	42
110	220	165	132	110	94	83	73	66	60	55	51	47	44
115	230	173	138	115	99	86	77	69	63	58	53	49	46
120	240	180	144	120	103	90	80	72	65	60	55	51	48

Figure 6.0.20—Number of segments.

Example 1: How far toward the objective will one wedge move a 26-inch diameter tree that is 80 feet tall?

Example 2: Will one wedge be enough to fell a 32-inch diameter, 100-foot tall tree that has 5 feet of back lean?

Example 3: If a tree has 4 feet of back lean, a 16-inch diameter, and is 55 feet tall, will one wedge be enough to fell the tree?

Example 4: Will one wedge be enough to fall a tree that is 8 inches in diameter, 55 feet tall, and has 5 feet of back lean?

Segments Summary

Summarizing the steps involved in calculating segments:

1. Calculate the tree height in feet.
2. Calculate the back lean of the tree in feet.
   - Measure the length of the backcut plus the hinge in inches.
3. Convert the backcut measurement from inches to feet.
4. Calculate the number of segments.
5. Calculate the forward movement expected with one wedge.
6. Will you be able to overcome the lean using wedges alone?
   - **Yes**: Develop a wedging plan.
   - **No**: Use the OHLEC size-up process to reassess.

When it comes to wedging back-leaning trees, there are many more considerations than simply knowing how much motion will result from using one fully inserted wedge.

Limiting Factors

There are limits to how much you can move a tree. Successfully felling a back-leaning tree depends on several factors:

- A correctly constructed undercut and hinge
- An accurate measurement of tree height in feet
- An accurate measurement of the amount of back lean in feet
- The fiber characteristics in the hinge and the wedging platform
- The number and size of wedges available

- The size of the ax you use to drive wedges
- Elasticity of the hinge
- Tensile strength of the hinge
- Sawyer's physical ability to drive a wedge

Knowledge Check

When felling, how do wedges work?

During felling, should you place wedges parallel or perpendicular to the hinge?

Which one has a greater mechanical advantage: a 1- by 12-inch wedge or a 1- by 6-inch wedge?

What can you use when hanging wedges are not available?

Why are segments important?

Can you overcome the lean of this tree? Why or why not?

- Segment length: 18 inches
- Tree height: 120 feet
- Back lean: 4 feet

Summary

In this module, you learned to:

- Describe and discuss how wedges work
- Describe the different types of wedges
- Explain the different uses of wedges
- Explain how to use wedges in felling operations
- Calculate the number of segments in a tree

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