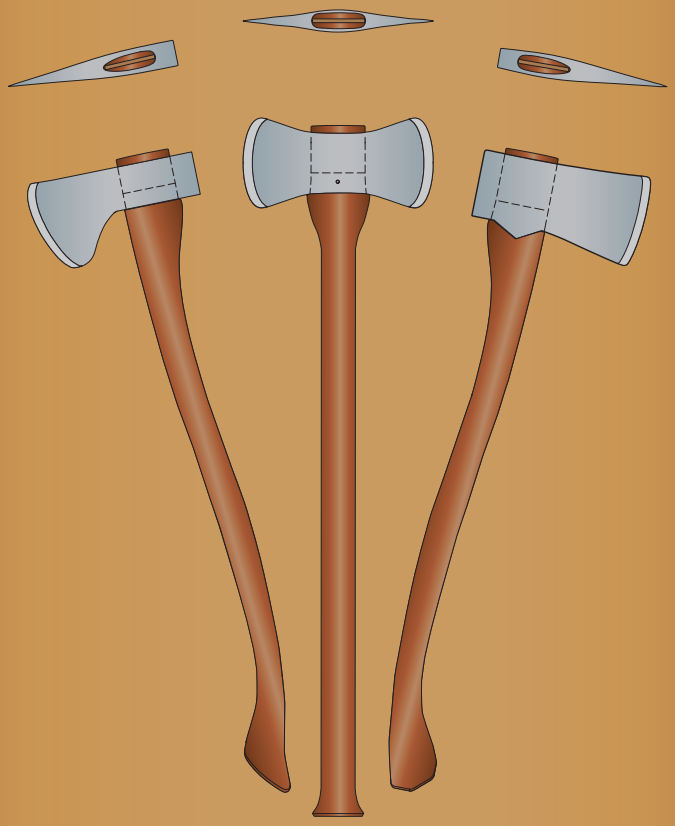
USDA

United States Department of Agriculture

One Moving Part



The Forest Service Ax Manual

Forest Service | National Technology & Development Program | 1823–2812P–NTDP Recreation | October 2020

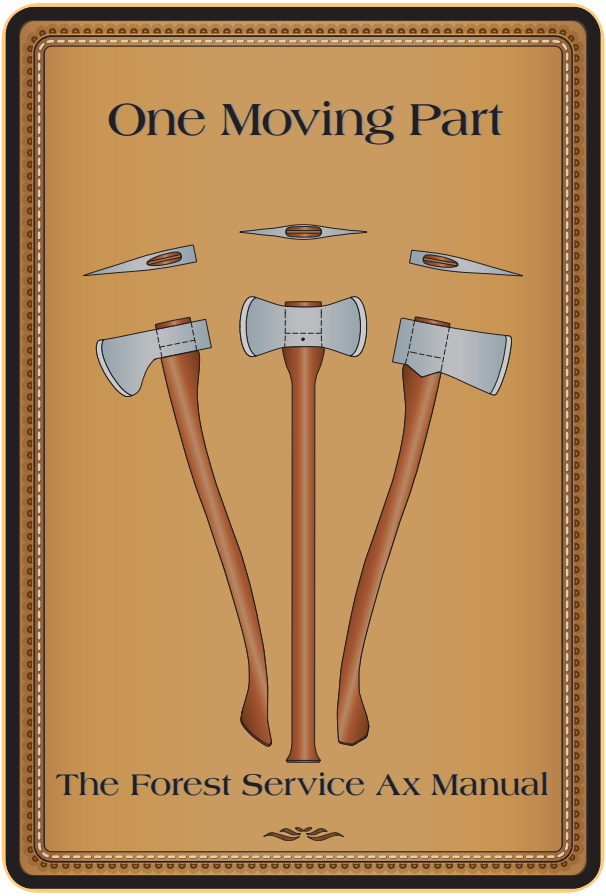
Axe Handles

One afternoon the last week in April
Showing Kai how to throw a hatchet
One-half turn and it sticks in a stump.
He recalls the hatchet head
Without a handle, in the shop
And go gets it, and wants it for his own.
A broken-off axe handle behind the door
Is long enough for a hatchet,
We cut it to length and take it
With the hatchet head
And working hatchet, to the wood block.
There I begin to shape the old handle
With the hatchet, and the phrase
First learned from Ezra Pound
Rings in my ears!
"When making an axe handle
the pattern is not far off."
And I say this to Kai
"Look: We'll shape the handle
By checking the handle
Of the axe we cut with."
And he sees. And I hear it again
It's in Lu Ji's *Wen Fu,* 4th century
A.D. "Essay on Literature"—in the
Preface. "In making the handle
Of an axe
By cutting wood with an axe
The model is indeed near at hand."
My teacher Shih-hsiang Chen
Translated that and taught it years ago
And I see: Pound was an axe,
Chen was an axe, I am an axe
And my son a handle, soon
To be shaping again, model
And tool, craft of culture,
How we go on.

—Gary Snyder, U.S. Poet Laureate

Cover illustration—Two different types of single-bit ax and a double-bit ax.

Poem illustration—A father sawing off a broken ax handle to make his son an ax.



Bob Beckley
Project Leader

U.S. Department of Agriculture, Forest Service
National Technology and Development Program

3E32A03—Ax Manual

October 2020

"Lincoln the Railsplitter" by Norman Rockwell.
—Collection of The Butler Institute of American Art, Youngston, OH

"Give me 6 hours to chop down a tree and I'll spend the first 4 sharpening the ax."

—Abraham Lincoln

Foreword—A Shared Inheritance

In today's society, new technology and mechanization have replaced, with unintended consequences, the need for much of the lore and skills maintained by American pioneers. What used to be required knowledge by most is now known by few. Commensurate with these losses is a similar lack of awareness that traditional tools are required to manage some of our most cherished backcountry and lands in the National Wilderness System. Recognition of these issues brought about the development of this book, and others, to preserve what is hopefully an enduring legacy and appreciation of historic, traditional tools, the traditional skills to use them, and the pride that comes from mastering them.

—Robert Wetherell, Supervisory Program Leader, U.S. Department of Agriculture, Forest Service, National Technology and Development Program

National Technology and Development Program Traditional Tools and Skills Publications

- An Ax to Grind: A Practical Ax Manual
- The Crosscut Saw Filer
- Crosscut Saw Manual
- Crosscut Saw Tooth-Setting Tool
- Crosscut Saw Underbucking Tool
- The Crosscut Sawyer
- Dovetails and Broadaxes: Hands-on Log Cabin Preservation
- Handtools for Trail Work
- New Tools for Old Saws
- Saws That Sing: A Guide to Using Crosscut Saws

Abraham Lincoln's ax.
—Abraham Lincoln Presidential Library and Museum (ALPLM)

Acknowledgments

This manual is dedicated to the memory of Dr. Don Jastad; axman, crosscut sawyer, mentor, and friend.

Special thanks to those axmen, crosscut sawyers, friends, and mentors who helped make this manual possible:

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- Sunni Bradshaw, for organizing and designing this manual and for designing the ax posters.
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- Deb Mucci (retired), for providing the illustrations in this manual and for developing the ax poster drawings.

Don Jastad earned the title "Bull of the Woods" at the International Lumberjack Championships, Century 21 Exposition, Seattle World's Fair, 1962 (near right). Jastad participated in the Forest Service Traditional Skills demonstration at the Florida Folklife Festival, 2005 (far right). *—Courtesy of Dr. Don Jastad*

Contents

Ax Condition

Many of the axes shown in this manual appear in unrestored condition, similar to what you might find in a garage, shop, or barn, or what you might purchase at a garage or antique sale.

Chapter 1—Introduction

An old saying that experienced axmen commonly hear goes something like, "my grandfather had the same ax his entire life, although he did replace the handle numerous times and the head twice." While humorous, this saying actually speaks to the intrinsic value of the ax and its place in American history.

Have you ever heard someone say "he can't get the hang of it?" Today, that expression typically means that someone does not understand something or is unable to complete a task. "Getting the hang of it" actually refers to the proper placement and alignment of an ax head on its handle. While the importance of the ax and the traditional skills required to properly maintain and use it have declined with the development of motorized tools (such as chain saws), the importance of the ax is so ingrained in our culture that we will forever use the expressions associated with it.

In this manual, the author provides a brief history of the ax, describes various types of axes and their uses, and explains how to choose, maintain, and personalize an ax to fit your needs. He also describes the historic importance of the ax in the U.S. Department of Agriculture, Forest Service, and explains why the ax is still relevant for fulfilling the Forest Service mission of caring for the land and serving people.

This manual serves as a guide for Forest Service employees, volunteers, and cooperators who work in the backcountry to maintain Forest Service trail systems, preserve historic structures, and protect wildlands. It is dedicated to preserving knowledge about the working ax and to the men and women who use this fundamental tool in the forests of America. It is not a comprehensive guide to axes and ax use, but is rather a primer to help ax users gain an understanding of this important tool and its safe and proper use.

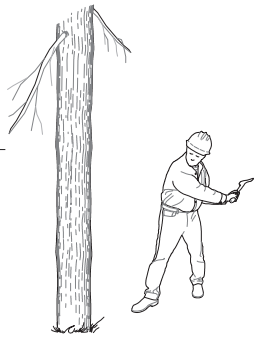
While this manual focuses mainly on axes, it also contains information about crosscut saws and wedges. Crosscut saws and wedges are companion tools to the ax and are particularly useful in wilderness settings where the use of motorized tools is prohibited.

To many of our ancestors on this continent, the ax was an integral part of life and a prized possession. People used axes, along with other traditional tools, to help carve out an existence on the vast American frontier. In some ways, the ax was as important to our ancestors as food and shelter, simply because it helped them to acquire both. The ax is, quite literally, one of the tools that helped to build America.

At first glance, the ax appears basic and uncomplicated, but it is far more than a metal wedge on the end of a stick. You can learn the basic skills to use this tool in a short time, but learning to master the skills takes a lifetime.

Let us guide our students over the road of discipline from materials, through function, to creative work. Let us lead them into the healthy world of primitive building methods, where there was meaning in every stroke of an axe, expression in every bite of chisel.
—Ludwig Mies van der Rohe

At one time, people learned traditional skills through hands-on tutoring and mentorship. As the use of traditional tools declined, hands-on instruction also declined. Other methods for conveying information about traditional skills evolved. Most recently, the internet has become a source of information for people interested in ax use and traditional skills in general.



There are hundreds of different ax styles and patterns (figure 1–1), covering a wide variety of specialized uses. This manual focuses mainly on American-style axes used in a forest setting. Axes from Australia and New Zealand also deserve recognition. People use these wider-faced, single-bit axes extensively in America's national forests; they are excellent for field and trail use.

Ax aficionados have very strong opinions about axes. Personal preferences for specific ax head styles, ax grinds, and handle lengths are an integral part of ax use. Historically, variations in axes generally worked for the needs of specific regions, or they became phased out or changed over time. There is no universal best choice for an ax, but over time and with trial and error, you can find the ax that works best for you.

Figure 1–1—Various ax styles and patterns.

A quality ax can last a lifetime with proper care, so choose your ax carefully and maintain it diligently. A new, mass-produced ax that you buy from the store today may not be an efficient cutting tool until you profile and sharpen it to fit your needs. Learn proper filing and chopping techniques and you will find your jobs easier.

Whether you use an ax or a crosscut saw, allow the tool do the work. A sharp, well-balanced tool will do the hard work for you; all you need to provide is the guiding force and direction. Chopping or sawing is strenuous, but it does not have to be difficult. Do not force the tool. Simply allow yourself to be an extension of it. Learn to develop a rhythm that enables you to move with the tool. Focus on smooth, fluid movements in conjunction with your breathing and you will find the work more enjoyable and rewarding. If you are fortunate enough to observe people who truly know how to use these tools, you will see a measure of grace and style in their movements.

Throughout his career, the author has been fortunate enough to receive mentoring from some of the best axmen in the Forest Service. The term "axman" is generic and refers to either male or female ax users.

The author's hope is to encourage readers to better appreciate the ax through an understanding of its nuances so that they may find the right ax for themselves and develop their own safe chopping habits and styles.

Chapter 2—The Ax in the Forest Service

At one time, the Forest Service required every vehicle entering the forest to have a shovel, an ax, and a bucket (figure 2–1). Forest Service policy no longer requires these tools, but they still play a valuable role. Many field-going personnel and forest visitors still carry these vital tools.

Relevance of the Ax in the Forest Service Today

The ax is a primary tool for accomplishing the Forest Service mission. It is especially useful for those going into designated wilderness areas where the law (Wilderness Act of 1964) prohibits chain saws and other motorized equipment.

Typical ax users include:

- Crews maintaining our Nation's forest trail systems
- Wilderness rangers, packers, stock users, and others traveling into our national forests
- Historic preservation teams restoring log cabins and fire lookout towers
- Firefighters using the pulaski (an ax/hoe combination tool) as a primary wildland firefighting tool

Whether people use the ax for felling, limbing and bucking (cutting into sections) trees, splitting firewood, restoring historic cabins, splitting fence rails, clearing trails, or fighting fires, this multipurpose tool is invaluable for a wide variety of tasks. In many cases, it is the only tool for the job. For the average forest visitor, the ax is a cost-effective tool that is easy to transport. Removing a downed tree across a forest road with a chain saw is easy, but chain saws can be expensive and they require gas and oil. Chain saws and fuel can be hazardous to transport in an enclosed vehicle, while an ax is easy to transport and requires no fuel. The ax takes up little room and, with training, is a safe and effective tool. Do not overlook or rule out the ax as part of your vehicle's standard equipment. Although people do not use the ax as often as they once did, it is still as useful a tool as it was in the past.

Figure 2–1—A vintage "Shovel, Ax, and Bucket" sign.

Prelude to Safety

Read this section; it is short, it is important, and it could save your life.

Safety is a constant theme throughout this manual. This section contains a few key points to always keep in mind.

Before you start to chop, honestly assess your personal health. Chopping is an aerobic activity that can quickly raise your heart rate. Be honest with yourself about your cardiovascular health and your ability to do strenuous ax work.

Along with your physical health, there are natural factors to consider. Whether felling trees or bucking downed logs, chopping involves moving wood. For your safety and the safety of those around you, you must understand that for every action there is an equal but opposite reaction. The effects of gravity are easy for most people to understand, but other pertinent forces, such as tree lean, tension, compression, and a variety of binds, are not as easy to identify. If you correctly identify the forces in the log or tree you cut, you may be able to mitigate these forces by the type of cut you make or the placement of the cut. If you do these things correctly, you can move the log or tree in the direction that you want. Learn the correct way to do the job so that you do not get hurt.

Your experience, technique, style, and the condition of your ax are irrelevant if you do not understand the mechanics of what you do. If you look at a complex cutting scenario and cannot envision the aftereffects of each cut, it is best to walk away and seek the help of someone with more experience. Unfortunately, good experience is often the result of bad experience. Learn from somebody else's mistakes, not from your own. Felling trees can be extremely dangerous and bucking logs can be even more dangerous, especially if a log intertwines with other downed logs on a hillside, creating multiple binds.

Obtain training and take it seriously; your life depends on it. The laws of physics are nonnegotiable.

Chapter 3—A Brief History of the Ax

The ax has been part of human history for thousands of years. From its earliest beginnings as a stone tool, people used the ax primarily for breaking rather than chopping. As early humans learned to chip the sides of a stone to create sharp edges, the cutting edge was born. From this early stage, the ax evolved from stone, to soft metals, to hardened steel. The durability and efficiency of the ax increased with each advancement. The shape of the ax head and the functionality of the ax itself changed with advancements in metallurgy. People developed specialty axes for a variety of uses, with many axes having nothing to do with chopping wood. The various uses for and functionality of the ax has made it one of the most versatile and important tools in the history of humankind.

When European explorers arrived in America, they brought European-style axes with them. The evolution of the ax in Europe produced a variety of specialized axes for chopping, hewing, and shaping, and for other commercial and domestic tasks. However, European axes were not stout enough for the timber types and hard use they faced in America. The most common ax styles used during America's early history were trade axes, the German ax, the Spanish ax, and the Anglo-American ax. These styles had narrow cutting edges and no poll (the extended metal backside of a single-bit ax head).

Strict regulations and high taxes placed on axes imported to America and on the materials required to manufacture axes made these tools scarce. As America grew, the demand for axes increased. Local mining and the processing of raw materials enabled village blacksmiths to begin producing the tools that helped to build this country.

The first axes manufactured in America were similar to their European counterparts, but they soon evolved into modified European-American patterns that eventually led to the variety of American patterns we use today. A poll on the back of the ax and a more rectangular cutting edge distinguished early American ax patterns (figure 3–1) from European patterns.

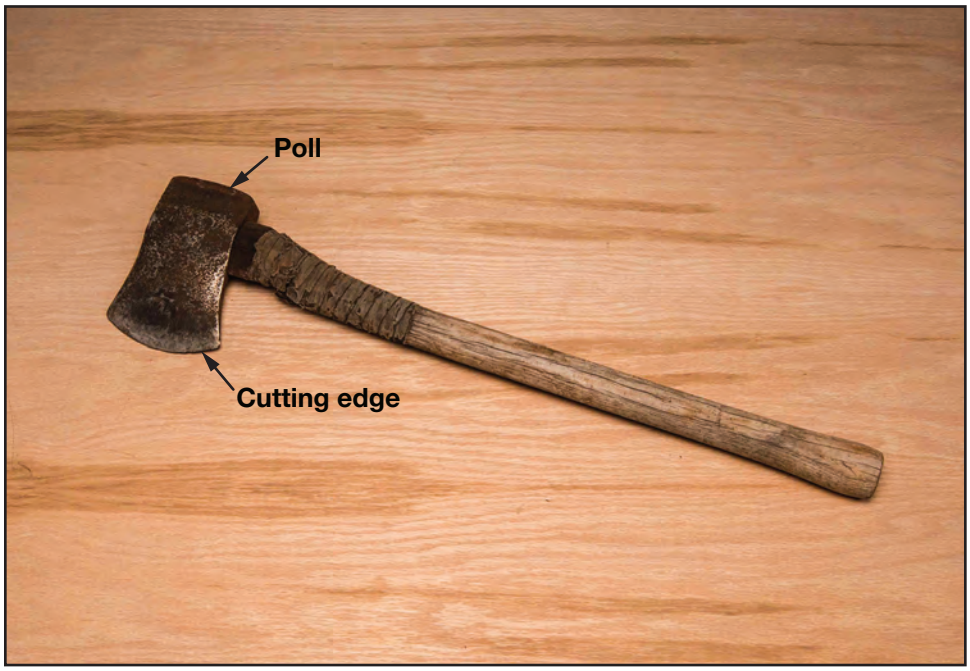


Figure 3–1—An early American, single-bit ax with the poll and cutting edge labeled.

The USS *Philadelphia,* a gunboat built and sunk in 1776, is on display at the Smithsonian National Museum of American History in Washington, DC. The display contains many artifacts, including several ax heads (figure 3–2) that show the transition from the European- to the American-style ax pattern (figure 3–3).

Figure 3–2—Two ax heads from the exhibit at the Smithsonian National Museum of American History in Washington, DC. *—Military History, Smithsonian Institute*

As American settlers moved west, the number of American ax patterns expanded. People changed the shapes and grinds of axes to adapt them to different tree species and sizes. This eventually led to development of the Puget Sound felling ax for the big timber of the west coast. When hung on a 44-inch handle, the narrow, elongated cutting edge of the Puget Sound felling pattern (figure 3–4) enabled lumberjacks to reach deep into and across the large-diameter timber of the Pacific Northwest.

The American ax-manufacturing industry reached its peak in the early to mid-20th century. Local blacksmiths producing individual axes gave way to a new industry of mass-produced axes for domestic use and for export around the world. Beginning in the 1940s, several important events led to the decline of the American ax-manufacturing industry.

During World War II, many American industries retooled to manufacture equipment necessary to support the war effort. At the end of the war, many of these companies chose not to return to manufacturing axes, or manufactured them only for a limited time and often in conjunction with the production of other tools.

The development of the chain saw also led to the decline of the ax-manufacturing industry. Though versions of motorized saws date back to as early as the

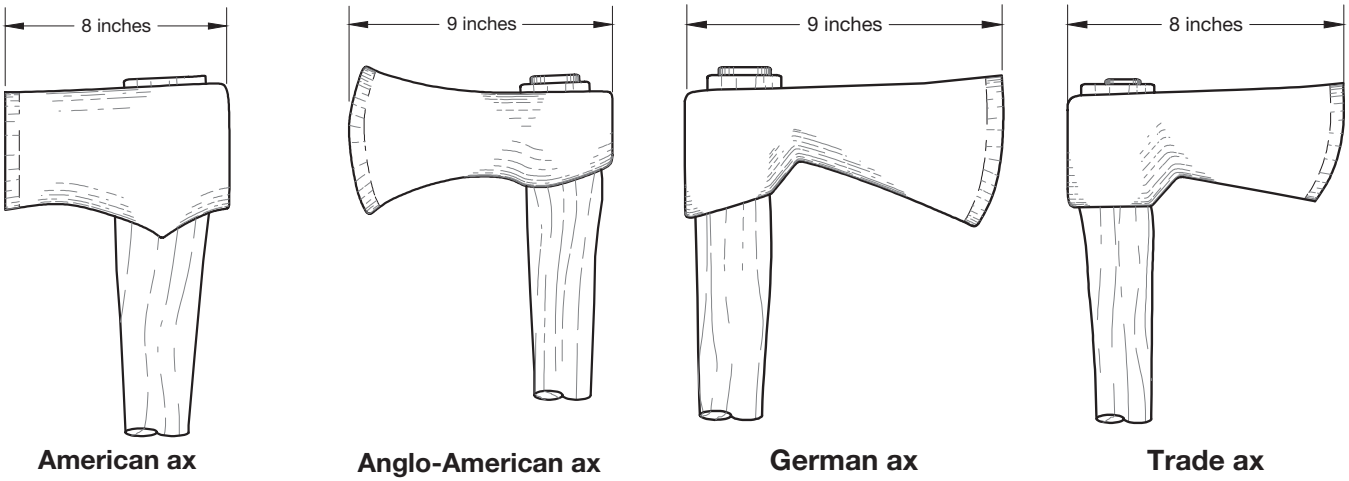


Figure 3–3—Early European- and American-style ax heads.

Figure 3–4—A Puget Sound felling ax head on a 44-inch handle.

late 1800s, these saws were large, heavy, and not easy to use in the woods. Loggers used the drag saw (figure 3–5), the most common of these early motorized saws, to buck logs using a vertical cutting motion. However, some models had a blade (also called a "bit") that loggers could rotate and use to make the horizontal cut in felling operations. Early chain saws became available in the 1920s, though they were unreliable and had numerous limitations. Initially, early chain saws could only make horizontal cuts. The carburetors of that era prevented sawyers from making diagonal cuts with chain saws, so the sawyers still required axes. During the 1940s and early 1950s, advances in carburetor technology and the development of smaller, lighter, and more efficient motors made chain saws more manageable and reliable.

Figure 3–5—Two young loggers using a Vaughn drag saw, circa 1921. *—University of Washington*

As people began to use chain saws more widely, the use of crosscut saws declined. Axes are companion tools to crosscut saws. Sawyers using crosscut saws to fell trees typically used an ax to chop out their sloping cut (figure 3–6) and to remove tree limbs. The move from crosscut saws to chain saws led to a decline in ax use.

Ax use further declined with the advent of modern chain saws. Although axes are still companion tools for saw work (figure 3–7), people primarily use them with saws to drive wedges and not to chop wood.

Only a few manufacturers in America today still produce axes, but other countries make quality axes and export them to this country.

Figure 3–6—An axman chopping a sloping cut.

Figure 3–7—Sawyers using a crosscut saw to perform a back cut. Note the ax and wedges at the base of the tree.

Chapter 4—Anatomy of an Ax

The first lesson in developing axmanship skills is becoming familiar with the parts of the tool. Knowing the various parts of an ax helps you to understand the purpose and functionality of the tool and enables you to properly fit an ax to your own individual needs. The ax is not a one-size-fits-all piece of equipment.

The ax consists of two primary parts: the head and the handle. The head and handle themselves have many parts. Figure 4–1 shows the various parts of single- and double-bit axes.

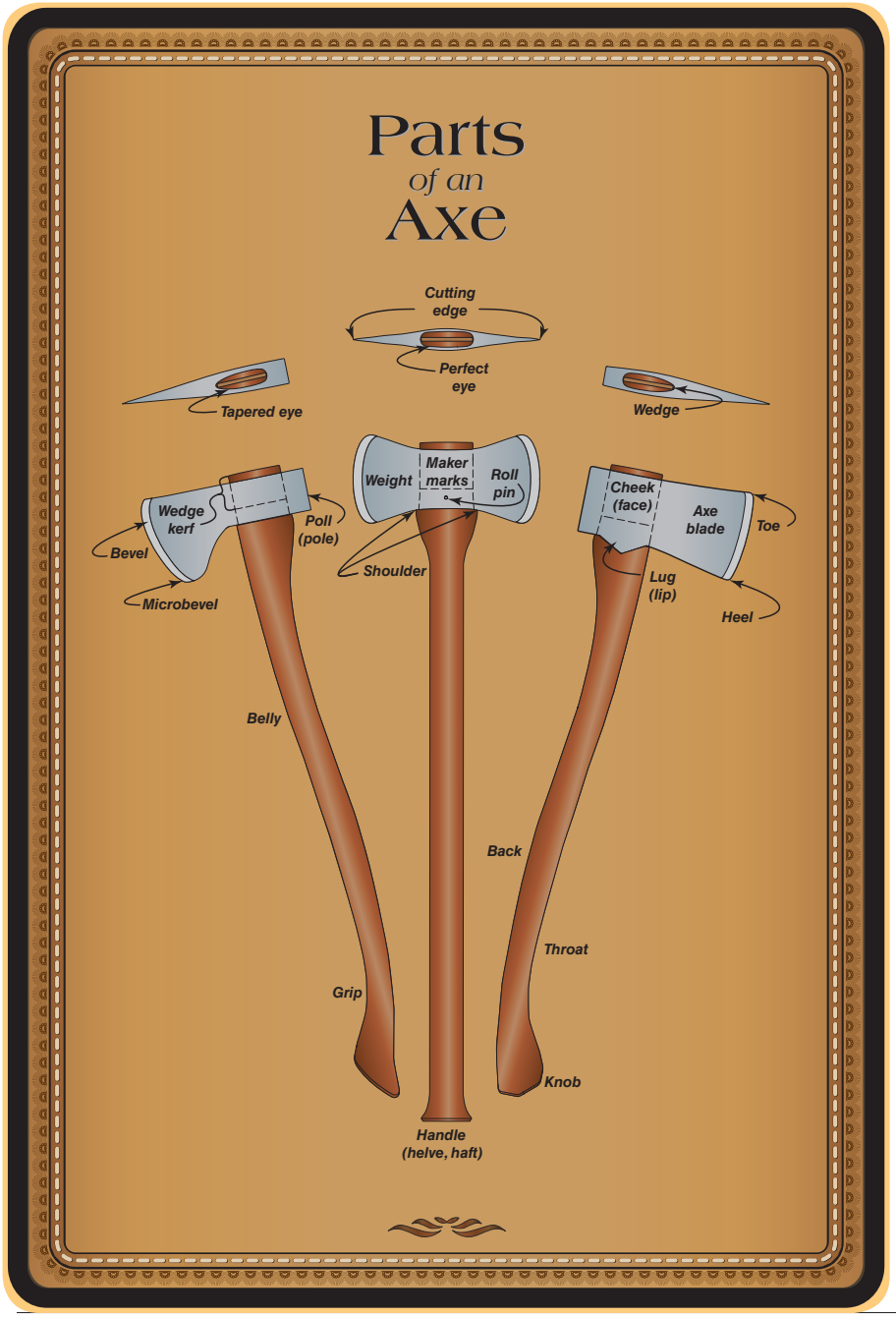
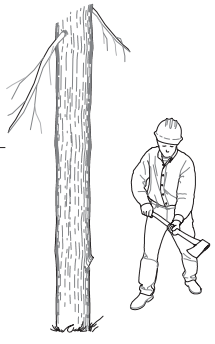


Figure 4–1—Pats of single- and double-bit axes. Refer to "Appendix A—Full-Page Ax Illustrations" for a larger version of this illustration.



Chapter 5—Types of Axes and Related Tools

Single-Bit Axes

The European single-bit ax evolved into the American single-bit ax with the addition of the poll. By adding weight to the back of the ax head, the poll provided better balance and increased the striking force of the ax. The additional change from the long, narrow European cutting edge to the shorter, wider American cutting edge increased the accuracy and durability of the tool. The poll and wider cutting edge of the American single-bit ax (figure 5–1) increased its cutting efficiency and made it the new standard.

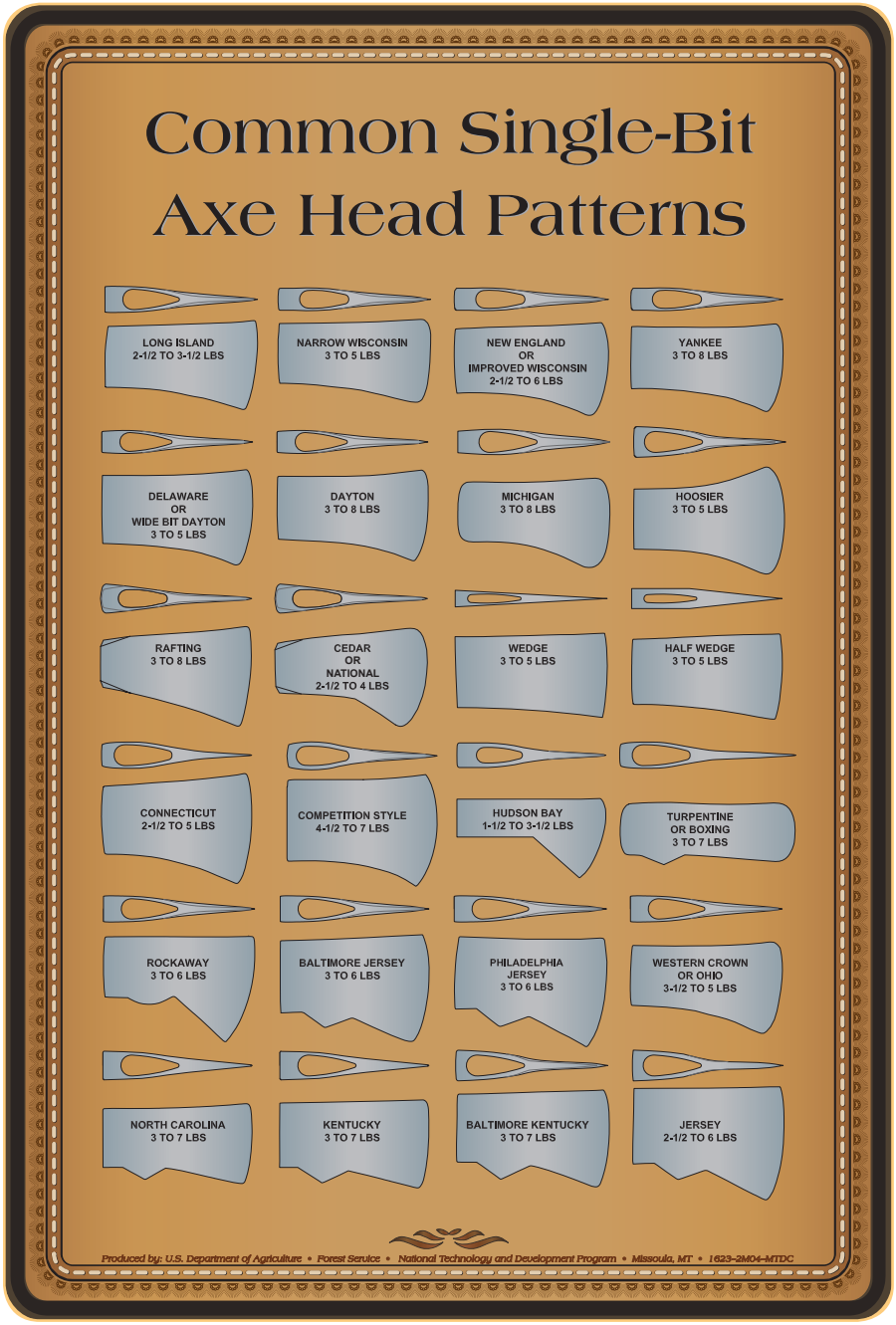
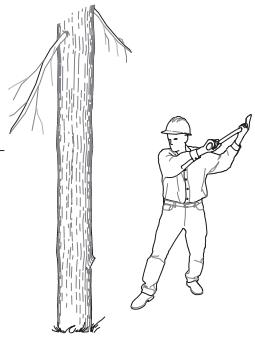


Figure 5–1—Common single-bit ax head patterns. Refer to "Appendix A—Full-Page Ax Illustrations" for a larger version of this illustration.



The poll also created a flat striking surface on the back side of the ax head, providing the user with a pounding or driving tool as well as a cutting tool. Keep in mind that, even today, the poll typically is not hardened steel and you should not use it to strike another piece of steel, such as a metal splitting wedge. Doing so will damage the poll (figure 5–2). Some modern axes may have hardened polls, but most vintage axes do not.

One exception is the rafting-pattern ax (figure 5–3). In the past, logs held together with steel cables and chains formed rafts that loggers floated downstream to the sawmill. The hardened poll on the back of a rafting-pattern ax allowed the loggers to drive metal fasteners to secure the cables and chains without damaging their axes.

Figure 5–2—A Winchester ax with a damaged poll.

Figure 5–3—Plumb 5-pound and 3½-pound rafting-pattern axes with elongated polls. The inset shows a rafting-pattern ax with a waffled poll.

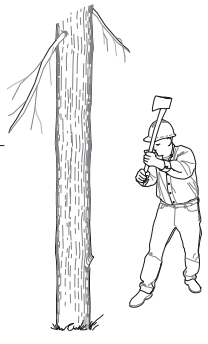
Splitting mauls and sledge hammers (figure 5–4) have hardened ends, so it is best to use one of these tools to drive metal splitting wedges or to strike other metal surfaces.

Today, typical single-bit ax heads weigh 3½ to 4½ pounds and typical handle lengths range from 30 to 36 inches.

Competition-style (or -pattern) chopping axes (figure 5–5) appear to be the next evolution of the single-bit ax. Australian axmen designed and developed this pattern. This ax is often in the 5 to 6 pound range and has a wider blade and shorter handle length (28 to 30 inches) than a typical American ax. The competition chopping ax is an extremely efficient cutting tool, but the weight and typical handle length may not be appropriate for novice axmen.

Figure 5–4—A sledge hammer (top) and a splitting maul (bottom).

Figure 5–5—Keech and Tuatahi competition-style chopping axes.



Double-Bit Axes

Despite early versions of the double-bit ax discovered in Crete, which date back thousands of years, the modern double-bit ax is uniquely American. Throughout history, people have used axes to serve multiple purposes and to meet a variety of chopping needs, but they designed the double-bit ax (figure 5–6) specifically for felling trees.

During the 1800s, the westward expansion of population and the influx of immigrants resulted in resource development on an unprecedented scale. America was growing, and the construction of cities, towns, and factories required a steady supply of lumber. The mining industry and railroads played a significant role in the growth of America, and these industries relied heavily on timber.

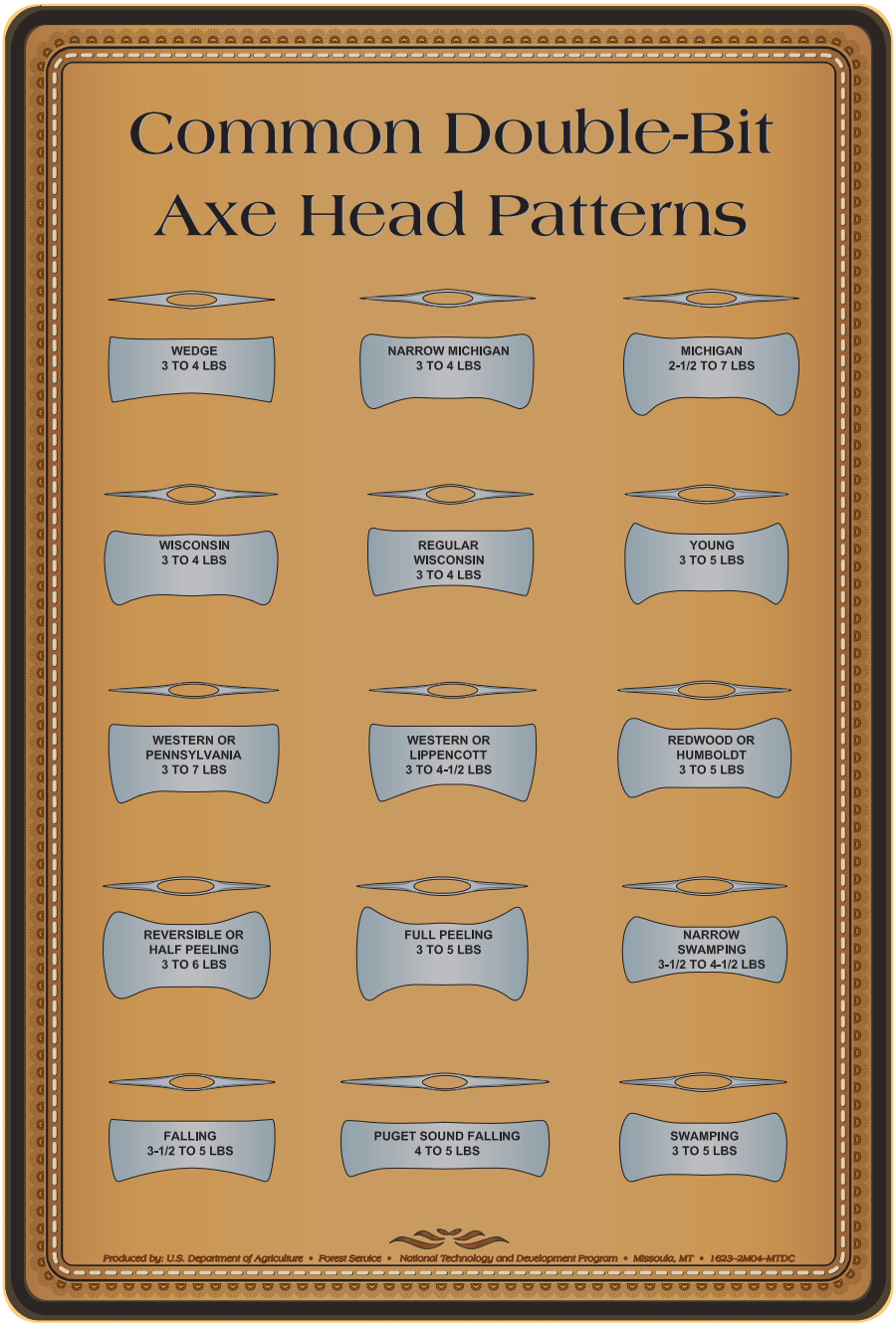


Figure 5–6—Common double-bit ax head patterns. Refer to "Appendix A—Full-Page Ax Illustrations" for a larger version of this illustration.

Crosscut saws were available in the early to mid-1800s, but saw manufacturers had not yet fully developed efficient cutting tooth patterns. This enabled the ax to remain the primary timber-felling tool. The modern double-bit ax began to gain popularity somewhere around the 1840s.

The logging industry employed thousands of lumberjacks to meet the growing demand for lumber. Frequently working and living in remote logging camps, these lumberjacks relied on their own tools for their livelihood. Back then, the loss of an ax could mean the loss of employment. Many stories describe how these loggers so cherished their axes that they carried them with them wherever they went.

Because companies paid lumberjacks by piecework or by the volume of timber they cut, the lumberjacks often searched for ways to increase their efficiency. The development of the double-bit ax provided the logger with two cutting edges instead of one.

Axmen will probably always debate the proper sharpening techniques for a double-bit ax. The Forest Service's preferred method is to leave one edge thinner and sharper and the other edge thicker so that it doesn't have as sharp a cutting angle. Ax nomenclature refers to the thinner, sharper edge as the "keen" edge and the thicker edge as the "stunt" edge. The difference in cutting edges allows axmen to use the proper edge for the type of wood they cut. The keen edge sinks deeper into wood that is free of knots and allows the axman to remove bigger chips. The stunt edge is better in harder, dense wood, such as tree limbs or knots, and allows the axman to work without bending, chipping, or otherwise damaging the cutting edge of the ax.

The visual differences between the keen and stunt edges can be subtle. Many experienced axmen rely on other visual indicators to identify the cutting edge they wish to use. These visual indicators could correspond with the side of the ax that has the manufacturer's mark or may be a mark the axmen place on the side of the ax or ax handle (figure 5–7). Personalizing the ax handle is a good way to identify which is the stunt edge and which is the keen edge.

Figure 5–7—This True Temper Kelly Works Flint Edge double-bit ax (stamped "CMSTP&P RR") has a mark on the handle that indicates the keen edge.

Pulaskis

The pulaski (figure 5–8) is the field tool that the Forest Service uses most commonly today. Named after Forest Service ranger Ed Pulaski, who saved most of his crew of wildland firefighters during the massive fires that burned Idaho and Montana during 1910, the pulaski is the Forest Service's primary firefighting tool.

The head of the pulaski has an ax blade on one side and a grubbing hoe (perpendicular to the ax blade) on the other. The grubbing hoe is similar in shape to an adz, but it is stouter and not as sharp. When properly maintained, the end of the grubbing hoe is sharp enough to cut roots, but stout enough to resist being chipped or damaged by rocks. Users can fell trees with the ax blade and dig fireline or build trails with the grubbing hoe. While it is an efficient firefighting or trail tool, the pulaski typically is a poor choice for felling trees, limbing, or for making precise cuts. Designed primarily for fighting fires, the balance of a pulaski makes it a poor replacement for an ax; a single- or double-bit ax is the better choice when chopping is the primary objective.

As with axes, the pulaski has gone through numerous changes through the years. Some designs incorporated wider hoe ends, reinforced hoe ends, different shaped hoe ends to increase cutting efficiency, and other design changes. While some of these changes modified the design, the basic pulaski design is still more or less the same as the original (figure 5–9).

Today, pulaskis have an average head weight of 3¾ pounds and a 36-inch handle. The pulaski has a straight, ergonomic, double-bit ax handle that allows the user to switch easily from the grubbing end to the ax end. Some taller members of trail and firefighting crews replace the 36-inch handle with a 40- to 44-inch handle (figure 5–10) to reduce stooping and back fatigue. The longer handle appears to provide better balance to taller people using the pulaski, though chopping accuracy decreases with handle length.

Figure 5–8—A Kelly World's Finest pulaski.

Figure 5–9—Early pulaski designs. Although designed as a wildland firefighting tool, early pulaskis were originally sold as grubbing tools.

Figure 5–10—A standard pulaski with a 36-inch handle (top) and a pulaski with a 44-inch handle (bottom).

The Forest Service Pulaski and the Man Who Designed It

The pulaski is one of the best known and most commonly used wildland firefighting tools in the world. The tool, and the man who designed it, deserve special recognition in this manual.

Edward Crockett Pulaski (figure 5–11) was most likely born on February 9, 1868, in Green Springs, OH, to parents of Polish descent. Pulaski's distant relative, Casimir Pulaski, fought under General George Washington during the Revolutionary War.

At 16, Pulaski headed west into the Idaho and Montana territories. He worked at various jobs over the next couple of decades before joining the Forest Service in July 1908 at age 40.

Known as "Big Ed," Pulaski wasn't a typical Forest Service employee. The Forest Service was in its infancy, and most employees at that time were young and college educated. Pulaski had a lifetime of practical skills learned from working outdoors.

Pulaski led a fire crew during the summer of 1910 when massive wildfires spread across North America, burning an estimated 3 million acres in Idaho and Montana and 40 to 50 million acres nationwide. He is credited with saving many crewmembers about to be overrun by fire. He recounted the story in the August 1923 edition of "American Forestry," stating, "On August 20 a terrific hurricane broke over the mountains. It picked up the fires and carried them for miles. The wind was so strong that it almost lifted men out of their saddles, and the canyons seemed to act as chimneys, through which the wind and fires swept with the roar of a thousand freight trains."

Pulaski knew the fire would overtake his crew. Of the roughly 120 men in the area, Pulaski was able to gather 45 men and lead them to a nearby mine tunnel. One of the men perished along the way.

Pulaski and the remaining 44 crewmembers, along with two horses, had barely entered the mine when the fire swept over the area. Some of the crewmembers panicked and wanted to run from the mine. Pulaski drew his pistol and warned, "The first man who tries to leave this tunnel I will shoot." He didn't need to use the gun.

As the fire swept over the area, the mine timbers caught fire. Water seeping into the mine enabled the men to hang wet blankets over the entrance and to fill their hats with water to throw on the burning timbers.

Figure 5–11—"Big Ed" Pulaski.

Some of the men, including Pulaski, eventually succumbed to the heat, smoke, and gasses, falling unconscious. When the air began to clear, and the crewmembers slowly regained consciousness, all but five of those who entered the mine had survived.

When it was safe, the crewmembers exited the mine and made their way across the burning logs and smoking debris to the town of Wallace, ID, more than 3 miles away. As Pulaski described the situation, "We were all in terrible condition; all of us were hurt or burned. I was blind, and my hands were burned from trying to keep the fires out of the mine. Our shoes were burned off our feet, and our clothes were parched rags. We were covered with mud and ashes."

Pulaski spent 2 months in the hospital with temporary blindness and pneumonia.

The Pulaski Tool

In the early days of wildland firefighting, firefighters had no specialized firefighting tools and used whatever tools they had on hand.

The history of the pulaski is a bit of a mystery. The Council Tool Company may have developed a similar tool for clearing land as early as 1876 (the author believes this tool to be the ax-mattock).

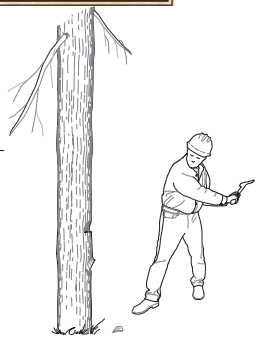
In one story, Earle P. Dudley, a Forest Service employee who worked with Ed Pulaski, claimed to have had a local blacksmith build him a pulaski-like tool out of a pick in 1907.

In another account, Coeur d'Alene Forest supervisor William Weigle sent rangers Joe Halm and Ed Holcomb to Ed Pulaski's hometown blacksmith shop in late 1910 or 1911 to build a specialized tool for planting trees. Halm and Holcomb cut one blade off a double-bit ax and welded a mattock hoe at a right angle to the remaining blade. They also added a removable shovel attachment. Forest supervisors evaluating the tool at a meeting in Butte, MT, during 1911 considered it inadequate for planting trees.

Pulaski continued to experiment with and improve the tool design, removing the shovel and reshaping and lengthening the ax and mattock blades. By 1913, Pulaski had designed and developed the tool that now bears his name (figure 5–12). By the 1920s, the pulaski became the accepted primary firefighting tool, and commercial tool companies began manufacturing it.

With only minor design changes and modifications, the pulaski has continued to be the primary wildland firefighting tool for more than 100 years.

Figure 5–12—The original pulaski, built by Ed Pulaski, on display in the Wallace Mining Museum, Wallace, ID.



Undercutter Axes

The undercutter ax (figure 5–13)—also called a chain saw ax or chisel ax—looks similar to a pulaski. Ax manufacturers originally designed the undercutter ax for the logging industry in the early days of the chain saw. Early chain saw carburetors had to be in a vertical position, making a diagonal undercut using a chain saw difficult. Rather than use a chain saw to make a diagonal cut, loggers made a series of close horizontal cuts and used the chisel end of the undercutter ax to chop out the wood between the cuts (figure 5–14). Manufacturers developed the undercutter ax to remove or clear the wood from the undercut. While the pulaski and the undercutter ax may look similar, the pulaski has a hoe end for grubbing in the dirt and the undercutter ax has a chisel end for removing wood. Manufactured between the mid-1930s and the early 1950s, undercutter axes were short lived but useful.

Figure 5–13—An undercutter ax.

Figure 5–14—Using the chisel end of an undercutter ax between two horizontal cuts to create an undercut.

Cruiser, Saddle, and Camp Axes

Forest Service crews do not use shorter-handled, lighter-weight axes as often as they once did. These smaller axes include cruiser axes, saddle (blazing) axes, camp axes, and boy's axes. Traditionally, cruiser or saddle axes tended to have double bits, while camp or boy's axes tended to have single bits.

Timber crewmembers especially liked the double-bit cruiser ax and carried it in their packs or on their horses. Crewmembers historically used the cruiser ax to mark timber and timber sale boundaries.

The original saddle ax—also known as the blazing ax—was smaller and lighter than the cruiser ax. People historically used the saddle ax (figure 5–15) as a light camp ax and for blazing trails. Blazing refers to the act of marking a trail by chopping bark off sections of trees, indicating a direction of travel. Traditionally, the Forest Service blaze was a small mark above a larger mark (figure 5–15, inset). The blaze looked similar to an upside-down exclamation point. Forest Service crews no longer blaze trails with an ax; they mark trails with appropriate signage instead.

Figure 5–15—A Shapleigh Hardware Company Diamond Edge saddle (blazing) ax.

The true cruiser or saddle ax has a double bit, up to a 2½-pound head, and a handle as long as 28 inches (figure 5–16). Commonly today, you may find an ax with up to a 3½-pound head referred to as a cruiser, but this is really a full-sized ax with a short handle. The difference is in the size of the eye of the head; a true cruiser, saddle, camp (figure 5–17), or boy's ax has a smaller eye to accommodate the traditionally smaller handle.

People tend to categorize these smaller axes together. They are popular with people using stock. Because these axes have shorter handles and lighter heads, they are best suited for intermittent use and not for chopping all day or for felling large trees.

Figure 5–16—This Collins cruiser ax with a 2¼-pound head on a 28-inch handle is well suited for light-duty chopping.

Figure 5–17—A Dillon Camp single-bit camp ax and a Marbles double-bit camp ax. Both axes have 2-pound heads.

Brush Axes

Although Forest Service trail crews no longer commonly use the brush ax (figure 5–18)—also known as the brush hook—it is an excellent tool for clearing small trees or heavy brush. The standard brush ax used by the Forest Service has long, hooked blades and is similar in thickness to a heavy machete. The blade fits a standard 36-inch single-bit ax handle. Other, less common brush ax models have round or oval handles. The sharpened inside edge severs small saplings or brush. The hooked upper end serves several purposes. People can use the hook to pull material into the blade and to pull the material out of the way after severing it. Another type of brush ax has a hooked blade and a chopping blade on the opposite side.

Manufacturers do not design brush axes for felling or bucking large logs; people use them as clearing tools. For smaller material, people can use one or two hands to choke up on the handle—holding the ax just below the head—and use it like a machete. For heavier material, they can use two hands and more of a full swing. The model the Forest Service uses has a typical head weight of about 3¾ pounds. Other styles range from 2½ to 6 pounds. Brush axes do not require an ax-type profile and are easier to sharpen because of their overall thinner blade design.

Using the brush hook to clear brush requires a degree of finesse. Because brush typically has multiple stems, the hook may be prone to catching on a branch or other obstacle, which may deflect the strike from its intended target. Rather than the overhead chopping motion used with an ax, the brush hook works more efficiently with an upward or downward side cut using a sweeping motion.

Figure 5–18—Three brush axes.

Swede Axes

The Swede ax (figure 5–19)—or Swedish brush ax—is similar to the brush ax. Some people refer to the Swede ax as a Sandvik, but this is strictly a brand name and other companies make similar tools. The Swede ax is not a true ax; manufacturers design it for cutting small brush and limbs. This tool has a removable or replaceable blade fixed to a yoke and handle. The steel cutting blade is typically 7-inches long, 1¾-inches wide, and 1⁄16-inch thick, and handle lengths range from 24 to 28 inches. The Swede ax is lightweight (about 2 pounds), making it an ideal trail tool for cutting small material. The short handle and relatively light weight allow users to hold the brush with one hand and chop with the other.

Like the brush ax, the Swede ax blade is much simpler and easier to file and maintain than a traditional ax. A mill bastard file is the proper tool for filing a Swede ax and a whetstone is the proper tool for sharpening it. If possible, try to maintain the shape of the factory edge.

Figure 5–19—A Swede ax.

Specialty Axes

As a necessary tool for a growing country, the ax evolved with society to fulfill a multitude of purposes. While this manual focuses on typical axes that the Forest Service uses today, the reader should understand that there are axes designed for other purposes. Some manufacturers design axes for splitting rails, notching logs, cutting ice, cutting sod, and butchering animals, to name only a few uses.

The ax and hatchet shown in figure 5–20 are two versions of Forest Service marking axes. The insets show the "US" stamp on the poll end of the ax and hatchet. The Forest Service used these marking axes to identify sale logs for commercial logging operations on National Forest System lands.

Figure 5–20—A Forest Service timber marking ax and hatchet. The insets show "US" brands.

Hatchets

Similar to specialty axes, there are numerous types of hatchets available (figure 5–21). Hatchets are basically small axes. Like axes, they come in different styles for different purposes. The standard hatchet typically has a head weight of less than 2 pounds and a handle length of less than 20 inches.

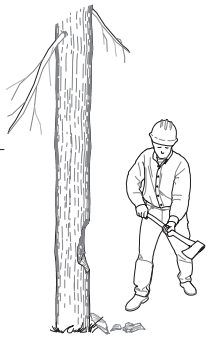
Few Forest Service field employees carry hatchets anymore because hatchets have limited applications in general forestry work. This is not to say that hatchets have limited value or that they are not useful tools. Hatchets are extremely useful for historic preservation work on log cabins and buildings. People commonly use the broad hatchet for this type of work. The broad hatchet is a smaller version of the broadax. Today, people commonly use other styles of hatchets for shingling or roof repair, carving, hunting, and camping.

Figure 5–21—Two Boy Scout hatchets; a Bridgeport with a steel handle (top) and a Plumb with a wooden handle (middle); and a broad hatchet (bottom). The broad hatchet, like the broadax, is used for shaping rather than general-purpose chopping.

Miniature Axes and Child's Axes

At one time, manufacturers and blacksmiths across America made numerous types of miniature axes (figure 5–22). Today, we may look at these tools as novelties, but they once served a more utilitarian purpose. These high-quality tools were excellent camp or kitchen axes, but their true value may have been as a child's first real ax. With the significant role that axes played in family life, everyone needed to know how to use the tool properly and safely. In the past, parents commonly gave children real tools, then taught the children to use the tools properly. Regardless of where these miniature axes were produced (in a factory or at home), they were important tools for learning critical life skills. Using these axes helped to instill a strong work ethic at a young age and taught children to respect tools and develop confidence in using them.

Figure 5–22—Miniature ax heads, from left to right: a single-bit ax head marked "Missoula, Mont.," a Norlund Hudson Bay pattern single-bit ax head, a Winchester broad hatchet head, and a Norlund double-bit ax head.



Survival Axes

While working on this manual, the author received numerous inquiries asking about the best type of survival ax. Those looking for a survival ax must determine their needs for the area of the country in which they live. Keep in mind that "survival ax" is a generic term made popular by the survivalist (or prepper) movement. In reality, any ax can be a survival ax if the user has the knowledge and skills to use it properly.

The ax can be an important survival tool, but it is not the only tool you need. Your overall survival skills and familiarity with the outdoors are more important than the style and weight of your ax. Skilled outdoors people may find that a small, lightweight ax or hatchet meets their needs, whereas people with less skill may be better off with a larger ax. Your ability to use and maintain an ax efficiently and safely, not the ax itself, will help to keep you alive in a survival situation.

To determine the type of ax that is appropriate for your needs, take into account your skill level and how you will use the ax. If you will use the ax primarily to chop wood for heat, cooking, or to build a shelter, a large ax may be preferable to a small one. Think about the energy you will expend and the calories you will burn. In a survival situation, these factors are critical. A heavy ax head with a long handle moves more wood in less time than a light ax head with a short handle. This is especially true for large-diameter logs.

Preservation Tools

Axmen use axes to chop wood. Heritage specialists use preservation tools (including axes) to shape logs into a finished product (e.g., a cabin, a floor, and so forth).

Broadaxes

The broadax—also known as a hewing ax—is not a typical chopping ax, but no ax manual would be complete without a few words about broadaxes.

The broadax (figure 5–23) is a favorite tool of Forest Service employees and volunteers who restore historic log structures across the U.S. The design of the broadax makes it the best ax for squaring or flattening the sides of round logs. Employees and volunteers also use broadaxes and hatchets for timber frame construction. The design of the broadax enables precise chopping using short, controlled strokes. Despite its large size and weight, people use the broadax with finesse (not power and force) to do detailed work and to shape logs.

The broadax head is similar in shape to a wood chisel. One side is beveled and sharp, while the other side is flat. This design helps users to cut a flat surface on the log. Broadax heads also typically have a slight cant (slope) beginning at the eye and extending to the cutting edge, which also helps users achieve a flat cut. If the broadax had a straight, flat plane from the cutting edge through the poll, it would not cut a flat surface as easily.

Broadaxes typically have short handles because longer handles impede the user's ability to perform fine hewing work. Broadax handles are generally offset for left- or right-handed users so the users do not scrape their knuckles on the log as they chop (figure 5–24). The offset handle and slight cant of the broadax head enable the user to achieve a flat cut.

Figure 5–23—A side view of a broadax showing the offset handle.

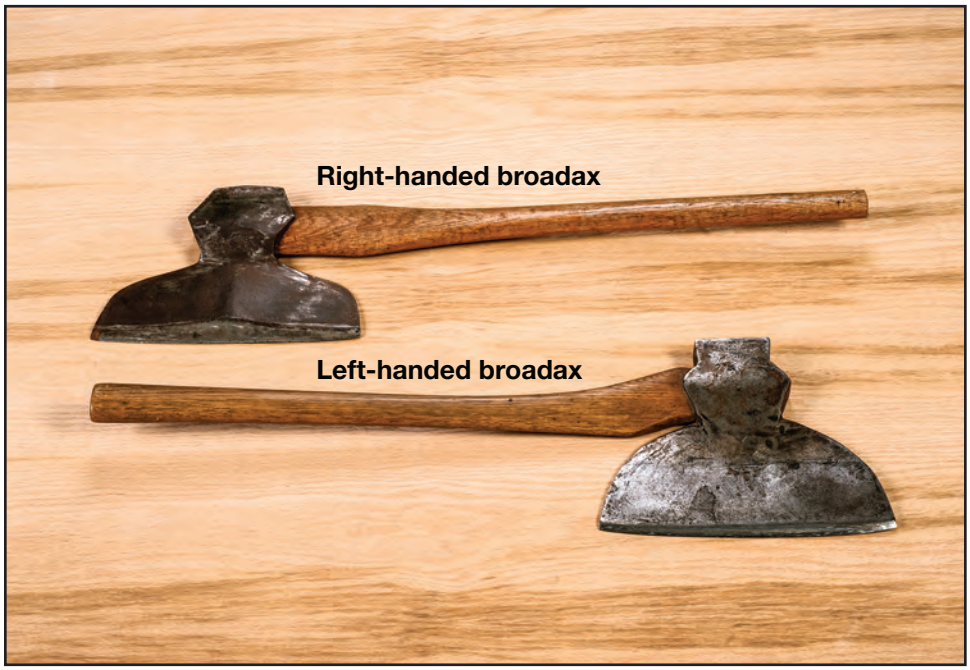
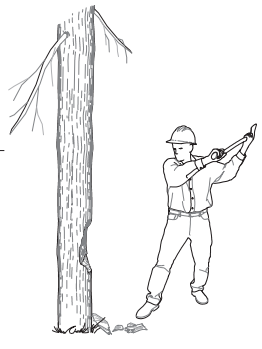


Figure 5–24—A broadax head and handle for a right-handed person and for a left-handed person.



Not all broadaxes have canted heads and short handles. Some broadaxes have a straight, flat surface (from the cutting edge through the poll) and longer, full-length handles (figure 5–25). This style of long-handled broadax provides speed and power where fine, detailed work (such as hewing railroad ties or bridge beams) is not required.

Broadaxes weigh more than standard chopping axes; typically a minimum of 5 pounds and frequently around 8 pounds.

Adzes

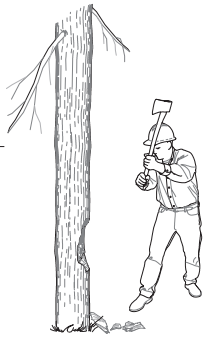
The carpenter's—or hewing—adz is not an ax, but an edged tool used for hewing logs. This specialized tool plays an important role in historic building preservation. It is usually a finishing tool and not a primary hewing tool. Preservationists use the broadax to make a flat surface and then use the adz to finish or smooth out the hewing gouges.

In some respects, the adz used for historic building preservation may look similar to a garden hoe, but the adz has a sharpened, chisel-shaped edge. For the types of log cabin restoration and historic preservation work that the Forest Service performs, the full-sized adz, the gutter adz, and the bowl adz (figure 5–26) cover the majority of the Forest Service's basic needs. The gutter adz and bowl adz have a scooped or concave head that is useful for making log cabin notches.

Do not confuse a hewing adz with an adz hoe—also known as a grubbing hoe. The adz hoe (figure 5–27) has a heavier and stockier profile that people use for grubbing and trail construction.

Figure 5–25—A broadax with a long handle.

Figure 5–26—Various adzes (right)—note the differences in curvature of each blade—and a gutter adz and bowl adz (below).



As with the ax, the adz comes in many different styles, depending on its specific use. Manufacturers design specialty adzes for building construction, shipbuilding, bridges, mining, and the railroad. The type of work performed determines the type or style of adz used. An adz used for fine or finishing work is lighter and has better balance than an adz designed for shaping railroad ties. Some manufacturers design adzes with a poll end for driving spikes, similar to a single-bit ax, while others design adzes with a pin on the back for placing wooden dowels.

The eye of the adz head is rectangular and tapered, and the curved handle contributes to the efficiency and ergonomics of the tool. The eye of the adz and the eye end of the handle are square. After placing the handle in the head, friction and motion hold the adz head to the handle, similar to a pick head and handle.

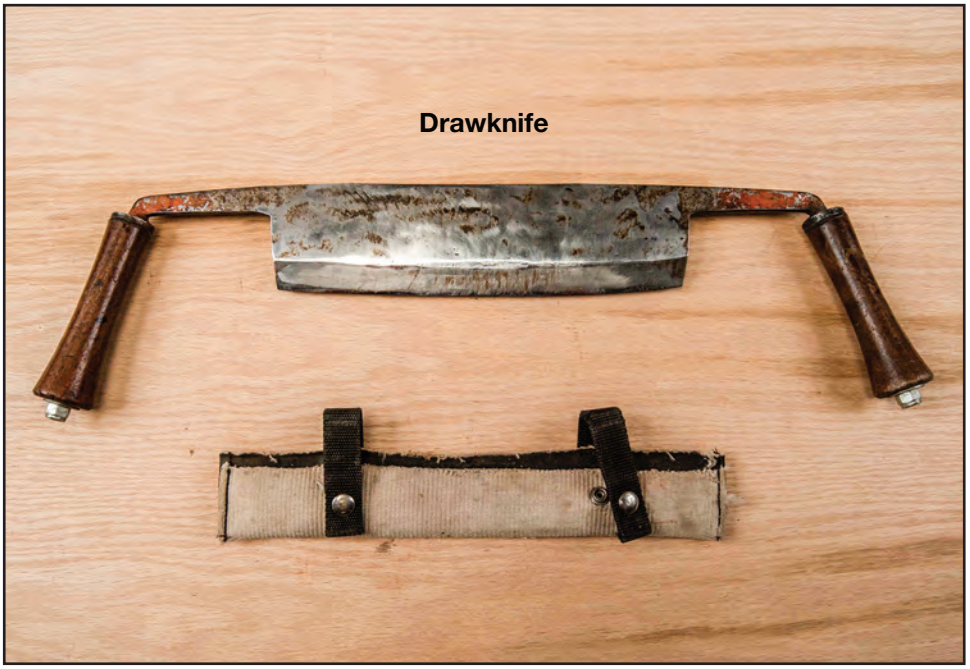
Figure 5–27—An adz hoe.

Other Preservation Tools

Some other edged tools that Forest Service historic preservation teams commonly use include a variety of chisels, froes, slicks, drawknives, and other types of tools (figure 5–28). The Forest Service National Technology and Development Program publication "Dovetails and Broadaxes: Hands-On Log Cabin Preservation" (1523-2802P-MTDC) <https://www.fs.fed.us/t-d/php/library_card.php?p_num=1523%202802P> provides information about many of these tools and about various preservation techniques.

Figure 5–28—A roofing hammer (right), a fro and mallet (below), a slick (following page, top), and drawknife (following page, bottom).


Slick


Drawknife

Chapter 6—Selecting the Right Ax for You

The previous chapter covered only a small number of the types and styles of axes that the Forest Service commonly uses. A standard, general-purpose chopping ax may meet your needs, or you may find that several different ax styles and sizes serve you better.

At one time, manufacturers sold ax heads and handles separately. An axman would select the most suitable ax head and handle that fit his or her body size and profile. Manufacturers sold ax handles as blanks (figure 6–1). These handles were typically too large, with the wedge slot in the eye uncut. The axman would shape and cut the handle to accommodate his or her size and profile.

Most axes today come prehung and fitted with a generic handle. The majority of these axes have the head pressed onto the handle. Axmen typically must profile the head and shape the handle to fit their hands properly. Mass-produced axes often have heads and handles that do not align correctly.

If you choose a new, mass-produced ax, remember that it will look and feel completely different after you reshape the head and handle. Be aware that new, mass-produced axes frequently do not have the same quality as vintage or custom/semicustom axes.

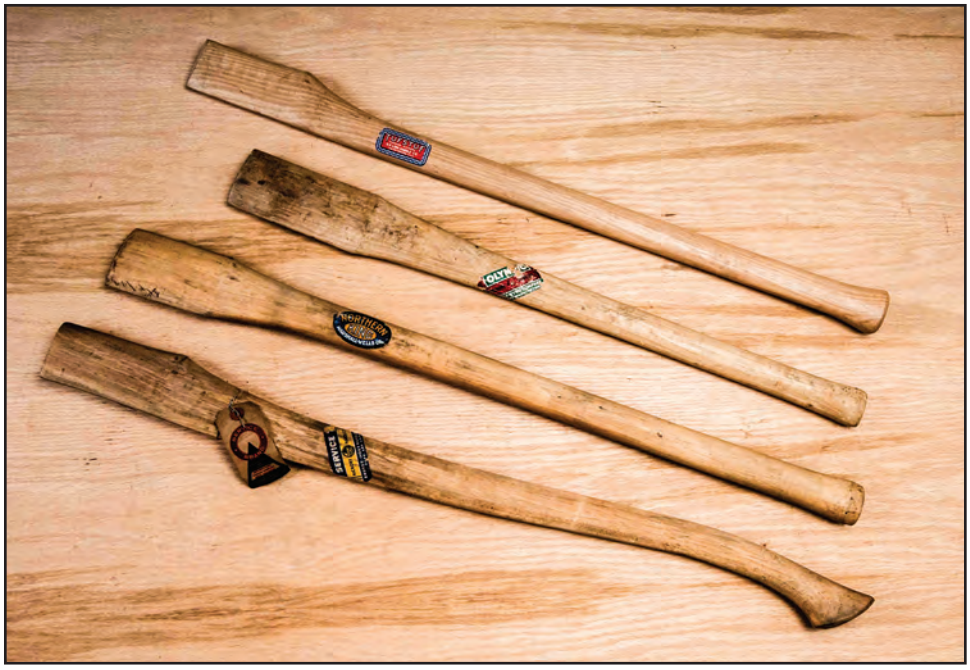
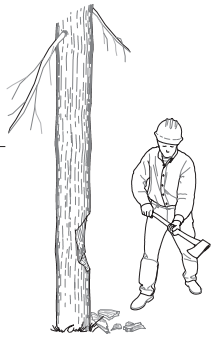


Figure 6–1—Unused old stock ax handle blanks.



Ax Size and Weight

Selecting the correct head weight and handle length are two of the most important factors for any axman to consider. People and axes come in all different shapes and sizes. A head weight or handle length that does not fit your body could prove awkward and dangerous to use. The type of ax you choose depends on your size, physical ability, and the types of chopping you do. To find the right ax, you should experiment with as many types of axes as you can. Ax websites and forums contain considerable discussion about the best weight and size for an ax. Many of these discussions seem to center on occasional ax use, and not on axes used for daily work in the woods. They are also the opinions of the people posting the information and may not be appropriate for you.

You should always be in control of your ax. The weight of the head and length of the handle should be balanced for your body and profile. It is better to start with a light ax and to work your way up to a heavier ax as your chopping skills and stamina improve.

Ax heads typically—but not always, especially with newer, mass-produced axes—have a stamp on the side that indicate their weight (figure 6–2). For example, an ax head made in the U.S. and marked "3.2" means it weighs 3½-pounds (table 6–1). Countries that use the metric system may mark their axes in kilograms. Hence, a 2.1-kilogram ax head weighs a little more than 4.6 pounds.

Table 6–1—Common United States ax head stamps.

Stamp	Weight (pounds)
3^1	3¼
3^2	3½
3^3	3¾

Figure 6–2—Ax heads with the weight marked on the side.

A good starting weight for a working ax head is 3 to 3½ pounds. The proper handle length depends on your height and arm length. As a general starting point, the handle should reach from the ground to your hip (figure 6–3). Using these weight and length criteria as a starting point, you can begin to understand the mechanics of efficient chopping, and can determine the type of ax that works best for your needs and body type. You may change the head weight and handle length of the ax as you gain proficiency.

A lighter ax is easier to swing, allowing you to chop for longer periods without becoming overly fatigued. In addition, learning to chop with a lighter ax allows you to improve your accuracy. After you become proficient with a lighter ax, you can move up to heavier axes until you find the right head weight. You should only increase head weights in half-pound increments. Half a pound is actually a considerable weight difference, especially when swinging an ax throughout the day.

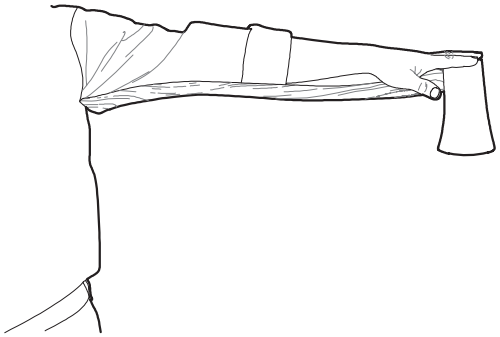
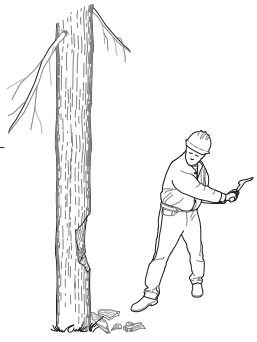


Figure 6–3—Various ways of measuring a suitable ax handle length.



One style of ax is usually sufficient for most people and their basic chopping needs. Someone who uses axes for multiple purposes or specialized needs may require more than one style of ax. The author's ax head weights range between 2½ and 5¾ pounds and his handle lengths range between 26 and 44 inches. Each handle has the proper shape to balance with each ax head.

The ax in figure 6–4 has a 2¼-pound head on a 26-inch handle. This combination is a good, lightweight camping ax. It is suitable for cutting and splitting small firewood, limbing, driving wedges, and felling small trees. Although this small ax is capable of heavier work, it is best suited for light-duty chopping.

Small axes require additional energy and effort when chopping large material. Using a heavier ax would save time and energy. The head weight of an ax is an important component in severing fibers and displacing wood chips. A short-handled, 2¼-pound ax is not ideal for chopping wood all day; you really should not use it for anything more than light-duty work.

One of the author's favorite axes is a 3½-pound Rockaway head with a 34-inch handle (figure 6–5). This handle is a little long, but is perfectly balanced for the head. A 3½-pound head is excellent for field or trail work and is suitable for someone who does not chop every day.

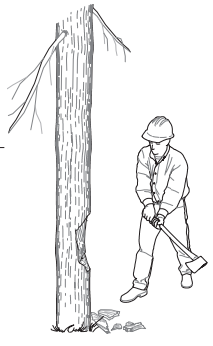
Figure 6–4—A 2¼-pound single-bit ax head on a 26-inch handle. The inset shows the weight marking.

Figure 6–5—A 3½-pound Rockaway head on a 34-inch handle.

Consider Australian- (figure 6–6) and New Zealand-pattern chopping axes for chopping large-diameter logs or for chopping on a regular basis. You can typically find these single-bit axes in the 4½- to 5½-pound head weight range with 28- to 30-inch handles. This head weight enables the ax to hit harder and penetrate deeper. The shorter handles also increase accuracy. These axes can remove larger chips from a log. Many people may find these axes too heavy for extensive use, but axmen who chop on a regular basis prefer these patterns and weights above all other axes. Heavier axes with shorter handles are better suited for experienced axmen and may not be appropriate for novice axmen (figure 6–7).

Figure 6–6—Hytest Australian-pattern ax heads.

Figure 6–7—An Australian Keech ax (top) and a standard American single-bit ax (bottom). The Keech ax has a heavier head and shorter handle that is more appropriate for an experienced axman.



The double-bit Puget Sound felling ax is ideal for felling large-diameter trees. Figure 6–8 shows a Puget Sound felling ax with a 4-pound head on a 42-inch handle. The long, narrow blade and long handle length enable deep penetration across the breadth of large-diameter trees. The author has a similar ax head hung on a 44-inch handle, but finds the additional 2 inches of the 44-inch handle make a significant difference in the accuracy of his swings.

A 5¾-pound, single-bit head on a 44-inch straight handle is a good ax for splitting firewood (figure 6–9). The weight of the head and the long handle increase the head speed and power of the swing, making it easy to split most knot-free rounds of wood.

Figure 6–8—A True Temper Kelly Works Puget Sound felling ax.

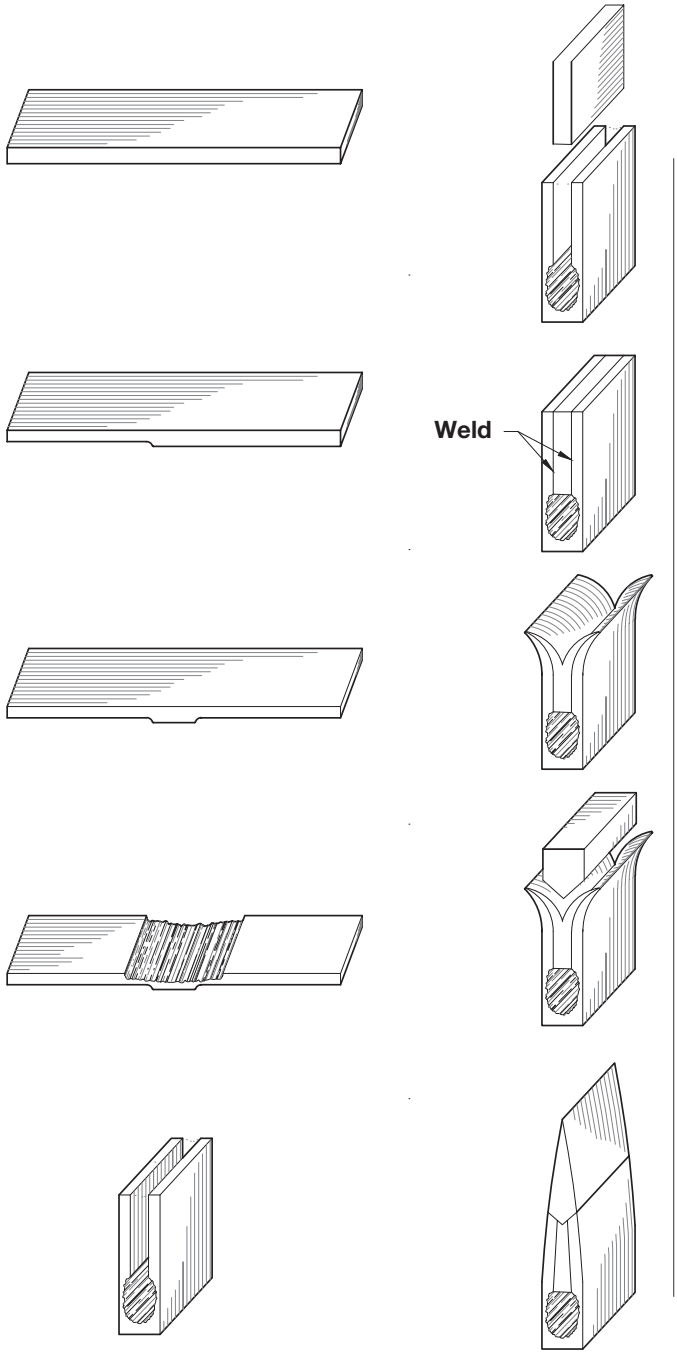
Figure 6–9—An American Axe and Tool Company splitting ax.

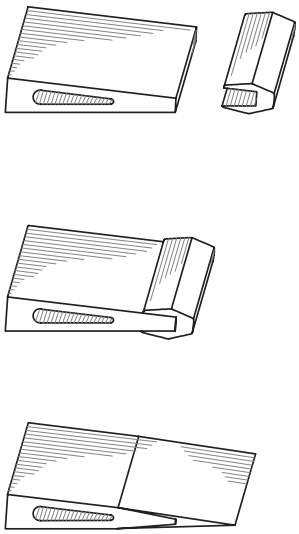
Ax Head Construction

Understanding how manufacturers make an ax head is an important part of evaluating and shaping the head.

Ax Head Materials

Historically, ax makers forged vintage or traditional ax heads out of iron and inlaid or overlaid hardened steel cutting edges into the blade during the forging process (figure 6–10). Modern ax heads are a solid piece of steel with the cutting edge tempered at the end of the manufacturing process.





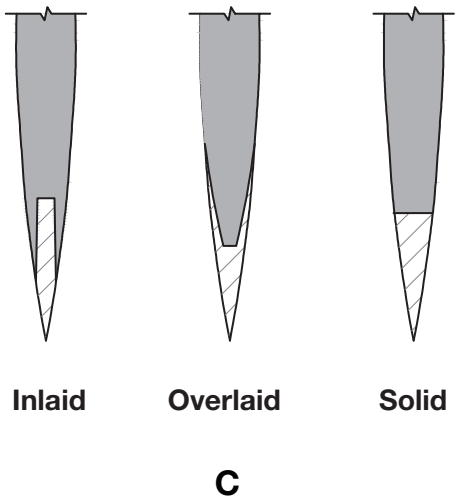


Figure 6–10—The processes for forging ax heads using inlaid hardened steel (A) and overlaid hardened steel (B). Completed heads made using inlaid steel, overlaid steel, and a solid piece of steel (C).

The hardened (tempered) cutting edges were durable and long-lasting. The softer center mass of the ax also provided an important feature: as the hardened steel cutting edge sank into a piece of wood, it transferred the shock of the blow into the ax head (figure 6–11). When the shock reached the cheeks of the ax, the softer metal helped absorb and dissipate the energy, reducing the amount of shock that transferred down the handle and into the axman's hands.

As noted earlier, manufacturers today forge or machine axes from a single piece of metal and harden the edges afterward. The rest of the ax body (including the poll on a single-bit ax) is generally softer. The rafting-pattern ax is one exception; it has a hard poll.

The choice between a forged or machined ax head is a personal preference. Forged axes are much more common. Look for quality craftsmanship, good steel, and proper tempering when purchasing a new or used ax head. Both forged and machined heads provide excellent service when properly profiled, sharpened, and maintained.

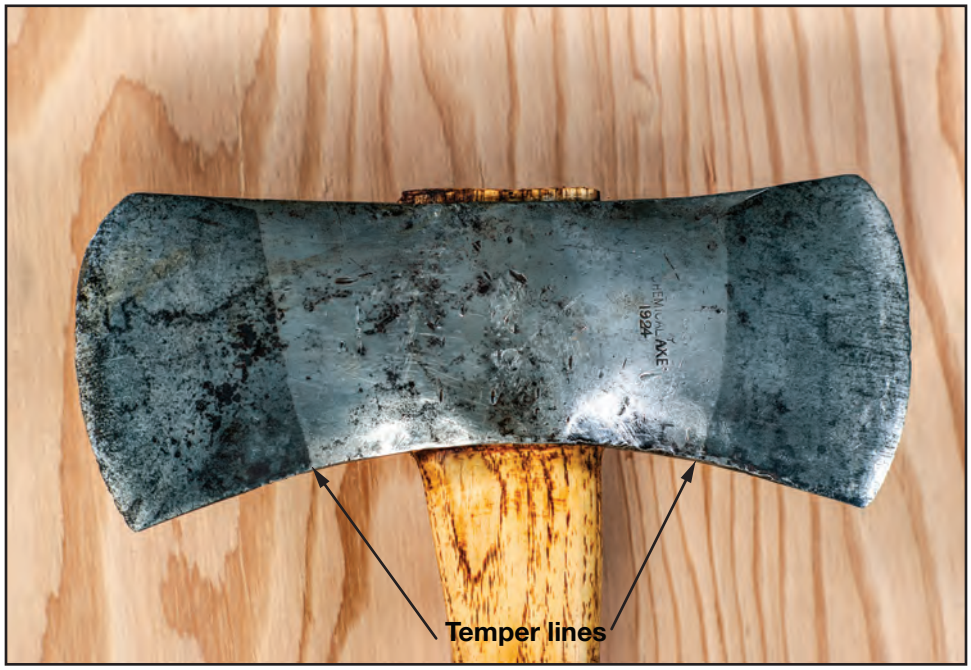


Figure 6–11—A 1924 Sager Chemical ax head with the temper lines of the blade indicated. The tempered steel is harder than the softer center of the ax head.

Ax Head Patterns

Ax head patterns in the U.S. developed rapidly in the 19th century. At one time, the U.S. manufactured hundreds of ax head patterns. The ax is such a fundamental tool that ax head patterns emerged for purposes other than chopping wood. Of those ax head patterns designed for chopping wood, manufacturers included slight variations to distinguish their designs from their competitors' designs. Rival ax manufacturers commonly produced similar ax patterns with different names to build brand loyalty, naming the pattern after the shape of the ax or its intended use. To foster regional loyalties, manufacturers also named patterns after the areas where the patterns were developed or commonly used.

As people traveled or moved around the country, the most common ax head patterns became more widely recognized and the names and styles became more standardized. Ax patterns that provided the best form, function, and durability endured, while other patterns faded away.

Single-bit ax heads (figure 6–12) offer more versatility for chopping and driving wedges, while double-bit ax heads offer better symmetry and an extra cutting edge. New, mass-produced axes come in limited styles and weights. Refer to "Chapter 5: Types of Axes and Related Tools" for a more complete description of single- and double-bit axes.

Figure 6–12—Single-bit, lugged ax patterns.

Single Bit or Double Bit?

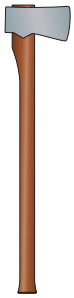
Choosing an ax is a personal preference. Both single- and double-bit axes provide unique advantages. Single-bit axes have a poll for driving wedges, while double-bit axes have two cutting edges. A newly purchased double-bit ax may provide better symmetry and balance, but you must profile the ax head and modify the handle to meet your individual needs. A single-bit ax head and handle properly shaped to your needs and size also provide symmetry and balance. Whichever type or pattern of ax head you choose, be prepared to spend time shaping and profiling the head and handle.

Competition Axes

People commonly refer to the style of ax head on chopping axes as a competition pattern. Head pattern is not the only thing that determines a competition ax. Manufacturers produce grades of axes and grinds specifically for competition. Competition patterns with appropriate grinds are applicable for fieldwork and general chopping.

Selecting an Ax Handle

A good ax head without a good ax handle has limited value. People also call ax handles "hafts." The terms are interchangeable. For consistency, this manual uses the term "handle."



The trees wept as they fell, for the handle of the ax was of their own.

—Bob Beckley

People often take great care to choose an ax head, but neglect to choose a good handle. Do not underestimate the value of the handle; it is an integral part of the tool and requires careful selection.

You may have better luck purchasing a high-quality handle directly from a manufacturer. Commercial retail outlets order handles in bulk and may not specify the grade or quality of the handle they sell. By contacting a handle manufacturer directly, you can request the qualities you seek in the handle, such as hickory, sapwood, heartwood, straight grained with no grain runout or knots, and so forth.

There are ax handle manufacturers that produce quality products, but finding them may require diligence. Refer to the "Additional Resources" section for more information. When ordering handles, the author always orders the best ("AA grade").

Ax Handle Materials

Historically, manufacturers made wooden ax handles, but they now also produce axes with fiberglass or synthetic handles (figure 6–13). These handles are unbreakable, but can increase vibration when you chop. Manufacturers do not design fiberglass and synthetic handles for you to reshape them. Properly shaping a handle to fit your hands is an important ergonomic aspect of chopping. With this in mind, this manual focuses only on wooden handles.

In America, hickory is the preferred wood for ax handles. Hickory is a dense, tightly grained hardwood known for its durability and strength. Oak and ash are also suitable American hardwoods for ax handles. While hickory may be the preferred wood for ax handles, do not overlook other woods, especially if you use a lightweight ax or hatchet.

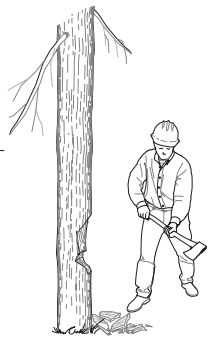
Other countries use beech, gum, or other, less dense woods for ax handles. These woods may be acceptable, depending on the type of chopping you do and the types of handle wood available.

Avoid softwoods, such as pine, fir, and spruce. If you are unsure what type of wood the handle is, run your thumbnail along the side. If your thumbnail leaves an indentation, the wood is most likely a softwood.

Wooden Handles

Experienced axmen use wooden handles because these handles reduce blisters, vibration, and shock.

Figure 6–13—A pulaski with a synthetic handle.



Pay attention to variations of heartwood and sapwood in the handle (figure 6–14), which often appear as two different colors of wood (i.e., part of the handle may have darker wood and part may have lighter wood).

Experienced axmen have had a long-standing debate about the strength and durability of handles that contain both heartwood and sapwood. Heartwood comes from the middle of the tree, while sapwood comes from the outer portion of the tree. Heartwood is darker in color while sapwood is lighter. Some axmen feel that there is a natural weak point in a handle where heartwood and sapwood join, making the handle more prone to splitting along this seam. Some feel that heartwood is harder but more brittle. Others feel that sapwood is the best choice because it is more limber and provides a subtle whip action to the chopping stroke. Still others feel there is no difference between heartwood and sapwood, and that it is simply a matter of aesthetics. Finding quality ax handles commercially is becoming increasingly difficult, especially handles that do not contain some combination of both heartwood and sapwood.

Interestingly, this debate has caused some measure of prejudice against hickory heartwood (red hickory), which people often place in a lower grade than hickory sapwood (white hickory) simply because of its color. Although this debate continues to this day, Forest Products Laboratory (FPL) research has conclusively shown that red, white, and mixed red and white hickory all have the same strength characteristics. FPL's research is available in the report, "Hickory, an American Wood" <http://www.fpl.fs.fed.us/documnts/usda/amwood/241hicko.pdf>.

Figure 6–14—A handle containing both heartwood and sapwood (top), and a handle containing only sapwood (bottom). Research has shown that there is no difference in the strength and durability of handles containing only sapwood, only heartwood, or a combination of the two.

The wood grain of many mass-produced ax handles often runs at an angle or even perpendicular to the cutting edge of the ax head. The grain should run parallel to the ax head for added strength and durability (figure 6–15). A handle with wood grain that runs perpendicular to the direction of the ax head is more likely to break. When selecting a handle, ensure that the grain runs parallel to the ax head and inspect the grain throughout the length of the handle. Depending on how the manufacturer cut the handle, it may contain sections where the grain does not run the full length of the handle. This is known as "runout" grain (figure 6–16). Areas where the grain runs short have an increased chance of splitting or separating. Runout on the belly or back of a handle (figure 6–17) is a clear indication that the grain of the handle is wrong.

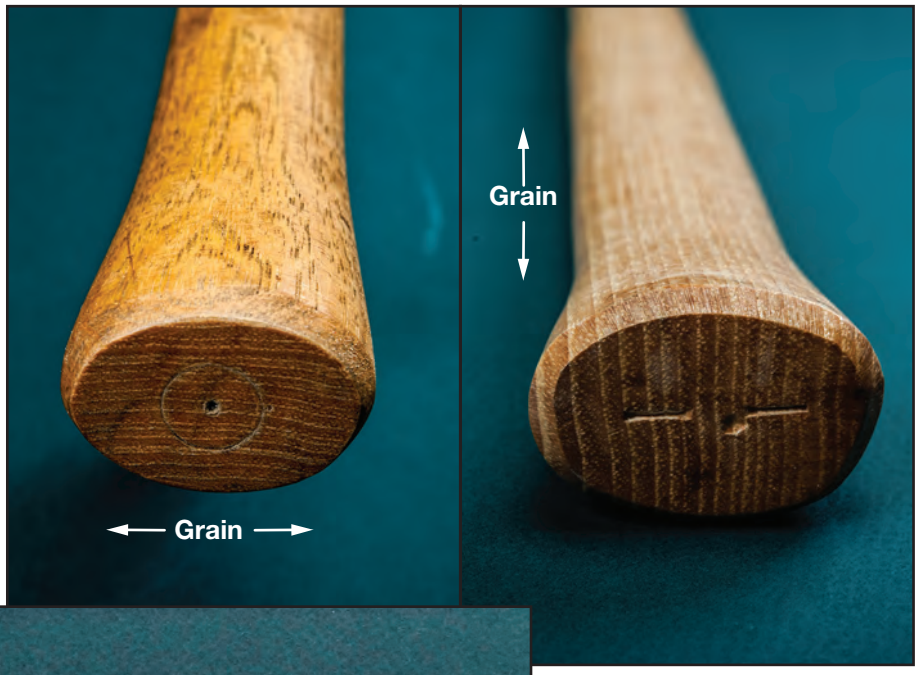
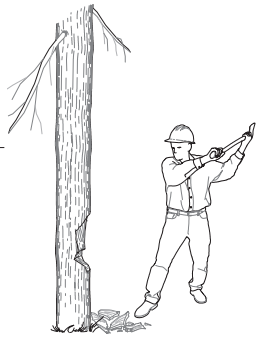


Figure 6–15—The grain of an ax handle running parallel to the ax head (left) and perpendicular to the ax head (right).

Figure 6–16—Wood grain that does not run the full length of a handle ("runout" grain).



Growth rings are another issue of long-standing debate. Many experienced axmen feel that an ax handle should have no more than 17 annual growth rings per inch of radius. The publications "The Ax Book: The Lore and Science of the Woodcutter" by Dudley Cook and "An Ax to Grind: A Practical Ax Manual" (9923–2823P–MTDC) <https://www.fs.fed.us/t-d/php/library_card.php?p_num=9923%202823P> (figure 6–18) by Bernie Weisgerber reinforce this view. However, many environmental factors influence a tree's growth and ring patterns. In the author's opinion, the characteristics and strength of the wood species and the direction or alignment of the wood grain in the handle are more important than the number of growth rings.

Figure 6–17—Runout grain on the back or belly of an ax handle is a sure sign that the grain runs the wrong way.

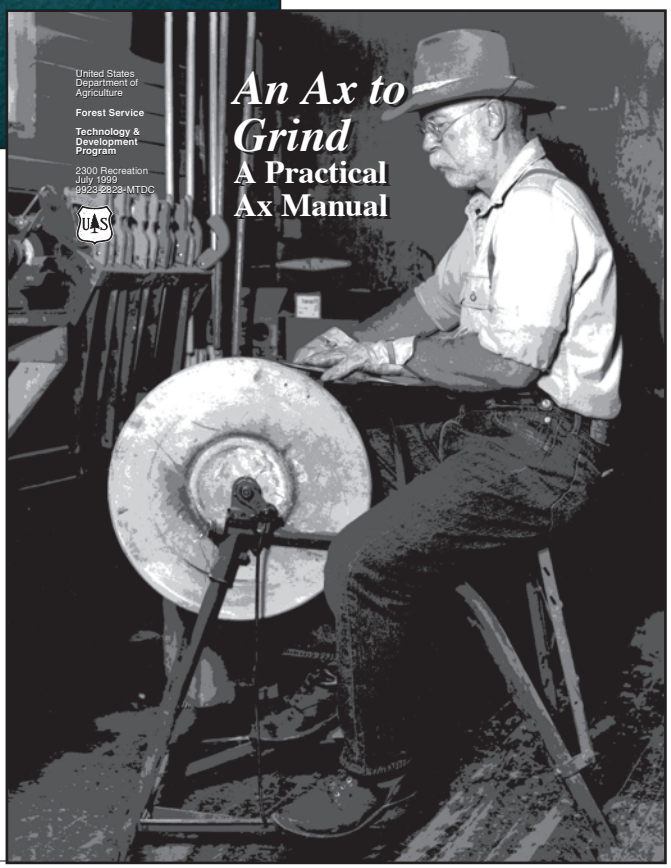


Figure 6–18—The publication "An Ax to Grind: A Practical Ax Manual."

Knots are another characteristic to focus on when choosing an ax handle (figure 6–19); they are a natural weak point where the ax handle could break. Try to select a handle without knots.

Be wary of painted handles when selecting an ax handle. Paint could hide defects in the wood or a grain that is not parallel to the ax head.

Ensure that the handle is not bent, bowed, or twisted (figure 6–20). A bent, bowed, or twisted handle affects accuracy. The handle should run straight and true when sighting down the length from the knob (end of the handle) through the eye. You may be able to correct some minor deviations when shaping the handle and fitting the handle to the ax head, but you should avoid a handle with a significant bend, bow, or twist.

Figure 6–19—A knot in an ax handle.

Figure 6–20—A bowed ax handle.

Types of Ax Handles

There are two basic types of ax handles: curved and straight (figure 6–21). There are also numerous variations of these basic types. Single-bit axes typically have curved handles, but can have straight handles (figure 6–22). Double-bit axes only have straight handles to enable users to chop with either blade.

Choosing a straight or curved handle for a single-bit ax is a matter of personal preference, but straight handles for single-bit axes are not as readily available as curved handles. If you cannot purchase a straight handle for your single-bit ax locally, you can purchase one through an ax handle manufacturer.

"Appendix B—Technical Drawings" provides technical drawings of handles for both single- and double-bit axes.

Axmen often debate which type of handle is best for single-bit axes. Many feel that the curved handle is purely aesthetic and that it actually detracts from chopping accuracy and power. Dudley Cook makes an excellent case for straight handles on single-bit axes, feeling that the straight handle is both stronger and more accurate. Other axmen feel that the curved handle facilitates ergonomic chopping and point to the fact that competition choppers use single-bit axes with curved handles.

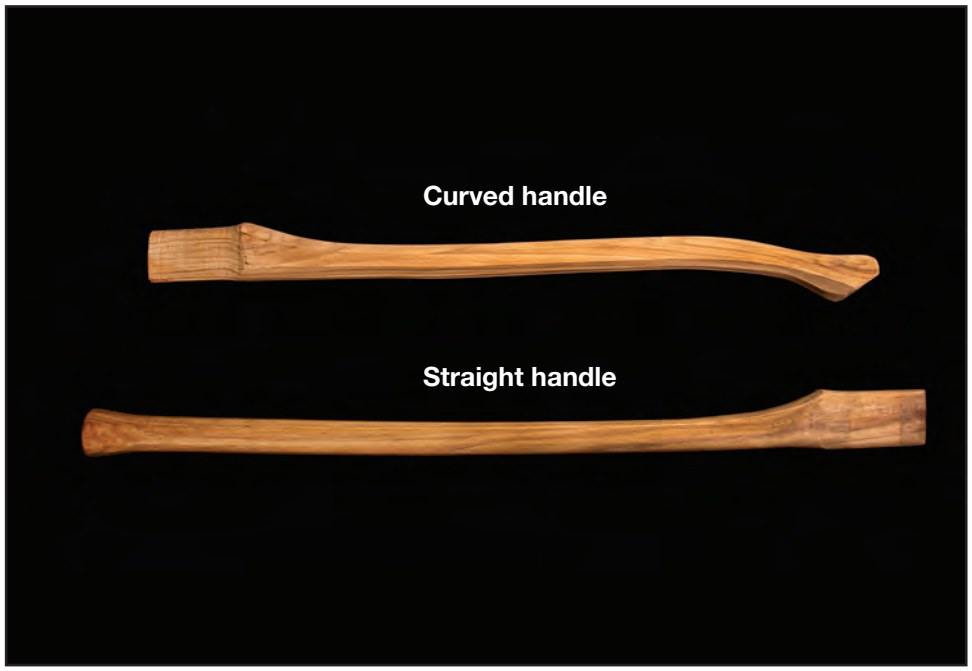


Figure 6–21—A curved single-bit handle and a straight single-bit handle.

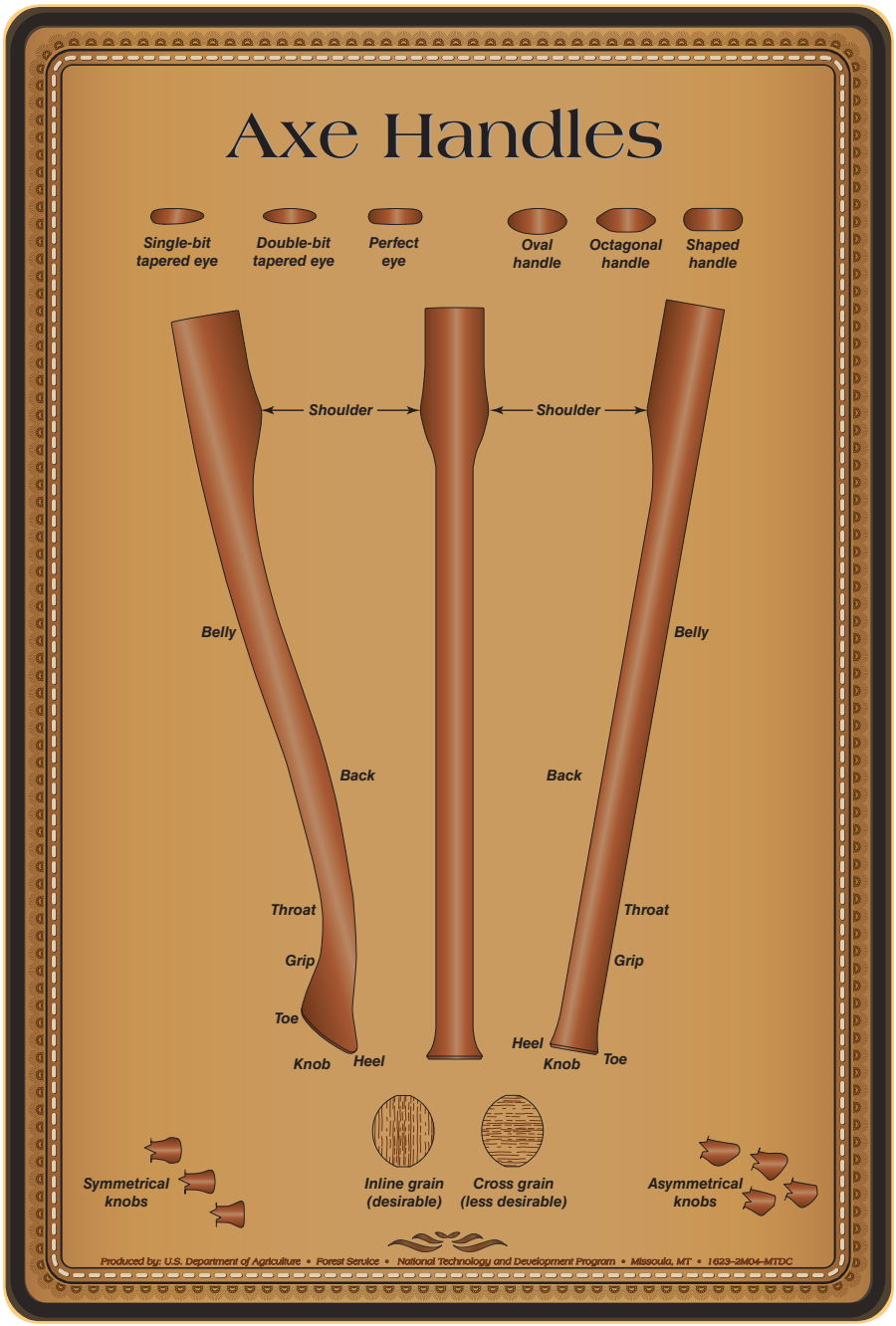


Figure 6–22—The parts of curved and straight ax handles. Refer to "Appendix A—Full-Page Ax Illustrations" for a larger version of this illustration.

With a curved handle, the striking angle at your wrist is more in line with your arm. With a straight handle, the striking angle at your wrist is slightly out of line with your arm (figure 6–23). When the hand, wrist, and arm are in line, a fluid transfer of power occurs, causing less fatigue on your wrist and arm. When using a straight handle, you bend your stationary hand at the wrist. Conversely, when using a curved handle, the wrist on your stationary hand is more in line with your body. When your stationary hand grips a curved handle above the fawn's foot (knob), keeping the axis of pivot more in line with the axis of a straight handle, your accuracy improves. The fawn's foot may also provide better control and reduced wobble while chopping.

Regardless of which handle you choose, your body is excellent at adapting to the nuances of the tools you use. With practice, you will develop accuracy with either handle style.

Figure 6–23—The angle of the wrist when using a curved handle (left) and a straight handle (below).

Chapter 7—Files and Filing Basics

Before shaping and sharpening your ax, you must understand the importance of files and learn proper filing techniques. Early files date back as far as 1200 to 1000 B.C. People hand-cut early files by striking a chisel into a strip of metal at a specified angle and interval. Around A.D. 1490, Leonardo da Vinci drew plans for a machine to cut the teeth for making files. However, no one before the mid-1700s successfully invented machines to cut files. Many people continued to hand-cut files until the Industrial Revolution, and some continue to hand-cut them today.

File Types

Choosing the correct file can be a daunting task. For a good introduction to files and filing, refer to:

- "Nicholson: The Guide to Files and Filing" <https://images-na.ssl-images-amazon.com/images/I/81h0ZOhlOXL.pdf>
- "Simonds: Facts on Files" <http://www.simonds-saw.com/handfiles/HAND%20FILES%20PUBLICATIONS/File%20Facts.pdf>

This manual focuses on the flat file; the best choice for filing an ax.

File Characteristics

As with high-quality axes, high-quality files are increasingly difficult to find. Manufacturers make files in a wide variety of shapes, sizes, tooth configurations, and cuts. Files can be flat, round, half round, triangular, or any number of other specialized shapes. The filer must be aware of the cut—how rough or fine the teeth are—and the number of teeth per inch of file length. The fewer teeth per inch a file has, the rougher the cut. The more teeth per inch, the smoother the cut. Regardless of the file cut, the larger a file, the fewer teeth per inch and the shorter a file, the more teeth per inch. Consequently, a 12-inch flat bastard file is coarser than a 6-inch flat bastard file (figure 7–1). Additionally, the fewer teeth per inch, the more aggressive the cut. For filing an ax head, the author prefers a 12-inch, flat, single-cut bastard file, although a 10-inch file is adequate. A file smaller than 10 inches does not allow for a long enough stroke to remove metal efficiently. After roughing in the shape, use an 8-inch (or sometimes a 6-inch) file for finer work and to remove the marks left by the coarser file.

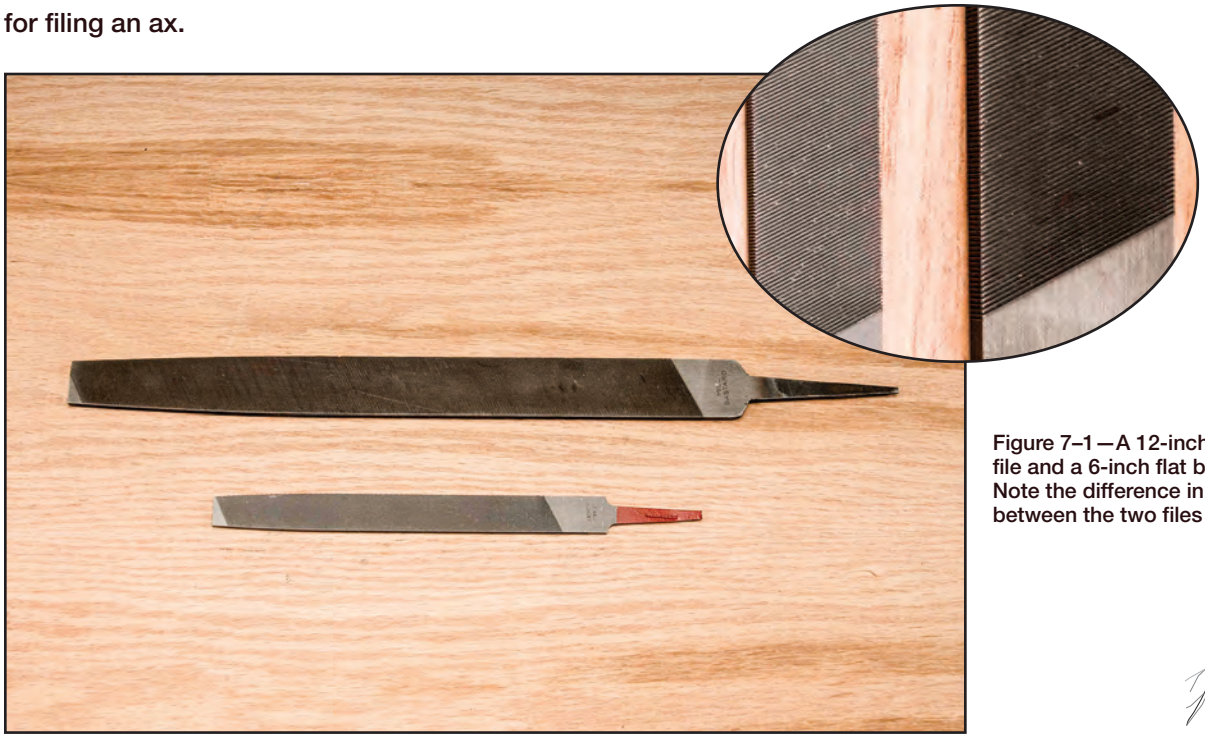
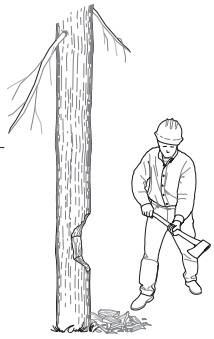


Figure 7–1—A 12-inch flat bastard file and a 6-inch flat bastard file. Note the difference in coarseness between the two files (inset).



File Patterns

Manufacturers cut files in either American or Swiss patterns. The standard American pattern files have three primary grades (from coarsest to finest): bastard cut, second cut, and smooth cut. Swiss pattern files have seven cuts (from coarsest to finest): 00, 0, 1, 2, 3, 4, and 6. The coarser the grade, the longer the file tooth and the greater the space between teeth. American patterns are limited and are better for coarser work. The finer-grade Swiss patterns are better for fine, detailed work. This is not to imply that you cannot achieve a smooth finish with American patterns.

American and Swiss file patterns are also measured differently. American files are measured from the point to the end of the tang, whereas Swiss files are measured from the point to the heel (figure 7–2).

File Tooth Cuts

The basic file cuts are single cut and double cut, but there are numerous other patterns (figure 7–3). The rows of teeth on single-cut files run parallel to each other at about a 65-degree angle from the centerline of the file. Single-cut files are excellent for sharpening tools and should be the main file you use on an ax. Use the single-cut bastard file for push and draw filing strokes. Use finer cuts for finish work. Double-cut files are excellent for rough work (i.e., for removing a lot of material). The rows of teeth on double-cut files crisscross each other, forming a diamond shape.

The first cut is called the overcut and the second cut is called the upcut. The upcut is finer than the overcut. Do not confuse a double-cut file with a second-cut file. A second-cut file is a less coarse version of the bastard file and it produces a finer finish.

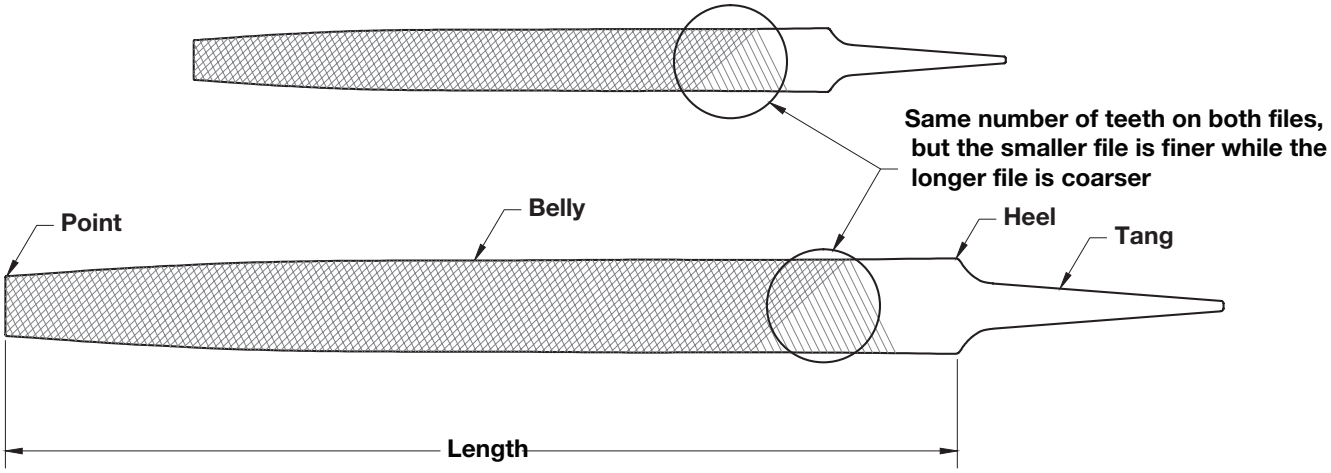


Figure 7–2—Swiss files are measured from the point to the heel.

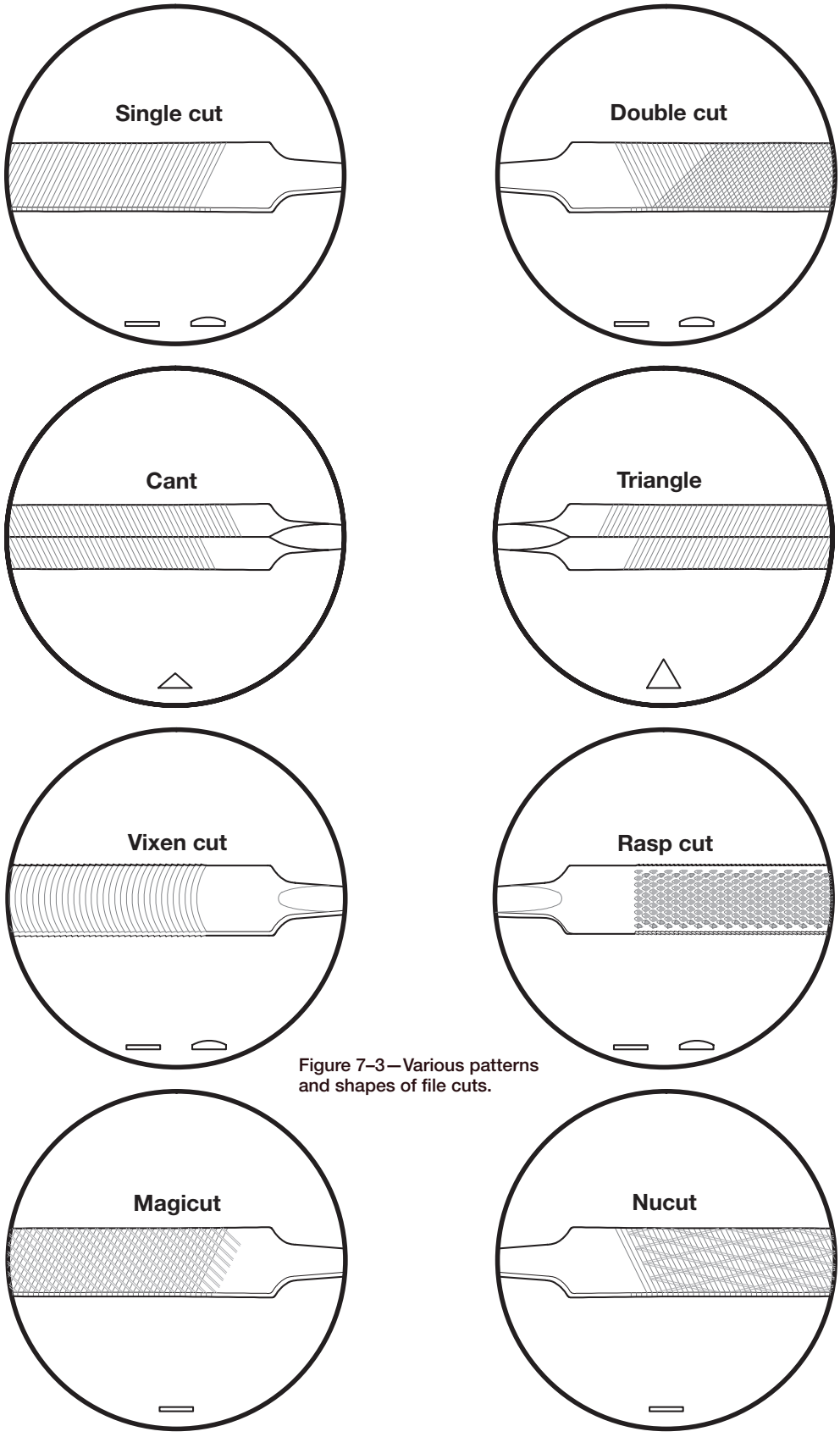
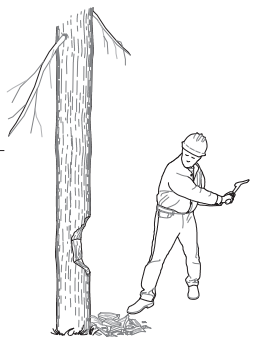


Figure 7–3—Various patterns and shapes of file cuts.



Rasps

Rasps—another type of file—have a series of individual, very coarse teeth (figure 7–4) designed specifically for cutting wood; they are very useful for the initial (rough) shaping of an ax handle.

Figure 7–4—A rasp (the author used a broken ax handle to make a handle for this rasp).

How a File Cuts

Before you begin to file, it is important to understand how a file cuts and proper hand-filing techniques.

The cutting teeth on a file face forward and only cut when you push the file. Using a file in a back-and-forth sawing motion can dull and damage the file. At the end of a stroke, you should lift the file off the ax head and bring it back to the starting point for the next stroke.

There are three main filing motions:

- Draw filing
- Lathe filing
- Push filing (also known as straightforward filing)

Push filing and draw filing are the two file strokes you use to sharpen an ax head.

Choosing the Right File for the Job

If a file is in good condition but does not cut well or skips over the ax head, use a smaller file for a better bite.

Push Filing

Push filing (figure 7–5) requires you to push the file straight ahead (along the longitudinal axis of the file) or at a slight diagonal angle across the work piece. Apply pressure on the front point of the file when beginning the stroke. This helps equalize the force you apply to the work piece. Leverage tends to favor the hand pushing the file at the start of the stroke. Apply pressure on the point and heel of the file as you slide it across the work piece. Apply pressure to the heel of the file when reaching the end of the stroke. Leverage at the end of the stroke favors the file point. Modify strokes as needed to prevent filing a groove. Watch the file to ensure that you are filing flat and not bowing the file under the pressure you apply.

Beginners commonly rock or seesaw the file during the stroke or try to remove too much material too quickly. Either of these actions can cause an uneven and convex surface. Push filing is the primary method for removing metal and shaping an ax head. Keep your body still and allow your arms to pivot about your shoulders. If your body moves while you file, you may create an arc in the work piece.

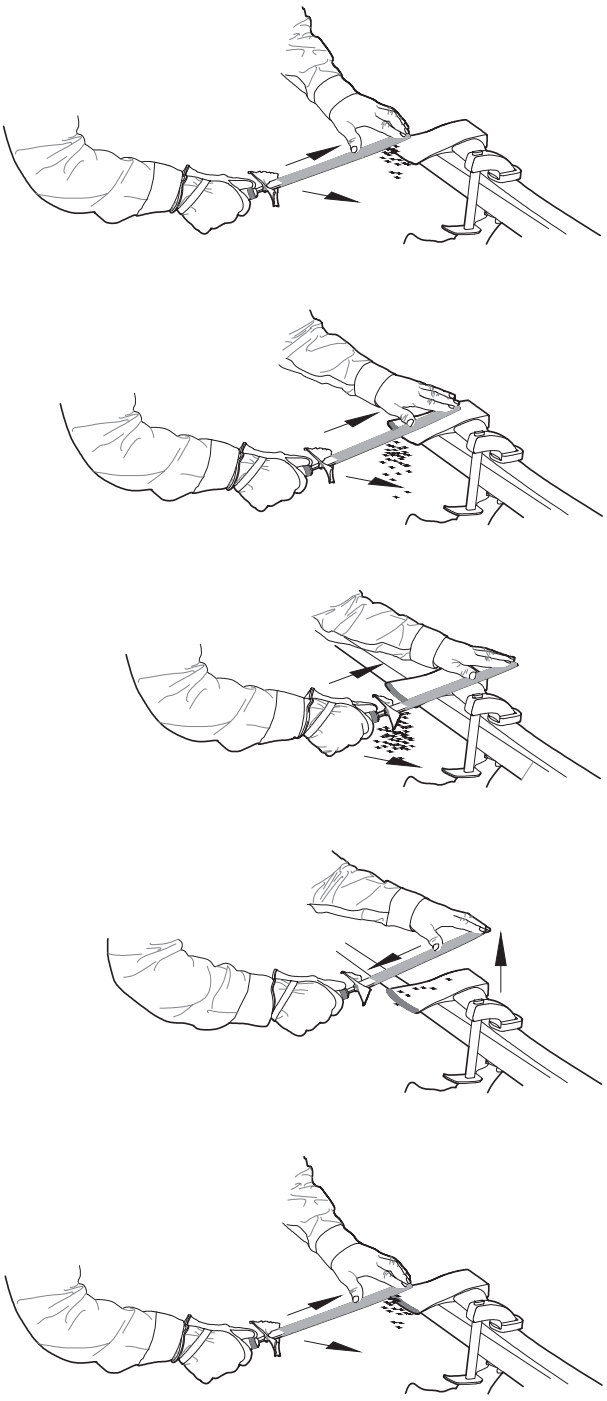
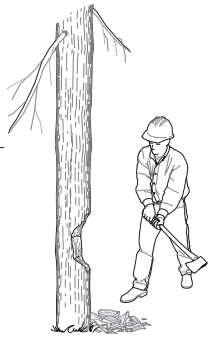


Figure 7–5—Push filing, showing the forward motion.



Draw Filing

Draw filing (figure 7–6) consists of a lateral (rather than forward) motion across the work piece and focuses on the edge and not the sides. When draw filing, hold the file at an angle so that the back edge of the file cuts and removes the steel. Depending on the file, you will need to experiment to find the right angle to remove curls or steel shavings rather than small filings. Start at about a 45-degree angle and adjust up or down to achieve the curls. Use a fanning motion and follow the direction of the cutting edge.

Filing is an art in itself. It involves patience, positioning your body properly, and an understanding of how a file works. Similar to using an ax, filing seems like a simple task that you can pick up with a few minutes of instruction. However, filing takes time to master. Learning proper filing technique helps make your ax an efficient cutting tool.

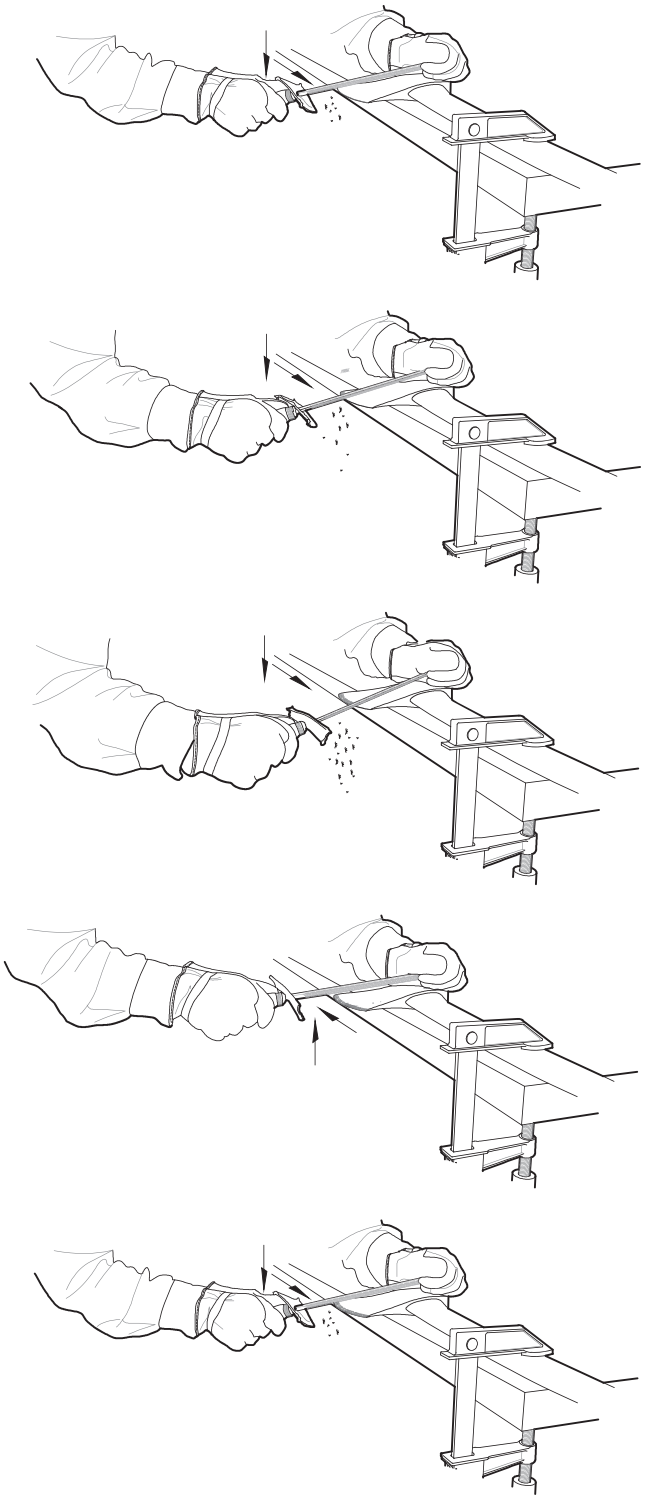


Figure 7–6—Draw filing, showing the lateral motion.

Filing Height, Stance, and Grip

Secure the work piece you are filing in a vise or clamp at about the same height as your elbow when your arm is bent (figure 7–7). If you do not secure the work piece firmly in a vise, chattering (when the file skips or bounces and loses contact with the work piece) or vibration could occur. In order to file efficiently and consistently, you must position your body properly and grip the file correctly. Begin with the filer's stance; place your feet far enough apart (slightly more than shoulder width) to provide stability. For right-handed people, the left foot is in front of the right foot. For left-handed people, the right foot is in front of the left foot. This puts the dominant hand in the proper position to supply power to the stroke while also providing a stable body position. It also gives your arms and shoulders full range of motion.

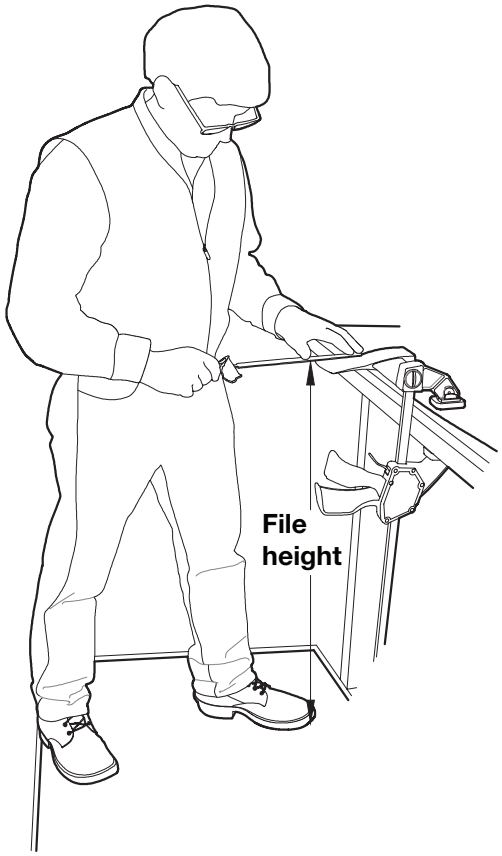
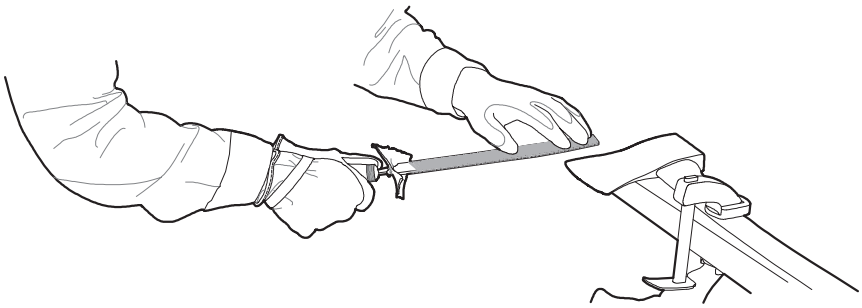


Figure 7–7—Filing at the proper height with the elbow bent.

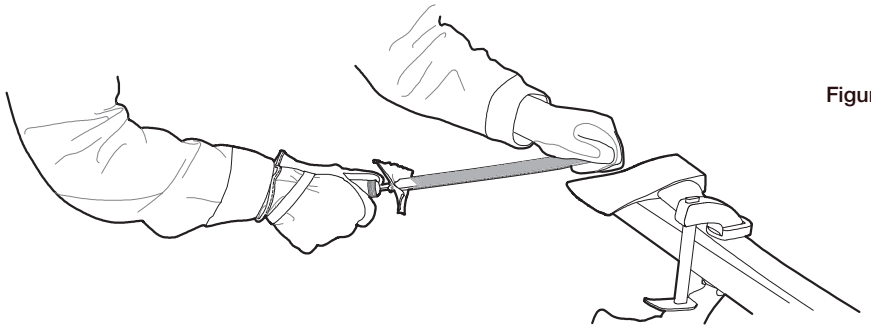
The following directions are for a right-handed filer. Simply reverse the directions if you are left handed.

Grip the file with both hands. The file handle should rest in the palm of your right hand with your thumb on top to apply pressure. Secure the opposite end of the file with your left hand. For normal filing, place the thumb and first two fingertips of your left hand on top of the file near the point, as shown in figure 7–8. For hard or heavy stock removal, place the thumb and ball of the palm of your left hand on top of the point of the file, as shown in figure 7–9. This grip allows both hands to apply hard and consistent downward pressure on the work piece. These two grips are useful for general shaping of the ax head profile. As the ax begins to take shape, you should adjust your grip to hold the point of the file with your thumb on top and index finger below, as shown in figure 7–10. This grip works best for fine, accurate work and curved surfaces, such as the convex surface of an ax head.



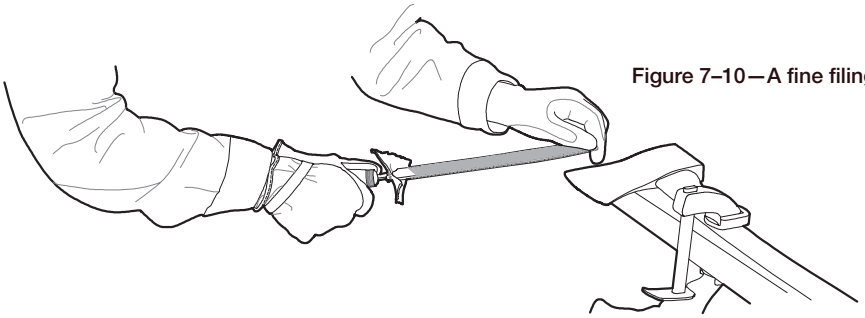
Standard

Figure 7–8—A normal filing grip.



Heavy

Figure 7–9—A heavy filing grip.



Light

Figure 7–10—A fine filing grip.

File Care

To lessen the chance of tooth damage, you should break in a new file by applying light pressure while flat-filing a soft piece of metal, such as brass, bronze, or smooth cast iron.

Always try to keep the file clean. Metal shavings can build up and clog the file's cutting teeth (referred to as "pinning"). A file card (figure 7–11) is a specialized brush with fine metal bristles designed specifically for cleaning files. A fine wire brush also works if you do not have a file card. One trick to help keep a file clean and prevent pinning is to rub blackboard chalk across the teeth to lessen the amount of metal filings that clog the teeth.

Keep files dry. While many tools benefit from a light coat of oil as a protectant, files do not. Oil on a file is difficult to remove and can make the file slide across the work piece rather than cutting into it.

Files stored together and unprotected can dull or damage the teeth. Where possible, store or hang files separately or wrap them individually in paper or cloth (figure 7–12) to ensure that they remain sharp and last longer.

Files wear out, but before you throw out a wornout file, try soaking it in white vinegar. The acetic acid in vinegar dissolves rust and can give a file a little more life. Be sure to wash and dry the file after soaking it to prevent rusting.

Figure 7–11—A file and file card. The inset shows a closeup of the file card.

Figure 7–12—Files separated and stored in a canvas roll.

File Safety

Always use files with tight-fitting handles. When filing with a loose handle (or no handle), the tang of the file could puncture the palm of your hand if the file slips. A loose-fitting handle is not only dangerous, but it also can produce a rocking or seesawing motion that leads to an uneven or concave surface.

Always use a hand guard when sharpening an edged tool. You can make a hand guard out of a piece of leather, firehose (figure 7–13), felt, or even a piece of cardboard.

Never use a file as a pry bar or lever. The file is hardened steel that can snap and release small bits of steel that can injure you.

Figure 7–13—A file with a firehose handguard.

Chapter 8—Sharpening and Shaping an Ax Head

A sharp ax is a safe ax; it is more likely to cut into and not scoop or glance off the wood. Proper filing techniques allow you to shape and sharpen an ax to maximize efficiency and safety.

Many people who sharpen an ax focus on the cutting edge with the intent of bringing the ax back to the condition it was in when it cut well. However, to sharpen an ax properly, you must pay attention to more than just the edge; the area behind the cutting edge is just as, if not more, important.

If you only sharpen the cutting edge as it wears down, you eventually lose the smooth transition you developed while profiling the ax head. As you file the cutting edge down, its relationship to the sides of the ax changes; the sides get thicker and the ax loses some of its efficiency for penetrating wood. Sharpening an ax properly involves maintaining the entire profile of the ax head, not just the cutting edge.

As discussed in "The Mechanics of Chopping" section in chapter 11, an ax should strike a log at a 45-degree angle to penetrate the log safely. A sharp, properly profiled ax can strike at a shallower angle and still penetrate the wood because of the gradual transition between the cutting edge and the sides of the ax. If there is no gradual transition because the sides of the ax are too thick in relation to the cutting edge, the ax requires a steeper angle to penetrate the wood. An angle steeper than 45 degrees leads to poor penetration and inefficient chopping.

An ax head must have a sharp cutting edge to efficiently displace wood. The typical Forest Service double-bit ax has a bevel sharpened to about 18 degrees for the clear wood (knot free) cutting side (known as the keen edge) and up to 28 degrees for the limbing/cutting through knots side (known as the stunt edge). In comparison, a racing ax could have a bevel of 14 degrees. Using an ax gauge is the easiest way to determine if you have the correct angle (figure 8–1).

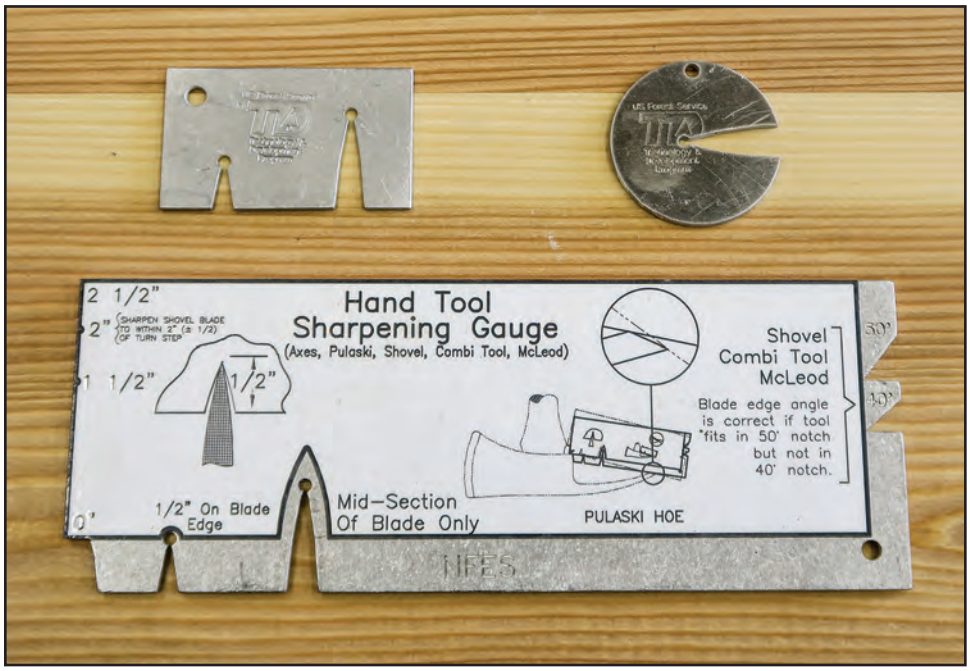
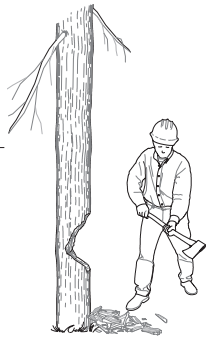


Figure 8–1—National Technology and Development Program sharpening gauges, used for measuring the correct angle of an ax head.



The microbevel and the bevel form the cutting edge of an ax (figure 8–2). The microbevel is an important part of the bevel; it provides strength to help prevent the cutting edge from chipping or breaking. Ideally, the bevel should be about 18 degrees while the microbevel should be about 25 degrees (figure 8–3). Keeping the microbevel to the desired degree can be challenging. This small, fine edge can be difficult to develop properly and can easily change through honing or stropping. Novice axmen may not know about the need for the microbevel.

While the angle of the cutting edge is important, you must remember how the edge blends into the grind—the area right behind the microbevel and bevel.

Many people use powertools to shape or sharpen their ax heads. Motorized sanders or sharpeners can be useful for removing metal to develop an ax's profile and to shape the ax head, but pay close attention so you do not overheat the ax head and ruin the temper or remove too much metal and change the profile. If

Figure 8–2—The microbevel in relation to the bevel. The inset shows a closeup view of the microbevel and bevel.

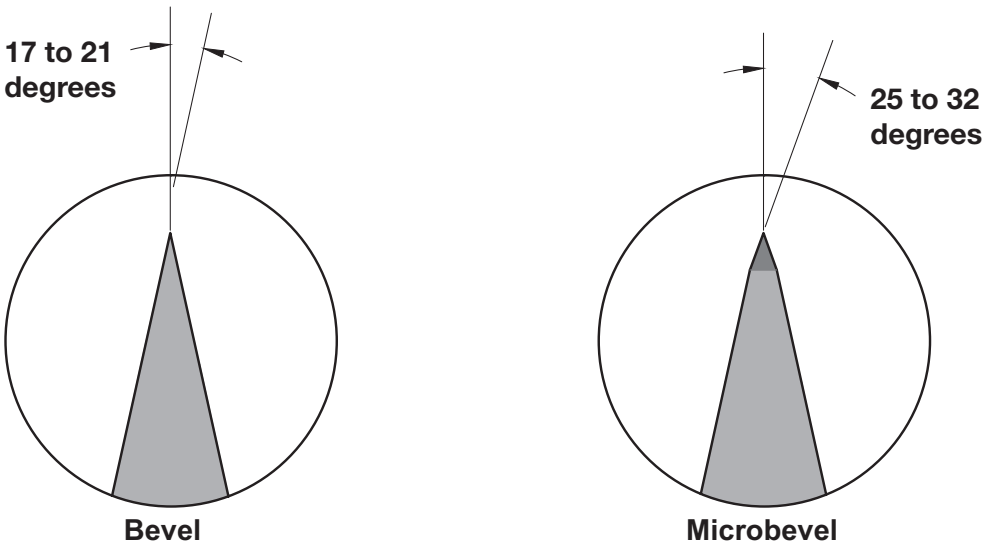


Figure 8–3—The correct angles for a bevel and microbevel.

you use a powertool, use it only to shape the ax head and not to sharpen the cutting edge.

When shaping an ax head, use a felt pen or marker to indicate the areas where you want to remove metal (figures 8–4 and 8–5). Work slowly and check your progress often. Never allow the powertool to contact the cutting edge and frequently check for heat build-up by touching the work surface with your bare hand. Mark the cutting edge with a felt pen and do not sand past this line (figure 8–6). The blade is thin at the cutting edge and it heats up faster than the body of the ax. Competition choppers frequently use powertools to shape and sharpen their axes, but this skill takes years of practice to develop. You should perform the final sharpening of the cutting edge by hand and should hone the microbevel using a fine diamond stone or whetstone (figure 8–7).

Figure 8–4—Marking the head of an ax with a felt pen to indicate where and where not to remove metal.

Figure 8–5—Marking an ax head to indicate high points to file and low points to avoid filing.

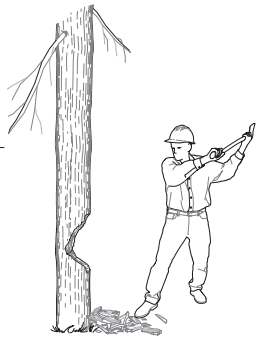


Figure 8–6—A cutting edge marked with a black felt pen. *—This photo was digitally altered.*

Figure 8–7—Using a whetstone to hone the microbevel.

Ax Head Shapes

An ax must do three things to cut efficiently:

- Sever wood fibers
- Displace wood chips
- Release from the wood

These three things depend on the interaction between the ax head cutting edge, profile, and type of grind. The cutting edge severs wood fibers while the profile and grind separate the wood chip and release the head from the wood. Only after an ax head dislodges and removes a wood chip can it sever new wood fibers to make the cut deeper. A sharp cutting edge that does not penetrate into the wood because the ax profile is too thick has little practical value. Likewise, a sharp ax with a cutting edge that is too thin penetrates deeply into the wood but will not easily release. An ax head properly shaped to displace chips and release from the wood is worthless if the cutting edge is not sharp enough to sever fibers (figure 8–8). All parts of the ax must work together.

Too thin
(Will penetrate into the wood but will not remove chips efficiently)

Correct

Too thick
(Will not penetrate the wood efficiently and may glance off the wood, creating a safety hazard)

Figure 8–8—A cutting edge that is too thin (left), a properly sharpened cutting edge (middle), and a cutting edge that is too thick (right).

Ax Head Profiles

The profile (shape) of an ax head determines if it penetrates deeply or shallowly into the wood. The basic shape for a Forest Service work ax is the convex profile (figure 8–9) with a chisel grind. The convex profile enables penetration, splitting force, and ease of release (the chisel grind discussed in the "Ax Head Grinds" section later in this chapter provides strength for the cutting edge).

In comparison, a flat-profiled ax is not only flat across the face of the blade, but also across its length. The flat-profiled ax (figure 8–10) has a steep edge and straight sides that enable the ax to penetrate deeper into wood, but it lacks splitting power, making it more difficult to move chips or release the ax from the wood.

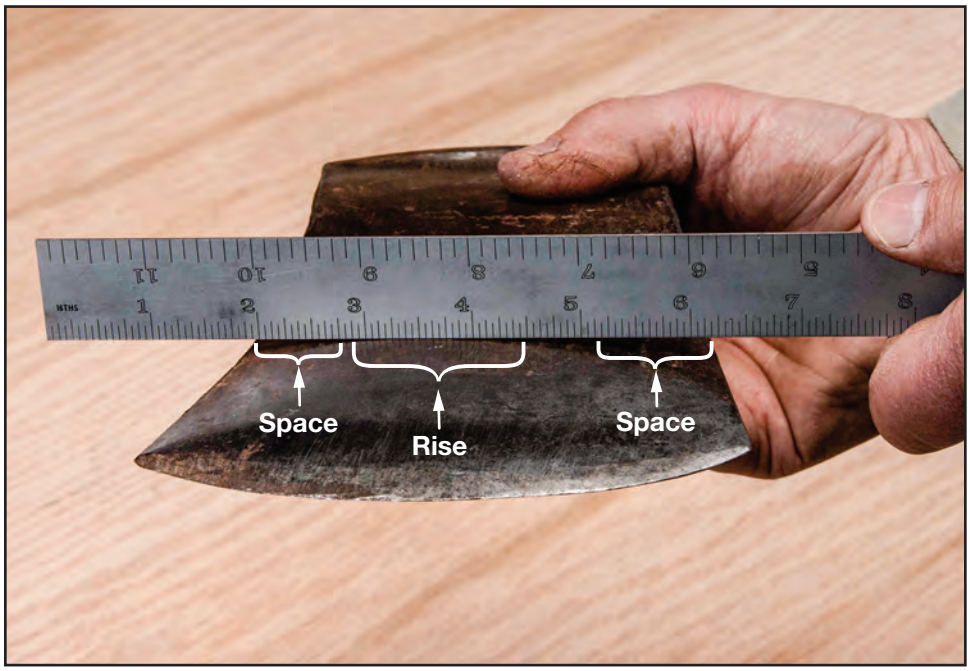


Figure 8–9—A convex ax head with a straightedge lying across the side to show the rise and the spaces to either side of the rise that create the convex profile.

The broadax or broad hatchet profile (figure 8–11) is like a chisel—sharpened only on one side. This chisel profile is for shaping wood rather than for chopping it. Do not confuse a broadax chisel profile with a chisel grind, which many chopping axes have.

Figure 8–10—A flat-profiled ax shows relatively little relief when a straightedge lies across the face or along the length of the blade.

Figure 8–11—The front, chisel-shaped, sharpened edge (left) and back, flat, unsharpened edge (right) of an ax head with a broadax profile.

The type of chopping and the type of wood both play a role in determining which ax head profile works best for a particular job. The convex ax head profile works best for general chopping purposes. The sharpened edge severs wood fibers and, as the cutting edge severs the fibers, the main body of the ax enters the wood. With a convex-shaped head, the sides of the ax provide a wedge to split the wood (figure 8–12). The actual cutting edge only starts the cut; the sides of the ax dislodge the wood chips.

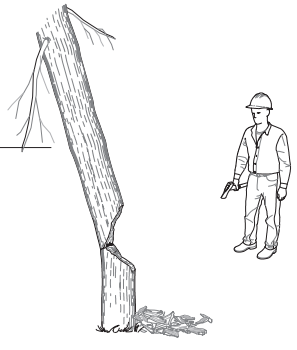
The ax profile also plays a role in edge strength. Convex profiles tend to be thicker and more durable. Flat profiles tend to have sharper angles that provide better depth penetration. The sharper angles could make the blade more susceptible to bending or breaking, especially when striking a hard knot or cutting into frozen wood. Flat profiles penetrate much better than convex profiles. While the flat sides provide better penetration, they can also provide excessive friction, making the ax more difficult to remove from the wood.

Figure 8–12—A convex head in a round of wood. Note that the sides of the ax head spread the round apart well beyond the cutting edge.

Regardless of the profile, all ax heads can get stuck in wood. The types of hollows (figure 8–13), bevels, and relief of the ax head can reduce the friction that binds it to the wood. Cutting or filing relief (figure 8–14) into the sides of an ax head reduces binding or sticking and allows the ax to more easily release from the wood.

Figure 8–13—The straightedge placed on the side of this Snedden ax illustrates the hollow behind the cutting edge.

Figure 8–14—A Tuatahi competition ax showing the additional relief filed into the sides.



Ax Head Grinds

Customizing the cutting edge of an ax with a specific grind can provide more bite, which allows you to remove bigger chips from a log. The grinds discussed in this manual refer to the microbevel and bevel of a cutting edge and how these blend into the ax profile. Adding a microbevel to the ax's grind provides strength and durability.

Grinds can be very specific to the types of wood you cut and are more important to competition choppers than to typical workers in the woods. The grind blends into the ax profile, providing a smooth transition from the cutting edge through the cheeks. The convex ax profile inherently provides this type of relief.

Once you profile the general shape of the ax head, you need to decide what type of cutting edge grind works best for the type of chopping you do. The cutting edge of a chisel grind is uniform from toe to heel. It is probably the most common and popular grind for basic ax use in America. Chisel grinds, in conjunction with a convex profile, are applicable for most types of wood (or most types of chopping).

A banana grind is an asymmetrical version of the chisel grind (figure 8–15). The cutting edge of a banana grind is wider in the center and narrower at the toe and heel. The edge can be either full or half banana. A half-banana edge is only slightly wider in the center than at the toe and heel. A full-banana edge fans up the cheek closer to the eye of the ax. It is considerably wider than a half-banana edge. Banana grinds are useful for chopping softwoods and some hardwoods, but not for very hard or frozen wood.

Figure 8–15—A double-bit ax with a banana grind on one cutting edge and a chisel grind on the other.

A flat grind is a symmetrical wedge from the edge of the ax to about 3½ to 4 inches back from the edge. Usually found on a flat-profiled ax (figure 8–16), flat grinds are the least desirable for general forestry use. Though it provides excellent depth penetration, an ax with a flat grind and flat profile will stick in the wood and not easily release. The cutting edges (bevel and microbevel) of the ax are also more likely to roll, chip, or break.

The chisel and banana grinds are the most common types of grinds. There are other types of ax grinds, depending on the region and country. This manual focuses on practical forest applications. You can search for other ax grinds on the internet. The Tuatahi website <http://www.tuatahiaxes.com/> provides helpful information about other types of grinds.

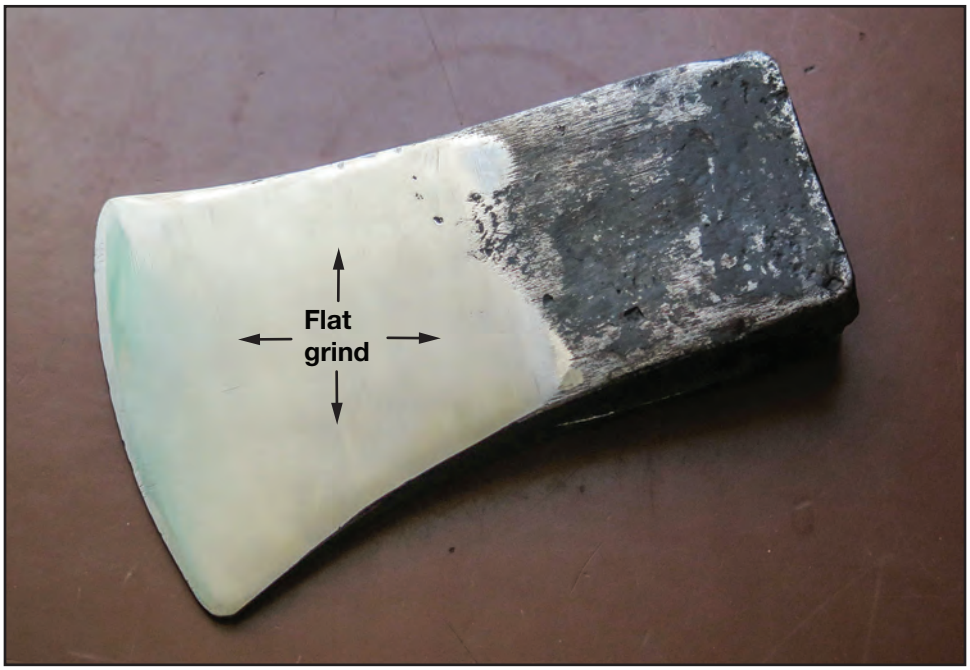
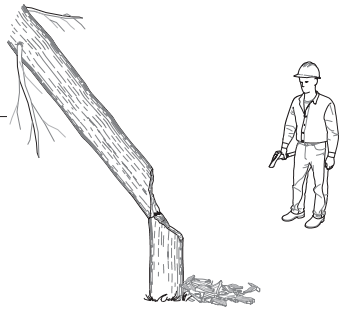


Figure 8–16—A flat grind on a flat-profiled ax.



Is Your Ax Head Worth Shaping and Sharpening?

It may not be worth your time or energy to shape and sharpen an ax head that has too much damage (figure 8–17). Begin by visually examining the ax head. Obvious defects can include a severely chipped or broken edge. If the cutting edge of the ax has minor or shallow chips, you may be able to file them out. A major chip in the edge may require you to file past the hard-tempered cutting edge and into the softer metal of the cheeks. Filing a cutting edge past the temper line produces an inferior edge. The softer metal does not hold an edge and does not stand up to hard use.

An over-filed head also may not be worth sharpening. Typically, the toe (figure 8–18), and sometimes the heel, of the cutting edge is filed so far back that you need to reprofile the entire edge to get it back into proper shape. Extensive filing sometimes brings the cutting edge out of the tempered zone and into the softer metal of the cheeks.

Figure 8–17—This ax had a manufacturing defect; it cannot be restored.

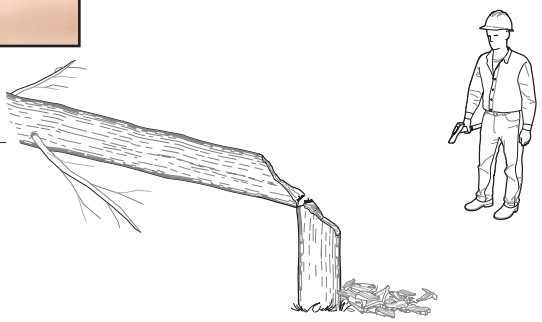
Figure 8–18—An ax head with a rounded toe.

Visual inspection of single-bit ax heads may reveal a severely damaged or mushroomed poll (figure 8–19). Driving metal wedges with the nontempered poll often causes this type of damage. You may be able to grind the poll back into shape, but could lose a lot of metal and weight from the back of the ax. The poll helps provide balance and a driving force while chopping.

Examine the eye of the ax. It should be symmetrical. The head may not fit the handle securely if the sides of the eye bulge or are otherwise deformed. This could indicate that the ax has been misused. With use, the bulge could continue to change shape and may break. An ax with a mushroomed poll often also has a bulging eye (figure 8–20).

Figure 8–19—An ax head with a mushroomed poll.

Figure 8–20—An ax head with a mushroomed poll and bulging eye.



Cracks or splits in the metal of the ax head are less obvious but serious defects to look for. These defects can be hairline cracks that are difficult to see, especially if the head is dirty. Clean the ax head thoroughly and examine closely for any cracks or splits, particularly in and around the eye. A cracked ax head (figure 8–21) could potentially break apart during use. You may be able to weld minor cracks, but cracks that extend into the cheeks of the ax can cause serious problems. Discard any ax head with these types of cracks.

The "Restoring a Vintage Ax Head" section in chapter 13 contains more information about defects in an ax head.

If a visual inspection confirms that an ax head is in good shape and worth the time and effort to sharpen, the next step is to examine the ax sides and cutting edge with your fingers (figure 8–22). Running your fingers across the ax sides and cutting edge reveals variations on both sides of the ax and helps you develop a filing plan.

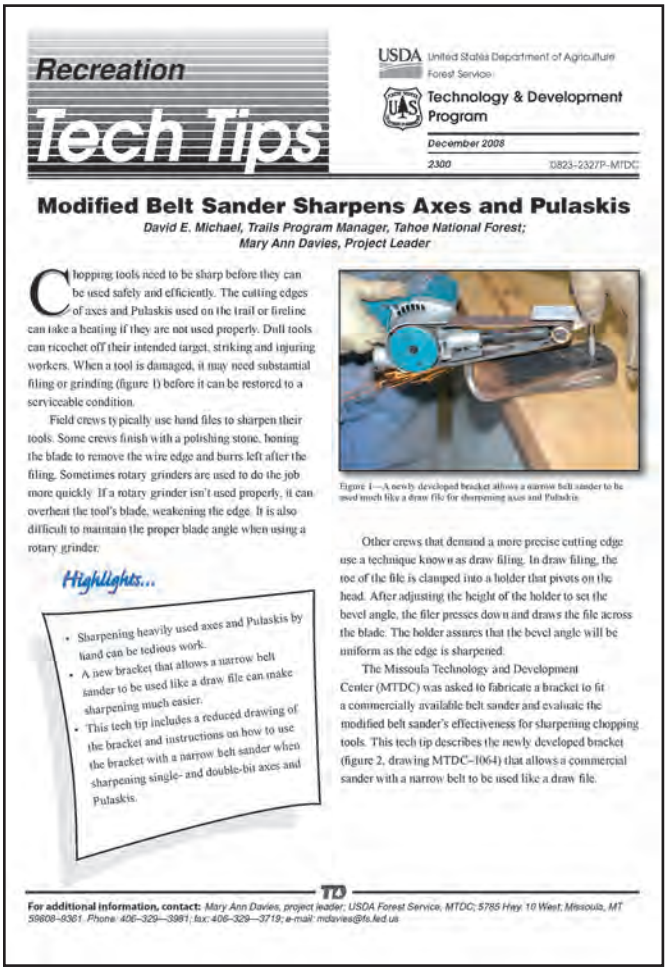
Figure 8–21—A crack in an ax head. When you see a mushroomed poll, check carefully around the eye for cracks.

Figure 8–22—Feeling the sides and cutting edge of an ax head can reveal high and low spots and can help you develop a filing plan.

Shaping an Ax Head

The publication "Modified Belt Sander Sharpens Axes and Pulaskis" (0823–2327P–MTDC) <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0823%202327P> (figure 8–23) provides instructions for making a sharpening jig for a 1-inch belt sander to assist with shaping an ax head. The publication explains how to mark an ax head so that the sharpening jig has a fixed point from which to swing. If you prefer not to put a small indentation in the ax head to serve as a pivot point, you can use rare earth magnets. These powerful magnets are available with a center hole and remain affixed to the ax head during use.

Before shaping, properly prepare the ax head by cleaning it and ensuring that it is free of dirt, oils, and rust. To begin shaping, properly secure the ax to a workbench so that it is stable and does not shift or move. Once you secure the ax, use a hand file or electric sander (figure 8–24) to begin removing metal from the ax head to achieve the desired profile and grind.



Recreation Tech Tips

USDA United States Department of Agriculture Forest Service
Technology & Development Program
December 2008
2300 0823-2327P-MTDC

Modified Belt Sander Sharpens Axes and Pulaskis

David E. Michael, Trails Program Manager, Tahoe National Forest;
Mary Ann Davies, Project Leader

Chopping tools need to be sharp before they can be used safely and efficiently. The cutting edges of axes and Pulaskis used on the trail or fireline can take a beating if they are not used properly. Dull tools can ricochet off their intended target, striking and injuring workers. When a tool is damaged, it may need substantial filing or grinding (figure 1) before it can be restored to a serviceable condition.

Field crews typically use hand files to sharpen their tools. Some crews finish with a polishing stone, honing the blade to remove the wire edge and burrs left after the filing. Sometimes rotary grinders are used to do the job more quickly. If a rotary grinder isn't used properly, it can overheat the tool's blade, weakening the edge. It is also difficult to maintain the proper blade angle when using a rotary grinder.

Figure 1—A newly developed bracket allows a narrow belt sander to be used much like a draw file for sharpening axes and Pulaskis.

Other crews that demand a more precise cutting edge use a technique known as draw filing. In draw filing, the toe of the file is clamped into a holder that pivots on the head. After adjusting the height of the holder to set the bevel angle, the filer presses down and draws the file across the blade. The holder assures that the bevel angle will be uniform as the edge is sharpened.

The Missoula Technology and Development Center (MTDC) was asked to fabricate a bracket to fit a commercially available belt sander and evaluate the modified belt sander's effectiveness for sharpening chopping tools. This tech tip describes the newly developed bracket (figure 2, drawing MTDC–1064) that allows a commercial sander with a narrow belt to be used like a draw file.

Highlights...

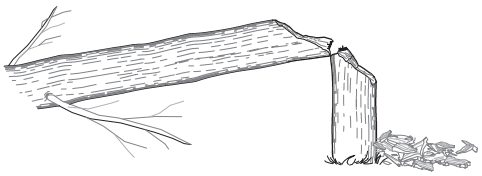
- Sharpening heavily used axes and Pulaskis by hand can be tedious work.
- A new bracket that allows a narrow belt sander to be used like a draw file can make sharpening much easier.
- This tech tip includes a reduced drawing of the bracket and instructions on how to use the bracket with a narrow belt sander when sharpening single- and double-bit axes and Pulaskis.

TD

For additional information, contact: *Mary Ann Davies, project leader; USDA Forest Service, MTDC; 5785 Hwy 10 West; Missoula, MT 59808–9361. Phone: 406–329–3981; fax: 406–329–3719; e-mail: mdavies@fs.fed.us*

Figure 8–23—The publication "Modified Belt Sander Sharpens Axes and Pulaskis."

Figure 8–24—Using an electric sander to remove metal from behind the cutting edge. A rare earth magnet provides an excellent pivot point for the sanding jig (inset).



When using an electric sander, frequently lift the sander off the ax head to check for heat buildup and to allow the head to cool as necessary (figure 8–25). The ax head should not be so hot that you cannot touch or hold it. Be especially careful around the cutting edge; this area is thin and heat can quickly build up and ruin the temper. The metal changes color if it starts to get too hot. If you notice the metal changing to shades of blue or purple, you are changing the temper of the steel and should stop immediately to prevent more damage. Never allow the sander to contact the cutting edge.

Although this manual discusses the use of powertools to profile and sharpen an ax head, it is extremely important to understand and learn the nuances of hand filing and stoning. Do not use powertools for the final steps of sharpening an ax head. Learning to use hand files and stones will give you a new appreciation for the effort required to shape and sharpen an ax head.

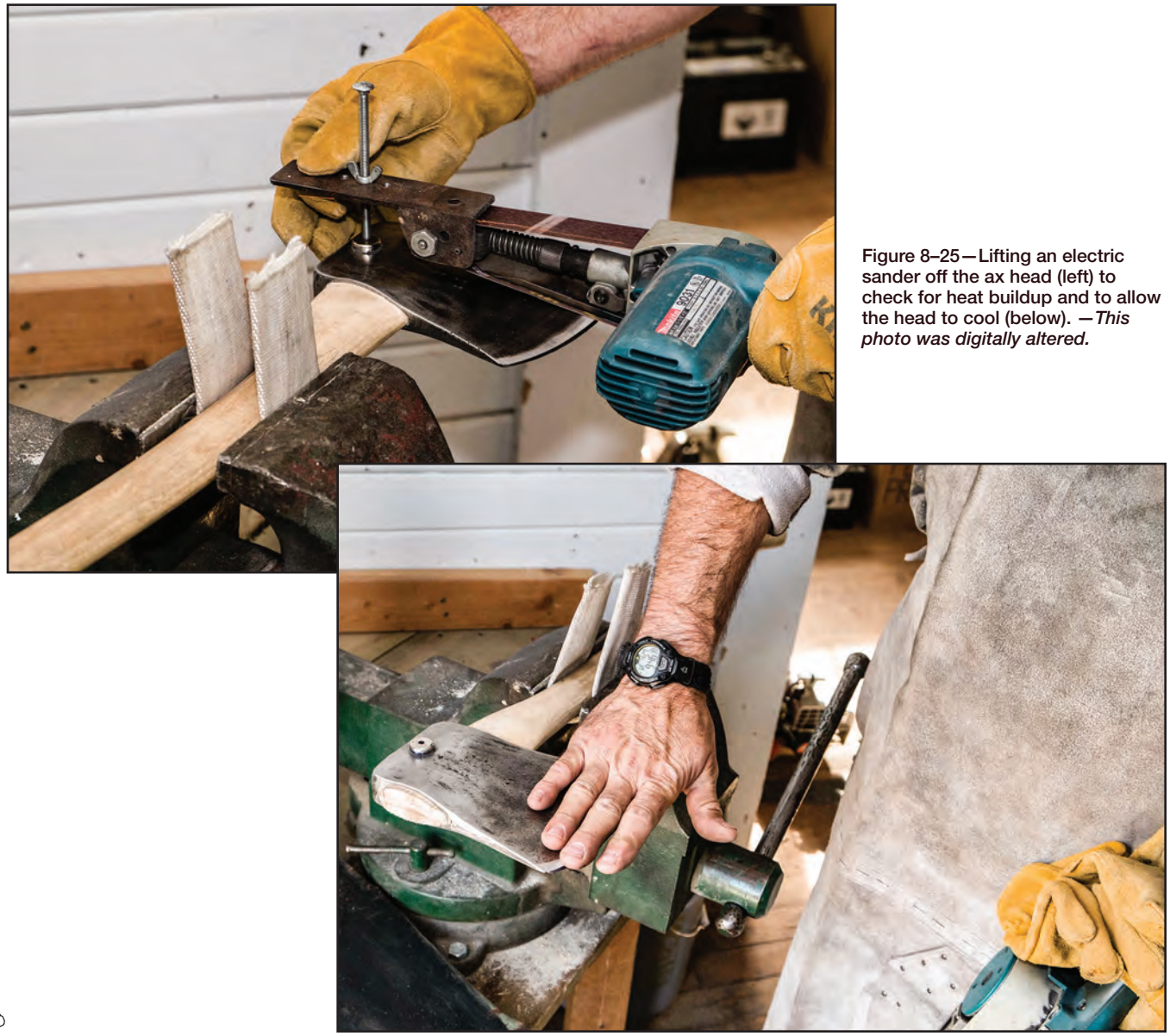


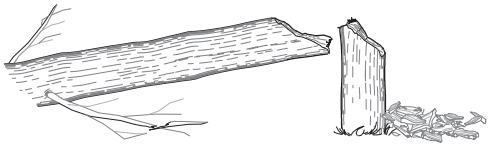
Figure 8–25—Lifting an electric sander off the ax head (left) to check for heat buildup and to allow the head to cool (below). —*This photo was digitally altered.*

Sharpening an Ax Head

To begin hand filing, secure the ax to a workbench with the head protruding over the edge. Ensure that the work area has adequate lighting to enable you to work safely and to monitor the progression of the filing. Begin by making long push strokes with the file toward the center of the ax head (figure 8–26). Do not file from the back side of the head toward the cutting edge; this can roll (bend) the edge of the ax head over. The file should have a handle with a guard on it for your protection. You should also wear good, cut-resistant or leather gloves, at least on the hand that may contact the cutting edge. The handle, file guard, and gloves protect your hands from cuts. Use both hands to file. Use firm, even strokes and lift the file at the end of each stroke (figure 8–27). Return to the point at which you started and repeat the process. Do not run the file back and forth across the ax head in a sawing motion; this will not produce the desired effect because the bastard file only cuts as you push it. Frequently tap the file to remove loose metal filings. If shavings clog or pin the file, stop and clean the file with a file card.

Figure 8–26—Using a push stroke on an ax head secured to a workbench.

Figure 8–27—Lifting the file off the ax head at the end of the push stroke.



The condition of the file and the pressure you apply determine the amount of metal you remove with each stroke. The more pressure you put on the file the faster it cuts. Stop frequently to examine the work visually and with your fingers (to identify high and low spots that your eyes may not see). Rotate the ax head as needed to file both sides evenly. Try to achieve a fan shape across the blade as you file. Leave the corners (tips) of the toe and heel a little bit thicker than the rest of the cutting edge (figure 8–28). The fan-shape filing helps to reinforce the toe and heel of the cutting edge.

Forming the Cutting Edge

As the ax head begins to take shape, use a draw stroke to begin forming the cutting edge (figure 8–29). Draw filing removes steel from just behind the cutting edge, helps shape the area, and provides a smoother finish to the ax head.

As you work, tip the file slightly so that the back edge cuts (see figure 7–6). Proper draw filing forms long curls of steel rather than just shavings. When filing close to the cutting edge, a thin metal wire or burr

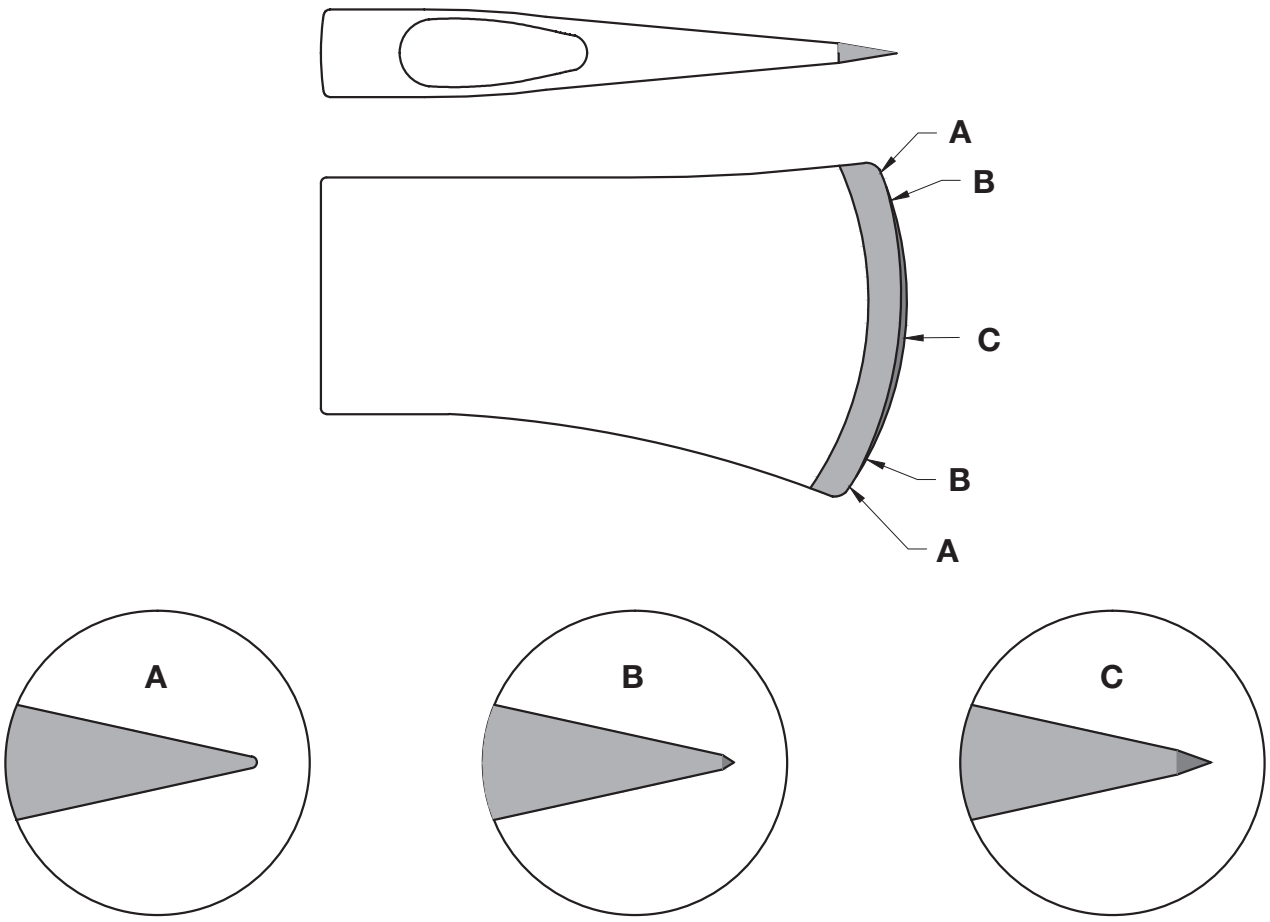


Figure 8–28—The ends of the ax head (the toe and heel) are unsupported edges. Leave the toe and heel slightly thicker to prevent the cutting edge from chipping.

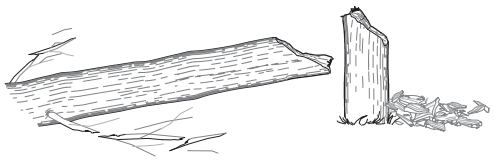
appears on the opposite side of the ax head. Use a whetstone to remove the burr. Beginners commonly make the mistake of applying more pressure midstroke, which can cause a hollow spot to form in the center of the ax head. Be aware of the tendency to apply more pressure midstroke and try to keep even pressure throughout the entire process.

Remove the ax from the workbench, rotate the head to the opposite side, and resecure the ax to the workbench. Do not focus on completing one side before working on the opposite side. Work both sides of the ax head with the file, using push and draw strokes until the sides are symmetrical and smooth. Use an ax gauge to confirm that you have shaped the ax head properly (figure 8–30).

As the ax head begins to take shape, the visual variations become less pronounced. A strong light source reflecting across the steel can pick up irregularities. As you work those areas down to the point where the ax head has a consistent finish, you will again need to rely on your sense of touch. While you may no longer be able to see the minute variations in the ax head, your fingertips will feel variations in thickness and will help identify areas where you need to concentrate to transform the ax head into an efficient cutting tool.

Figure 8–29—Using a draw stroke on an ax head secured to a workbench.

Figure 8–30—Using an ax gauge to ensure an ax head is symmetrical. Note that the tip of the cutting edge fits into the circle and the sides of the ax head are flush with the gauge.



Honing the Bevel

At this stage, you can also switch to using an ax stone or a diamond sharpening stone to begin honing the bevel (figure 8–31). Ax stones are round, carborundum sharpening stones that typically have a coarse and a fine side. Similar stones are available, but an ax stone fits nicely in your hand. Some ax stones have a grooved center that provides protection for your fingertips (figure 8–32). Ax stones in general require a lubricant to work efficiently. That lubricant is typically water, saliva, or an oil. The lubricant floats away metal filings as you sharpen the ax. Apply the lubricant and then work the coarse side of the stone in a circular motion along the side and up to the cutting edge of the ax. Once you create a burr on the opposite side of the ax, turn the head over and repeat the process. Repeat the entire process using the fine side of the ax stone.

Figure 8–31—Using an ax stone to hone the bevel.

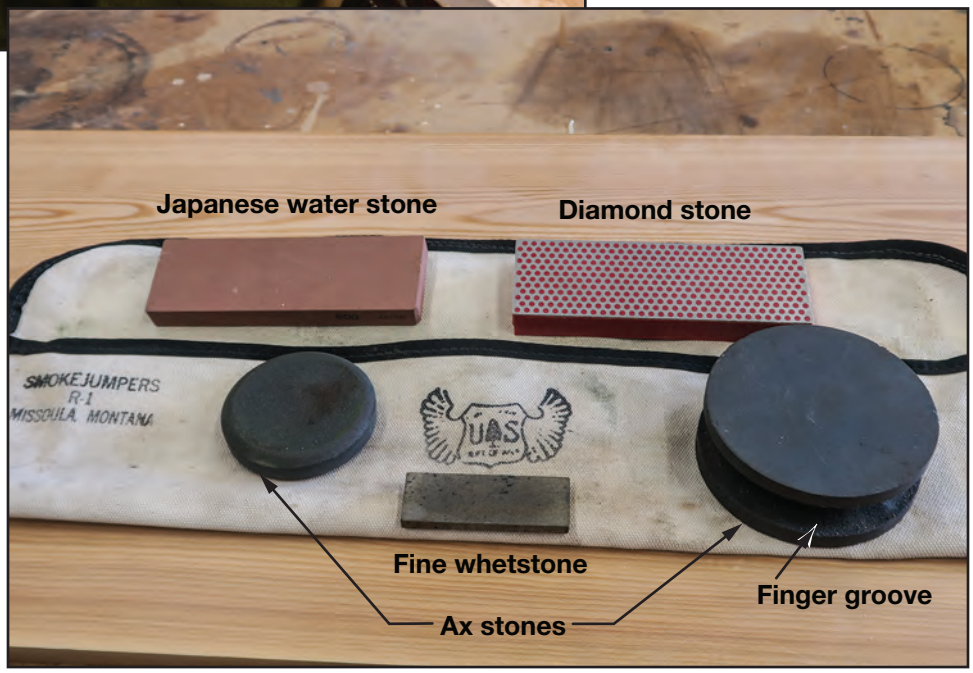


Figure 8–32—A Japanese water stone, a diamond stone, and three different ax stones. The ax stone on the bottom right has a finger groove.

Developing the Microbevel

Once you properly shape the ax head, you need to focus on the microbevel. The microbevel is an extremely important part of the ax head; it provides strength and durability to the cutting edge (figure 8–33).

Use a fine diamond stone or whetstone, such as a Hard Arkansas (or similar type) stone to develop the microbevel (see figure 8–7). As usual, axmen have their preferred techniques for developing a microbevel. These preferences may include the type and size of stone they use and the motion in which they move the stone. The author prefers to move the stone vertical to the edge, from toe to heel. This action helps to develop and establish the angle of the microbevel and its relationship to the rest of the cutting edge. Once you establish the microbevel, move the stone horizontally back and forth along the cutting edge. The microbevel itself is slight, perhaps 1/16 of an inch along the entire length of the cutting edge. Because the microbevel is so small, it is difficult to measure the angle accurately, but it should be about 25 degrees. You will determine through trial and error what angle and grinds work best for your ax and your cutting style.

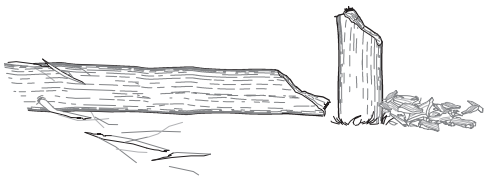
Whetstone or Wet Stone?

The proper term and spelling is whetstone. The word "whet" means to sharpen, so a "whetstone" is a stone used to sharpen edged tools.

To get the most out of a whetstone, keep the stone lubricated with water or oil. Mineral oil, a light machine oil, or automatic transmission fluid are acceptable oils. The lubricant helps carry away particles of metal—known as swarf—released through the stoning process that could otherwise cause the stone to clog and reduce its effective cutting power.

With few exceptions, the author uses only water on his sharpening stones. Oil permeates the porous texture of a whetstone, while water dries out and leaves the stone in its natural state. Once you put oil on a whetstone, you should continue to use only oil as a lubricant for that whetstone.

Figure 8–33—The microbevel adds strength and durability to the cutting edge.



Natural Sharpening Stones

With reduced demand, the cost of mining and producing high-quality, natural sharpening stones has risen dramatically over the last several decades. This is especially true for Soft Arkansas and Hard Arkansas stones. If you have a good sharpening stone, take care of it and it will last a lifetime.

Do not confuse the traditional whetstone with a water stone. Similar to a whetstone, water stones can be made of both natural and synthetic materials. Most water stones are synthetic and are made of aluminum oxide.

A water stone is softer than a whetstone. Because it is softer, the top, abrasive material wears away more quickly, constantly exposing fresh, sharp, abrasive material. This enables you to sharpen an ax faster. This may seem like an advantage, but it does have drawbacks.

Water stones can be expensive. Because they are softer, they wear out more quickly and are more prone to uneven wear. This requires you to flatten the stone regularly to maintain its shape. The author considers water stones best suited for sharpening smaller-edged tools, such as knives, chisels, and wood plane blades, rather than axes.

Putting the Final Cutting Edge on an Ax Head

Use a leather strop to put a truly sharp final edge on an ax head (figure 8–34). The strop hones and polishes the cutting edge to razor sharpness. A polished cutting edge has less friction as it enters wood, penetrating deeper and severing wood fibers better. Even more important than honing the edge, stropping an ax head removes any super fine thread or burr of steel (also known as feather or wire edges). It is possible to remove these threads or burrs with careful honing, but stropping does a better job.

Figure 8–34—Using a leather strop to sharpen a cutting edge.

A Leather Strop: Suede versus Smooth

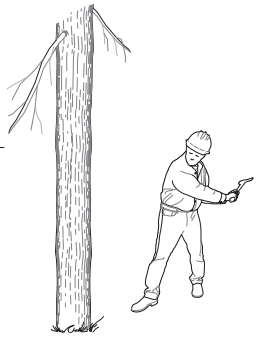
Suede (the flesh side of a leather hide) or smooth (the grain side of a leather hide) both work well for a strop. Suede may be a little better for heavier-edged tools, such as axes, while smooth may be better for finer-edged tools, such as knives and razors. Using honing compounds (figure 8–35) eventually makes both the flesh and grain sides of a leather hide nearly indistinguishable.

If you make your own strop, choose leather that is 1/8-inch thick or thicker and accepts a honing compound without becoming too slick or too thick.

Figure 8–35—Rubbing honing compound into a leather strop attached to a board.

Strop a cutting edge by moving the ax head backward against the leather so that the leather contacts the back side of the cutting edge. Always move an ax in the direction that does not cut into the leather. The proper angle is 35 to 40 degrees. Keep the cutting edge slightly elevated so that the ax head moves across the leather. Apply pressure on the back of the ax head and not on the cutting edge.

Because of the size and weight of an ax, the common barbershop strop is not appropriate for honing an ax head. For safety reasons, it is best to secure a piece of leather to a wooden board. The author uses a strop secured to a piece of hardwood that is 3-inches wide by 12-inches long. If you use a dedicated sharpening station, you can secure this board to your workbench. You can carry a small honing strop (about 1 inch by 3 inches) on a ½-inch piece of



plywood for honing in the field. Honing compounds are fine, abrasive materials that you can apply to a strop to assist with the final sharpening and polishing of your ax.

After spending so much time shaping and sharpening an ax head, it is important to keep it sharp. Experienced axmen carry a small sharpening stone to rehone their cutting edge throughout the day. Clean the ax head at the end of a day to remove any pitch. Hone the cutting edge and rub light machine oil or furniture or car wax over the ax head to protect it from rusting.

The publication "An Ax to Grind: A Practical Ax Manual" (9923–2823P–MTDC) <http://www.fs.fed.us/t-d/php/library_card.php?p_num=9923%202823P> provides additional information about sharpening axes.

Chapter 9—Reshaping or Replacing an Ax Handle

Finding an ax that is right for you may be as simple as replacing a bad or broken handle and reusing the head.

Keep in mind that many axes have good handles that are simply hung incorrectly—typically, too high above the shoulder (where the handle flares to fill the ax head eye). You may be able to use a rasp to remove wood from above the shoulder. You can then strike the knob of the handle with a wooden mallet to drive the top of the handle higher up through the top of the eye, enabling you to remove the wedge and, consequently, the handle. You can then reshape the handle and hang it correctly instead of replacing it.

Removing an Old Ax Handle

When you replace an ax handle, you may have to remove an old or broken handle. You can easily accomplish this task with the right tools. Begin by securing the ax handle in a vise and sawing off the handle just below the ax head (figure 9–1). After you saw off the handle, secure the ax head in a bench-top jig (figure 9–2) and use a drift pin (figure 9–3) to hammer the remaining portion of the handle free.

Refer to "Appendix B—Technical Drawings" for technical drawings of drift pin assemblies for different types of axes.

The bottom eye on most ax heads is slightly smaller than the top eye. This provides a tighter fit between the bottom eye and handle and enables you to drive a wedge into the top eye to secure the head to the handle. Conversely, it also enables you to use a hammer (a 3-pound steel hammer works well for this) and drift pin to more easily drive the remaining portion of a sawed-off handle from the bottom eye out through the top eye (figure 9–4). If the handle fits tightly into the ax head eye, you can create space and reduce friction by first drilling several holes into the ax handle (be careful to avoid any metal wedges in the handle).

Figure 9–1—Sawing off a broken handle below the ax head.

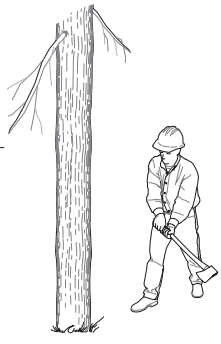


Figure 9–2—A simple bench-top jig secured by a vise.

Figure 9–3—Three drift pins used for removing a handle from the eye of an ax head.

Figure 9–4—Using a mallet and drift pin to remove the remaining portion of a handle from an ax head eye.

Making a Simple Jig

Using a jig to secure an ax head is better than securing the head in a vise. Securing an ax head too tightly in a vise can crush and alter the shape of the eye.

You can easily make a simple jig to suit your needs. "Appendix B—Technical Drawings" provides technical drawings for a couple of different jig designs.

A vise secures the bench-top jig shown in figure 9–2. You can easily remove the jig when you are not using it. The freestanding jig does not require you to saw off the handle. This may be useful if you want to salvage the handle, but you must remove the wedge and force the handle out through the bottom of the eye.

Shaping an Ax Handle

After carefully selecting an ax handle that is free of defects, it is time to customize it to fit your needs and body size. Do not assume that a stout handle is a strong handle. A handle that is too big and bulky is more prone to break than a thinner, properly shaped handle. Figure 9–5 shows a thick vintage stock handle and a thin vintage stock handle. Most handles you buy today are too thick; you must thin them down to properly fit your hands.

A properly shaped handle focuses the energy of the ax head when you chop. A thinner handle is more flexible, providing whip to the chop. Whip enables the ax head to hit harder while minimizing the impact vibration that transfers back through the handle to you.

A thicker handle is less flexible, transfers more vibration, and is also subject to greater stress where the handle enters the ax head eye.

The area directly below the eye is the most likely place for the handle to break because:

- Wood fibers at this junction receive the brunt of the energy transferred from the ax head.
- Repeated chops crush and flex the wood fibers.
- The wood outside the eye moves more than the wood inside the eye, causing wood fibers at the junction to weaken and eventually break.

To begin safely shaping the handle, secure it in a vise on a workbench or shave horse. You can use a number of tools to remove wood from a handle:

- Belt or orbital sander
- Block plane
- Drawknife
- Horseshoe rasp
- Old planer blade or other similar type of blade
- Spoke shave
- Wood rasp

Figure 9–5—A thick vintage handle (top) and a thin vintage handle (bottom).

The author prefers three tools for removing wood and shaping a handle: a rasp, a planer blade, and a spoke shave (figure 9–6).

The rasp gouges the wood, but removes it quickly and develops the rough shape. The planer blade or spoke shave provides a smoother finish. If you use a planer blade, pull the back side of the blade across the handle to provide better depth control and to help prevent gouging. If you use a spoke shave, you can preset its cutting depth.

Figure 9–6—Using a rasp (left), a planer blade (below), and a spoke shave (following page, top) to shave wood from a handle secured in a vise on a workbench.

Rotate the handle regularly to keep its shape symmetrical. Some handles may be so bulky that your best option is to remove excess wood using a band saw (figure 9–7) before thinning the handle using handtools. Be careful to maintain an elliptical or flat-faced shape to the handle; a handle that is too round will pivot freely in your hands, decreasing your chopping accuracy and creating a potential safety issue.

The author prefers an octagon-shaped handle; the flat sides and ridges make the handle easier to hold and less likely to pivot while chopping, and also provide a firmer grip in wet weather.

As the handle begins to feel more comfortable in your hands, use a felt pen to mark specific areas where

Figure 9–7—Using a band saw to thin down a thick handle.

you want to remove more wood and to avoid areas you have already finished shaping (figure 9–8).

You should remove wood primarily from the sides and back of the handle on a single-bit ax and primarily from the sides on a double-bit ax. Try not to remove wood from the belly of any ax handle; maintaining the belly helps to keep the head and handle better aligned.

Thin down the handle until it is comfortable to grip and your hands slide easily along the entire length of the shaft. Pay particular attention to the shoulder of the handle. Shape the shoulder to fit your hand as well as the ax head. Removing too much of the shoulder will leave gaps between the handle and the head.

The throat and knob of the handle (figure 9–9) also require special attention. This lower section of the handle is where you position your stationary hand; it must fit that hand comfortably. The knob is at the base of the throat and helps prevent the ax from slipping out of your hands as you chop. Do not remove too much wood from the throat or knob.

Figure 9–8—Using a felt pen to mark an ax handle.

Figure 9–9—The throat and knob of an ax handle.

When you thin down an ax handle, you not only need to make it fit your hands (figure 9–10), you also need to match the handle with the ax head. The "Steps for Hanging an Ax" section in chapter 10 provides further information about matching an ax head and handle. The goal is to find the proper balance between the two. The balancing point of an ax should be as close to the head as possible (figure 9–11). With a thinner handle, the center of mass (balancing point) is closer to the ax head and your chopping is more efficient.

The profile of an ax head also plays a part in the strength and durability of a handle. If the profile of the ax head does not enable you to easily remove the head from the wood you cut, the additional force required to remove it can further crush wood fibers at the junction between the ax head and handle, making a broken handle more likely. This commonly occurs when using an ax to split rounds of firewood.

Figure 9–10—A properly shaped, thinned down handle. Note how the fingers overlap the handle.

Figure 9–11—A properly balanced single-bit ax resting on one finger, indicating that the balancing point is close to the ax head.

Finishing an Ax Handle

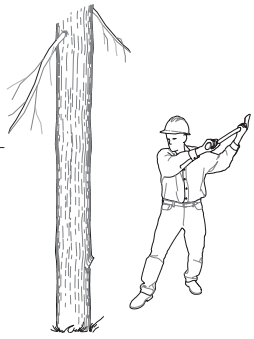
Once you slim down the handle to fit your preferences, proceed to the final step, which is finishing. Finishing removes all burs and rough areas that could cause blisters or splinters on your hands. The goal is to make the handle as smooth as possible, though many people prefer to leave the throat a little rough to improve the grip. Tools used for finishing a handle include:

- Cabinet scraper (or similar tool)
- 100-grit sandpaper (figure 9–12)
- Steel wool

Rub raw or boiled linseed oil into the handle after you achieve a smooth finish (figure 9–13). Wood is porous, so the grain of the handle absorbs the linseed oil, which helps to keep the handle from drying out. Allow the oil to soak in, then repeat the process until the handle is saturated. The linseed oil helps maintain and preserve the handle. Oil also helps maintain the handle's strength and flexibility. As needed, reapply a coat of raw or boiled linseed oil to maintain the handle. Boiled linseed oil dries faster than raw linseed oil.

Figure 9–12—Sanding down an ax handle to make it smooth.

Figure 9–13—Rubbing boiled linseed oil into a handle to achieve a smooth finish.



Raw or Boiled Linseed Oil

Manufacturers make linseed oil from flax seed. Raw linseed oil dries very slowly, whereas boiled linseed oil dries much more quickly.

Though referred to as "boiled," manufacturers do not actually boil the linseed oil; they add metal solvents to it that cause it to dry more quickly.

Be careful when using old-stock or vintage boiled linseed oils you may have on hand; manufacturers often used lead as a metallic dryer in these oils. Because you can absorb lead through your skin, you should always use latex or nitrile gloves when handling old-stock or vintage linseed oils.

A good recipe for a handle finish is equal parts of boiled linseed oil, turpentine, and beeswax. Warm the ingredients in a microwave to about 100 ºF and stir to blend them thoroughly before applying.

Leave the top of the handle (where it fits inside the ax head) free of oil or ensure that it is completely dry before inserting it into the ax head. Oil is a lubricant and can cause the ax head to slip on the handle.

If you shape handles on a regular basis, you can use a 3-inch-diameter piece of polyvinyl chloride (PVC) pipe about 36-inches long to soak the handles. Cap one end permanently and put a removable cap on the other end so you can periodically clean out the pipe. Fill the PVC pipe with linseed oil (it holds about 1 gallon) and soak the handle until it is saturated (figure 9–14). Wipe off any excess oil and the handle is ready to hang.

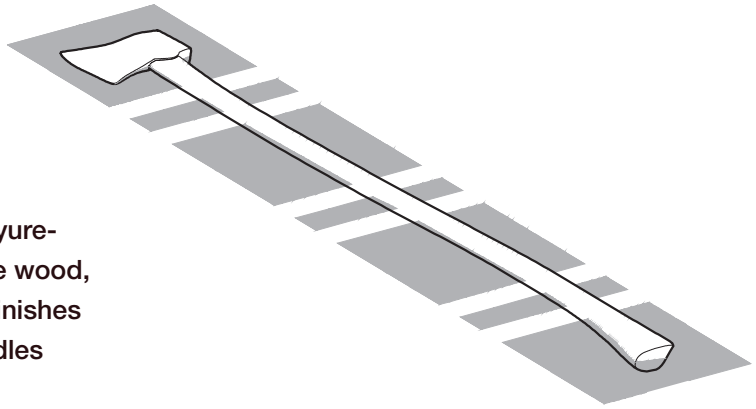
Figure 9–14—Removing an ax handle from polyvinyl chloride (PVC) pipe filled with linseed oil.

Be careful not to soak the handle for too long (about 20 minutes should be enough) or it will become too saturated and sticky or gummy. A sticky handle indicates that you have applied too much oil and allowed it to dry before it could penetrate the surface. If the handle is sticky, use a clean rag to apply turpentine, paint thinner, or mineral spirits to remove the excess oil. Allow the oil to loosen and then wipe the handle. Note: if the coat of excess oil is heavy, you may have to use steel wool to remove it. After the handle dries, you may have to recoat it with a lighter application of linseed oil.

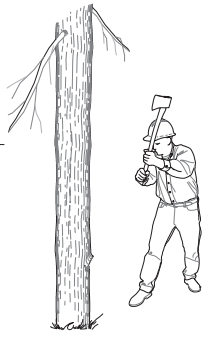
Remember to dispose of linseed oil-soaked rags properly. Heat is part of the drying and curing process. If you throw an oil-soaked rag in the trash, it may spontaneously combust and start a fire. Place the rag outside or in a safe location and allow it to dry thoroughly before disposing of it.

Once you hang the ax, apply a few drops of oil to the top of the handle and the top of the wooden wedge that fixes the handle to the head to keep them from drying out. Remember this adage about putting linseed oil on after you hang your ax handle:

Linseed your handle
Once a day for a week
Once a week for a month
Once a month for a year
Once a year after that



Harder finishes, such as paint, varnish, or polyurethane, provide better surface protection to the wood, but do not permeate the wood fibers. These finishes also could cause blisters on your hands. Handles should have an oil finish, not a hard finish.




Linseed
Oil

Chapter 10—Hanging an Ax

Hanging an ax is the process of fitting the head to the handle. Some axmen hang the ax after shaping the handle but before sharpening the head; they use the handle to help secure the ax to the workbench. Other axmen prefer to sharpen the head before fitting it to the handle. Either method works fine.

When fitting an ax head to its handle, take the time to do the job properly. Joining an ax head to a handle is a key step in making a safe and efficient ax.

Properly Fitting an Ax Head to Its Handle

A properly hung ax must meet three key criteria:

- The head must securely affix to the handle.
- The head must be in line with the handle.
- The angle of the head must align vertically with the handle.

The ax head must securely affix to the handle. An ill-fitting head is dangerous; it could become loose and separate from the handle, potentially injuring you or another person. The handle must fit the eye tightly and you must secure it with a wooden wedge. Competition choppers, as well as many experienced ax users, pin their ax heads through the handle (figure 10–1).

Figure 10–1—An ax head pinned to a handle.

You can pin the head by drilling a small hole through the head and handle and driving a roll pin through the hole (figure 10–2). Typical roll pin sizes are 5⁄32 inch or 3⁄16 inch. Place the pin about one-fifth of the way up from the bottom of the head, centered on the handle and below the wooden wedge in the kerf. This secures the head to the handle and prevents the head from flying off, even if it is loose. Forest Service employees should pin their ax heads to their handles. Pinning an ax head is generally the last step in hanging an ax.

Figure 10–2—Using a center punch to mark an ax head to insert a pin (right), drilling a small hole through the ax head and handle (below and facing page, top), and driving a roll pin through the hole (facing page, bottom).

The ax head must be in line with the ax handle. Assuming the handle is not bent or warped, you can sight directly down the cutting edge of the ax to ensure that it lines up with the center of the knob at the end of the ax handle (figure 10–3). Properly aligning the head with the handle is important for accuracy when chopping.

Vertical alignment helps prevent over reaching or under reaching while chopping and ensures the head is not hung too open or too closed. This enables the entire length of the cutting edge to efficiently sever fibers. Using a flat surface, such as a workbench, place the ax so that only the cutting edge and knob touch the surface. A properly aligned ax will touch the workbench somewhere between the midsection of the cutting edge or slightly lower on the heel of the cutting edge's curvature, as shown in figure 10–4.

Figure 10–3—Sighting down the midpoint of the heel of the cutting edge to ensure that it aligns with the center of the knob on the handle.

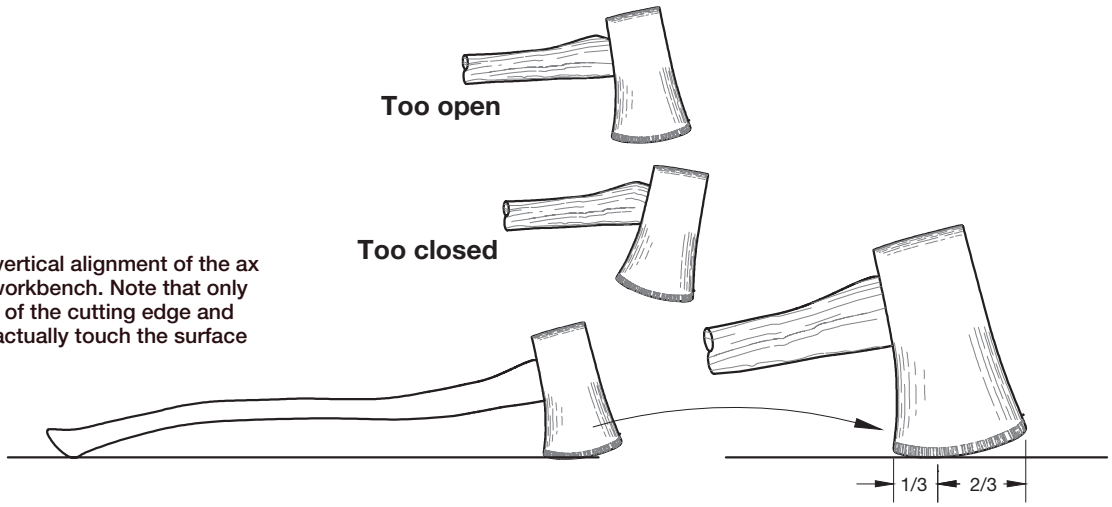


Figure 10–4—Ensuring vertical alignment of the ax by placing the ax on a workbench. Note that only the midpoint of the heel of the cutting edge and the knob of the handle actually touch the surface of the workbench.

Proper hang for a large, single-bit ax

Steps for Hanging an Ax

Joining an ax head to a handle is relatively easy, but it is not necessarily a quick procedure. You may have to fit, remove, adjust, and refit the handle numerous times to achieve a proper fit. If necessary, use a drift pin (see figure 9–3) to help remove the handle from the ax head. Using a drift pin to ease the handle out protects both the ax head and handle from damage. Using a simple wooden jig to hold the ax head steady makes the job easier and helps protect the head from damage (figure 10–5). Never pound an ax head with a metal hammer or mallet to loosen or remove the head from the handle.

Before fitting the handle, position it on top of or alongside the ax head to get an idea of how much excess handle will protrude from the top. Place the ax head at the shoulder of the handle (figure 10–6). Cut some wood off the top of the handle if several inches or more protrude above the head, but be careful not to remove too much. You want at least ½ inch of wood to stick out above the top of the ax head after hanging the ax. To end up with ½ inch of wood, start with 1 to 1½ inches to allow for some damage to the top of the handle when you secure the ax head.

Figure 10–5—A jig, drift, and wooden mallet.

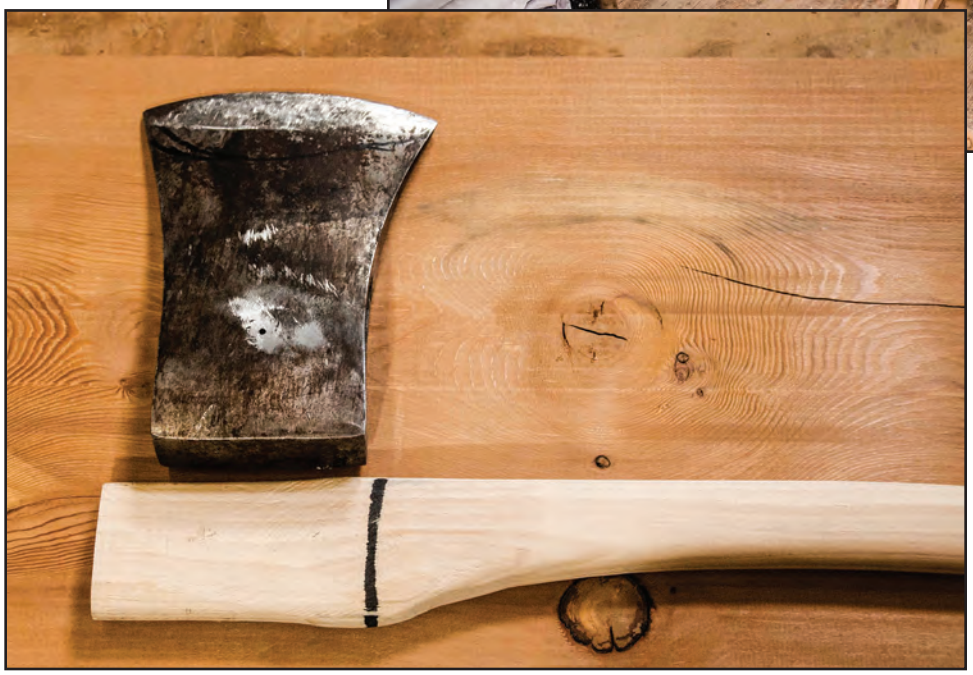
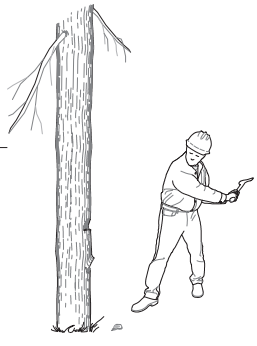


Figure 10–6—An ax head resting beside the shoulder of a handle.



Fit the handle into the bottom of the ax head eye for a trial fit. Some ax head patterns are relatively symmetrical. If you are unsure which is the top and which is the bottom of the ax head, look at the eye; it is slightly larger at the top to accept the wedge (figure 10–7). However, there are exceptions. For example, the eye of the full peeling ax, which is fully reversible, is symmetrical all the way through.

You may have to use a rasp to remove some wood to allow the ax handle to seat into the eye (figure 10–8). Again, be careful not to remove too much wood.

When shaping the section of the handle that fits into the eye, you must remove enough wood to properly align and fit the handle. The fit may actually be slightly loose. At this stage, being able to insert and

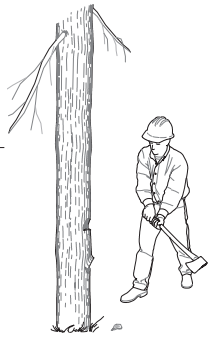
Figure 10–7—Looking through the top eye of an ax head. Note that the top of the eye is slightly larger than the bottom to allow for the placement of the wedge.

Figure 10–8—Using a rasp to remove wood from an ax handle.

remove the handle with minimal effort is acceptable and makes it easier to align the head properly. The goal is to achieve proper alignment and fit before the final step, which is driving the wedge into the kerf (slot) at the top of the handle to tighten and secure the head to the handle. As noted earlier, you can pin the head to the handle to ensure that the head does not fly off if it becomes loose. The handle must be secure and fit tightly into the head at the final fitting.

Once the ax head begins to accept the handle, use a wooden or rubber mallet (or a dead-blow hammer) to try seating the handle. Strike the handle on the heel to draw the head up onto the handle (figure 10–9). Strike with enough force to gain movement, but not so much force that you cannot easily remove the head.

Figure 10–9—Strike the heel of the ax handle to draw the ax head onto the handle. Note that the fawn's foot on this handle has a flat bottom.



The bottom of the heel on double-bit handles is flat. The bottom of the heel on some single-bit handles may be at an angle. Striking a handle at an angle could damage the handle's edges. It is best to cut about ½ inch off the bottom of the sloping handle before seating the head to provide a flat place to strike (figure 10–10).

Figure 10–10—Repairing a curved, single-bit handle with a damaged heel (left) by removing about ½ inch of the handle (below) and smoothing the heel using sandpaper (facing page, top).

Continue rasping and seating the handle until the head fits snuggly on the shoulder. Each time you place the ax head, sight down the cutting edge to ensure that it stays laterally aligned with the knob of the handle (see figure 10–3). If the alignment is to the right, remove wood from the right side of the handle that sits inside the eye (figure 10–11). If the alignment is to the left, remove wood from the left side of the handle that sits inside the eye. To align the handle, you may have to remove wood equally from both sides. Note: do not remove wood from the entire length of the handle, but only from the portion that sits inside the eye.

Figure 10–11—Ensuring the lateral alignment of the ax head with the ax handle by removing wood from the handle where it sits inside the ax head eye.

Along with checking the lateral alignment between the cutting edge and the center of the knob on the handle, pay attention to the vertical alignment between the cutting edge and the knob of the handle (see figure 10–4). To adjust the angle at which the cutting edge strikes, remove wood from either the leading edge or back edge of the handle where it sits inside the eye. If the lower portion of the cutting edge rests on the counter surface, remove wood from the leading edge (figure 10–12). If the upper portion of the cutting edge rests on the counter surface, remove wood from the back edge. Note: do not remove wood from the entire length of the handle, but only from the portion that sits inside the eye. Be careful not to remove too much wood. A rasp may be too aggressive for this procedure and may damage the edges of the handle. Use a scraper, knife, or sandpaper.

When you are satisfied with the fit between the ax head and handle, you are ready to join them together and secure them. Use a wedge that is about 3 inches long, depending on the depth of the ax eye. The wedge should reach into the handle kerf about one-half to three-quarters of the depth of the head (figure 10–13). A wedge this deep allows sufficient depth for holding power and allows you to saw off any portion of

Figure 10–12—Removing wood from the leading edge of the handle where it sits inside the eye of the ax head.

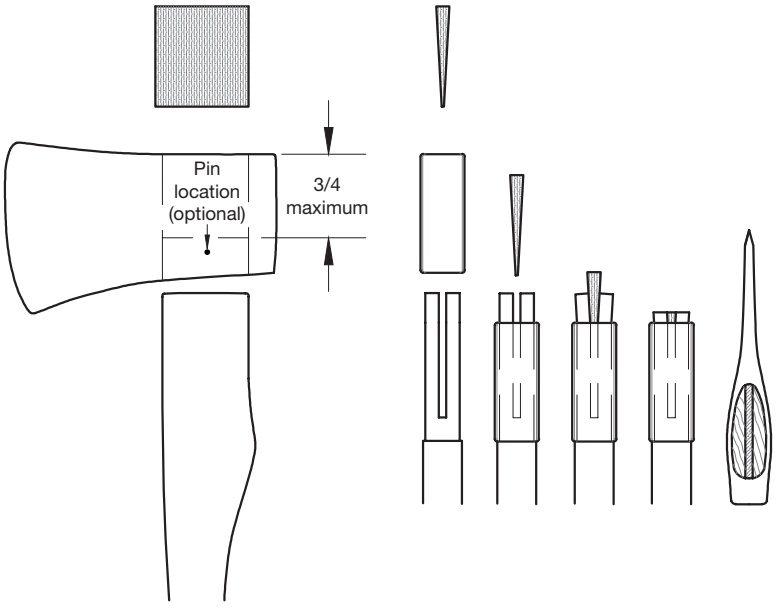


Figure 10–13—The proper depth of the wedge in the kerf.

the top of the wedge that you damage while fitting the head and handle. You can mark the handle to indicate the depth of the wedge (figure 10–14). Before joining the head and handle together, check the kerf on top of the handle. Is the kerf deep enough to accept the wooden wedge? If necessary, use a handsaw to deepen the wedge kerf to accept a wedge (figure 10–15).

Seat the handle into the ax head for the final time using the same process you used to fit the handle to the head (that is, strike firmly with a wooden or rubber mallet from the bottom of the ax handle to draw the head up). The ax head should rest against the top of the handle's shoulder.

Figure 10–14—Marking the depth of the wedge to indicate how far it will reach into the kerf.

Figure 10–15—Using a handsaw to make the ax handle kerf deeper.

Ideally, ¾ to 1 inch of the handle should protrude above the top of the eye. Using a fine-toothed saw, trim only enough off the top of the handle to create a clean, flat area for inserting the wedge. Use a good quality, properly sized wooden wedge to fit the handle. The wedge should extend the length of the ax head eye from front to back and about three quarters of the ax head depth from top to bottom.

Before driving in the wedge, coat its sides with dipropylene glycol (commonly known by the brand name "Swell-Lock"). Dipropylene glycol is a chemical that causes the wooden wedge to expand for a tighter fit. If you do not have dipropylene glycol, the bare wood is fine. Do not use linseed oil, which may act as a lubricant and cause the wedge to slip out of the kerf.

Drive the wooden wedge firmly and evenly into the kerf as far as it will go (figure 10–16). The wedge expands this top portion of the handle to grip the top sides of the eye (figure 10–17). This provides added

Figure 10–16—Using a wooden mallet to drive the wedge into the ax handle kerf.

Figure 10–17—The wedge expands the top portion of the ax handle to grip the sides of the ax head eye.

protection to prevent the head from becoming loose. If the head does become loose, you can simply drive the wooden wedge farther down. Saw the excess wedge off, but do not saw the top of the handle flush with the ax head. Leave about ¼ to ½ inch of handle protruding from the top of the ax head (figure 10–18).

Do not use metal crosstie wedges to secure the head. Although metal crosstie wedges are common in many commercially available axes, they crush wood fibers and could cause the handle to split. They can also make removing the handle more difficult.

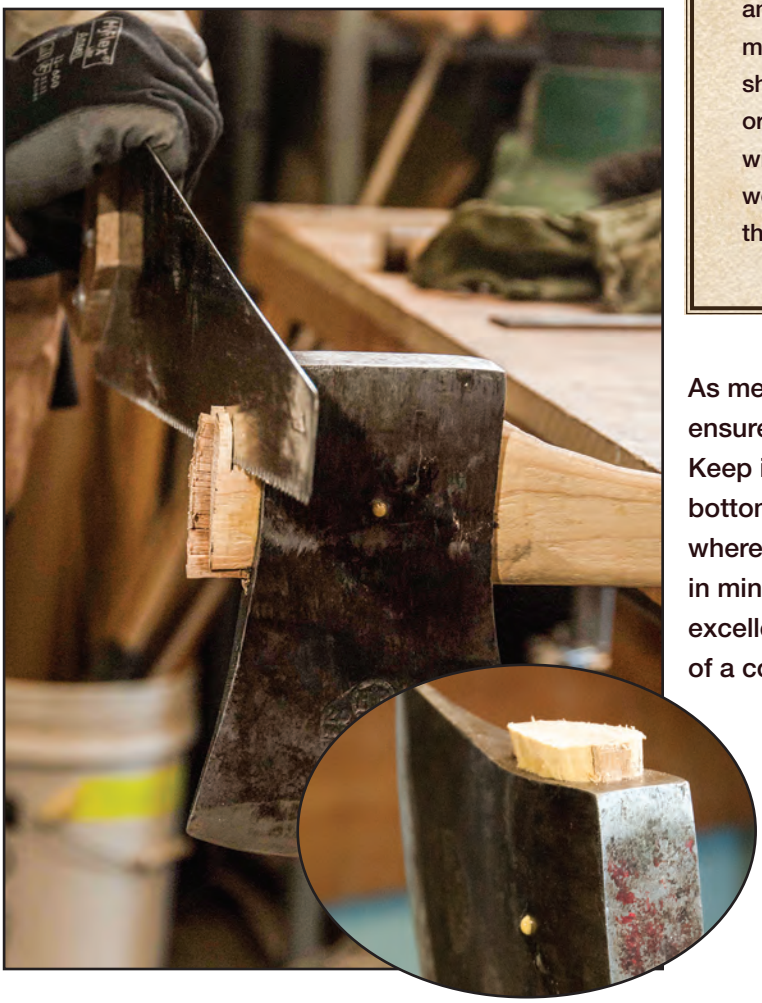
The majority of ax manufacturers today cut the handles flush with the top of the ax head, but leaving a little bit of handle protruding provides added security for keeping the head tight.

The Ax Head Wedge

Wedges used for securing an ax head to a handle come in many different styles, shapes, and sizes. Not all wedges are alike; some are metal, some are synthetic, some are softwood and others are hardwood, some have ridged sides, some are single tapered and others are double tapered.

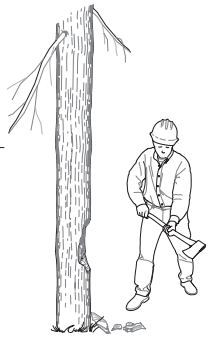
The author only uses double-tapered wooden wedges and prefers softwood instead of hardwood wedges because softwood wedges more readily expand and contract with the weather and relative humidity, keeping the ax head and handle tight. However, hardwood wedges are also acceptable.

You can shape and size wooden wedges to fit an ax head. Synthetic or metal wedges are not meant to be reshaped and many of them are too short to properly secure an ax head. Synthetic or metal wedges also do not expand or contract with changes in the weather or humidity. The wedge should extend one-half to three-quarters the depth of the ax head.



As mentioned earlier, pinning is the best way to ensure that an ax head stays secured to its handle. Keep in mind that the best location for a pin is in the bottom fifth of the head, below the wedge and kerf, where you can place the pin in solid wood. Also keep in mind that pinning the head to the handle is an excellent idea for a work ax, but will lower the value of a collectable ax.

Figure 10–18—Sawing off the top of the ax handle and wedge. Retain about ¼ to ½ inch of handle above the ax head to provide added security for keeping the ax head tight (inset).



To Crosstie or Not to Crosstie?

The author does not use the small metal crosstie wedges that come standard with most store-bought axes. These crosstie wedges serve little purpose in a properly fitted handle. Many people believe that crosstie wedges help spread out the wood of the handle from the front to the back of the ax eye. Being short and narrow, crosstie wedges do not have a lot of wedging power. Their primary purpose is to hold the main wedge in place. Using crosstie wedges has potential drawbacks. You place the main kerf wedge into a slot cut to the proper depth. That wedge spreads out the handle in the ax head eye. It should not split the handle when driven to its seated depth. When you use metal crosstie wedges, you drive them directly into the wood and not into a precut slot. The metal crosstie wedges crush the wood fibers and force them apart, which could cause the wooden wedge, and possibly the handle, to develop splits or cracks (figure 10–19).

Think about what happens to a round of firewood when you drive a metal wedge in using a maul. Driving in a crosstie wedge is essentially the same thing, but on a smaller scale. Another common practice is to use two metal crosstie wedges in the ax handle. This is counterproductive because the wood fibers between the crosstie wedges are compressed.

Using crosstie wedges also makes it more difficult to remove and replace the ax handle. If you use a crosstie wedge, round, metal ferrules may be best because they evenly distribute forces in a circular pattern across the handle.

In a field situation, if your ax head becomes loose and you must use metal crosstie wedges, drive one along each side of the wooden wedge, not across it. These wedges will be in the same kerf as the wooden wedge and are less likely to split the handle.

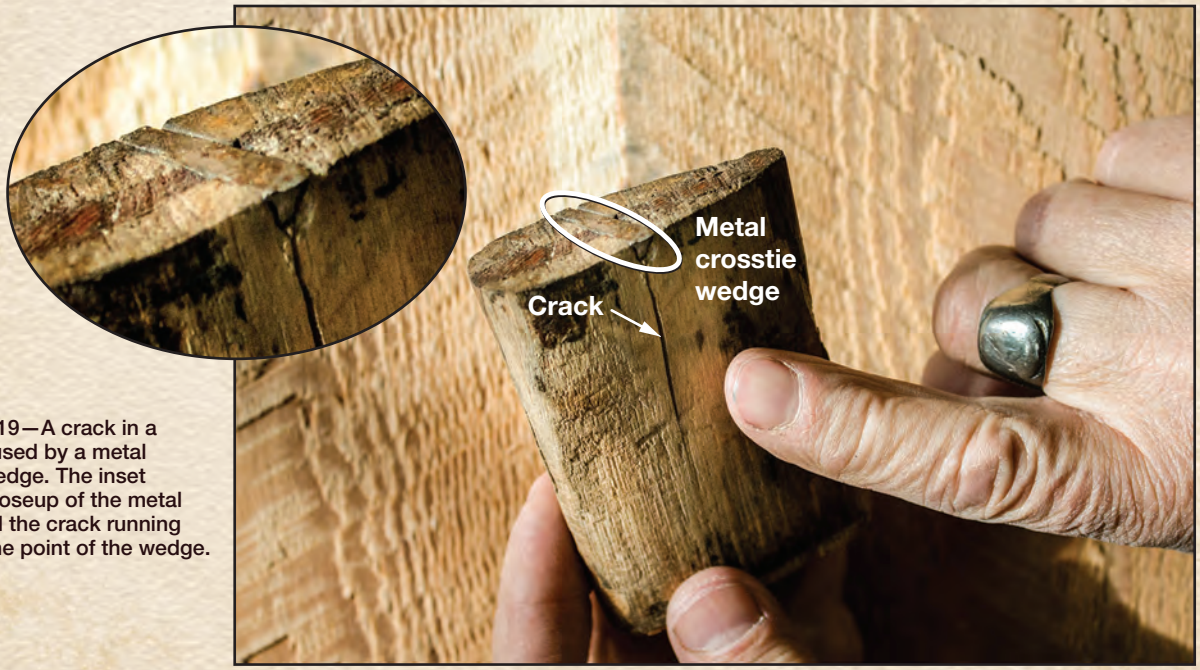
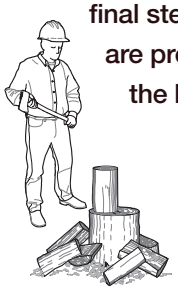


Figure 10–19—A crack in a handle caused by a metal crosstie wedge. The inset shows a closeup of the metal wedge and the crack running out from the point of the wedge.

After hanging the handle and pinning the ax head, recoat the handle with boiled or raw linseed oil as the final step in finishing the handle (several thin coasts are preferable to one heavy coat). You can soak the handle, as described in the "Finishing an Ax Handle" section of chapter 9, or simply use a rag to rub oil into the handle. The ax head can be useful in both situations; you can use it to keep the handle from dropping too far into the oil in the PVC tube, or you can hold it while you wipe excess oil from the handle.



Chapter 11—Using an Ax

The ax head is a cutting tool and the handle is the delivery mechanism. An ax in motion is powerful and can be dangerous. Before chopping, ensure that the ax is in good condition and that the work area is clear of other people and objects. While serious accidents are rare, it is best not to chop wood alone. Some national forests actually prohibit employees from chopping alone.

This manual provides an overview of basic chopping techniques and proper chopping ergonomics, but it is not an instruction guide about chopping. To chop safely and efficiently, seek hands-on training from an experienced axman.

Sizing up a log or tree is actually more complex than many people realize. You must understand the mechanics of chopping. Every cutting scenario is different. Remember, for every action there is an opposite but equal reaction. Unless a log is in a neutral position (i.e., lying flat on flat ground), the wood fibers you cut will either be under tension or under compression. As shown in figure 11–1, wood fibers under compression are pushing together and will close in when cut (possibly binding your ax), whereas wood fibers under tension are stretching and will separate when cut (sometimes with great force).

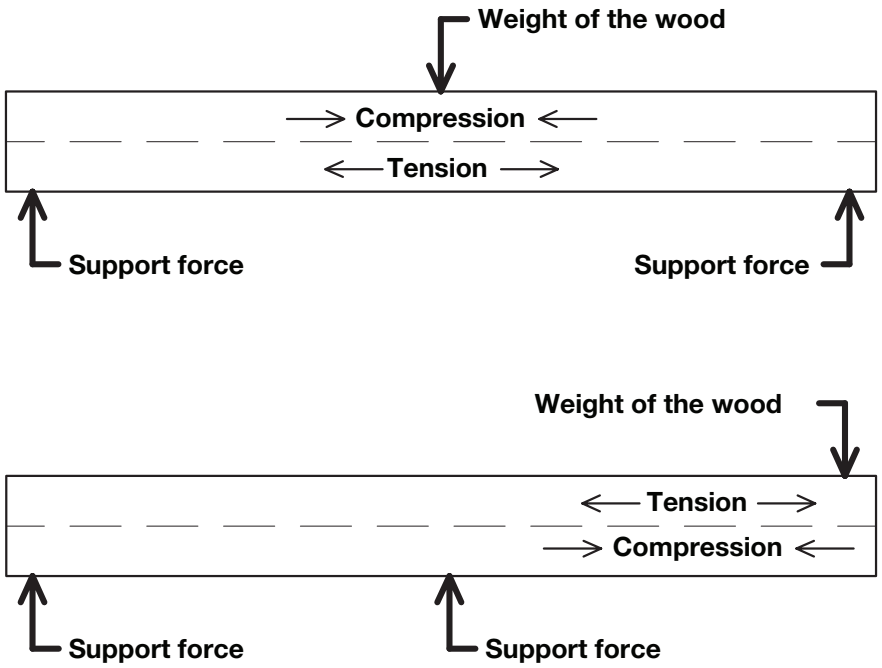
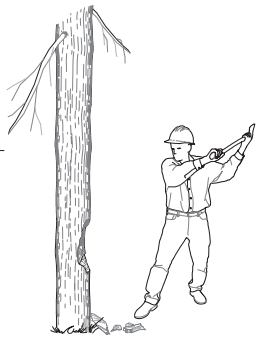


Figure 11–1—Compression and tension in a log supported on either end and in a log supported on one end.



Various types of binds can contribute to the forces you must consider (figure 11–2). These forces can vary, but gravity is one constant force that you must always take into account. A log or tree can reach its breaking point quickly and with considerable force.

What may be intuitive for experienced axmen may not be obvious to novice or inexperienced amen. This is why hands-on training and mentoring are so important for novice axmen.

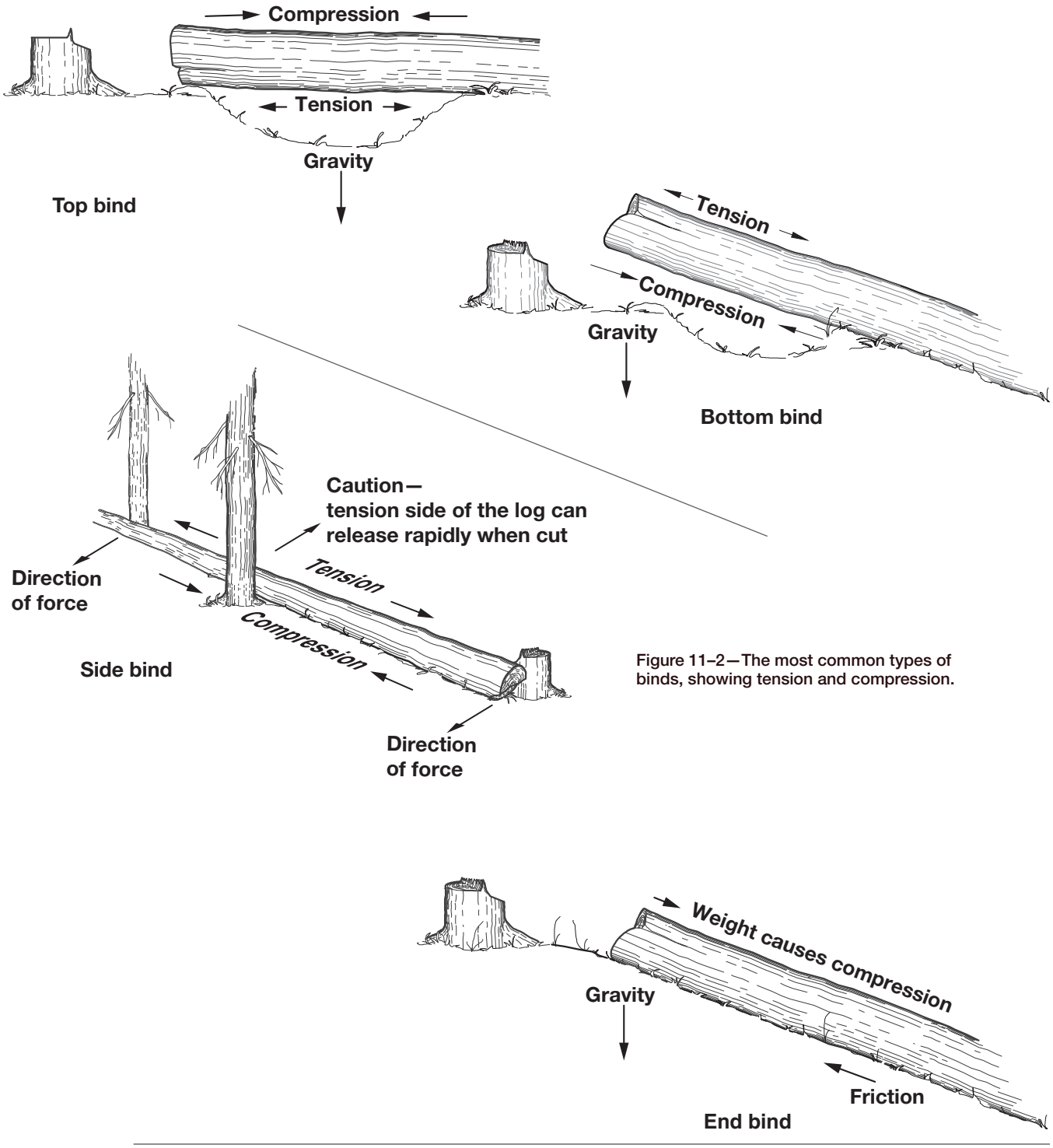
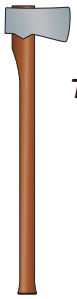


Figure 11–2—The most common types of binds, showing tension and compression.

The publication "Saws that Sing: A Guide to Using Crosscut Saws" (0423–2822P–MTDC) <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0423%202822P> (figure 11–3) contains a section called "Preparation for Bucking and Felling" that provides detailed information about situational awareness and hazards to look for when sizing up a cutting area.

Instructors for the Forest Service use the "Chain Saw and Crosscut Saw Training Course" (0667–2C01–MTDC) <https://www.fs.fed.us/t-d/php/library_card.php?p_num=0667%202C01> (figure 11–4) to teach sawyers to use crosscut saws. The instructors then certify the sawyers after this training.



The ax forgets what the tree remembers.

—African proverb

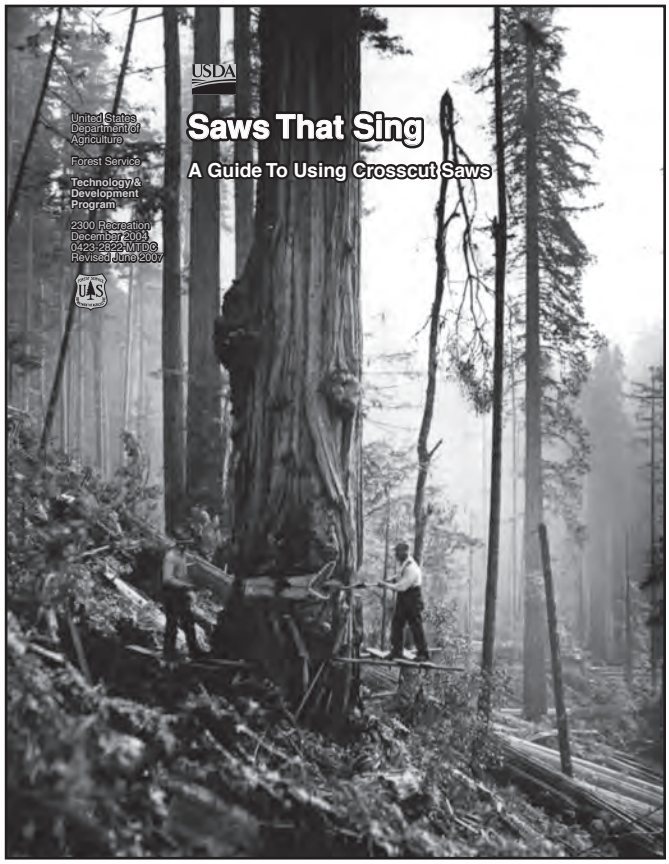


Figure 11–3—The publication "Saws That Sing: A Guide to Using Crosscut Saws."

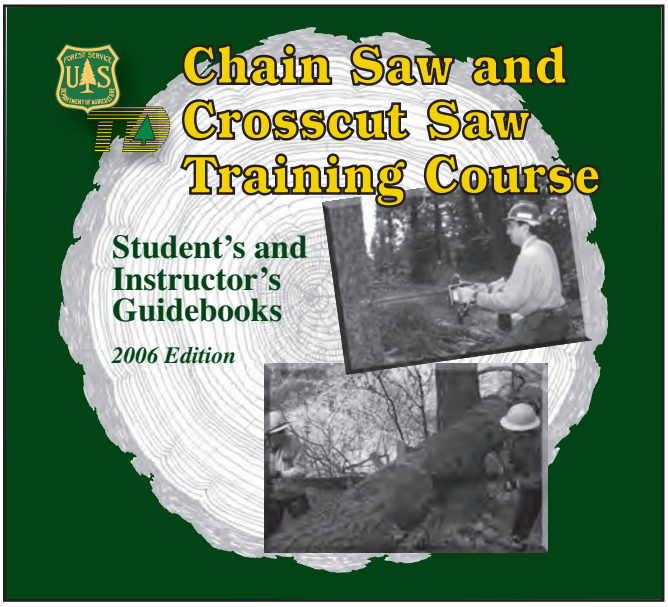
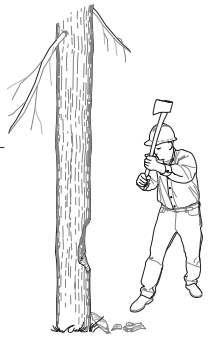


Figure 11–4—The "Chain Saw and Crosscut Saw Training Course."



Basic Ax Safety

As with every job in the Forest Service, the assignment begins with a safety review and a job hazard analysis (JHA) or risk assessment (RA). Review the worksite and identify safety concerns and hazards. Discuss them with your crew and ensure that everybody understands them.

Personal protective equipment (PPE) for Forest Service employees handling an ax in the field should include a pair of good quality leather workboots with at least an 8-inch top. The Forest Service requires employees in the field to wear hardhats and eye protection. Some people may choose to wear gloves while chopping, but gloves are optional. In some situations, wearing gloves may actually be dangerous; they may become slick when working in rain or other wet conditions, and you could lose control of your ax while chopping.

Chainmail Socks

Competition chopping requires competitors to wear chainmail socks (figure 11–5). These socks protect the competitor's feet and lower legs in case of an ax strike. Some forest crews also use chainmail socks to protect their feet and legs.

Figure 11–5—Chainmail socks.

Short Pants and High Heels

Loggers frequently cut the bottom hem off each leg (referred to as "stagged off") of their work pants. They sometimes cut off several inches, so that the bottom of the work pants end at the middle or top of their boots (figure 11–6). This is actually an important safety measure. Shorter pants are less likely to catch brush or branches that could trip the logger. Removing the hem also allows the pants to rip rather than to catch on the stub of a broken branch, which could cause the logger to stumble and fall. Whether you are chopping or sawing, stagged off pants are a good option for working in areas with tripping hazards.

Boots comprise another important piece of equipment for working in the woods. Leather boots with lug soles and at least an 8-inch top provide appropriate ankle support and foot protection. A tall heel, typically 2 inches, helps provide stability and balance for working on hillsides.

Another option is to wear boots with calked (also known as caulked) or hobnail soles. These types of boots are widely known as corks, or corked boots. The short metal studs on calked soles provide stability and gripping power, especially in wet conditions or when standing on a log. Corked boots are commonplace in the logging industry. They are appropriate for the woods, but not for paved or concrete surfaces. They can be slippery on pavement, which also wears out the hobnails quickly. Wearing corked boots indoors can damage floors. A logger who wears corked boots indoors generally slips the boots into sandals (figure 11–7) made from a piece of wood with a leather or firehose strap.

Figure 11–6—"Stagged off" pants and boots with heels.

Figure 11–7—Corked boots and logger sandals.

Handling an Ax

Ax safety begins with transporting the tool to the field. You have many hours invested in sharpening and hanging your ax, so you do not want to damage it before you even reach the worksite. When transporting the ax to the field, cover it in a sheath or, preferably, store it in a box. The idea is to protect yourself and the cutting edge of the ax. Use a good quality leather or mill felt sheath (figure 11–8). If necessary, you can make a temporary sheath out of a section of firehose, but you shouldn't use this sheath for long-term storage; the firehose can trap moisture against the blade and cause rust. Do not use duct tape; the residue sticks to the ax blade and transfers to the wood, adding friction when you cut.

While walking to the site, carry the ax where it balances comfortably in your hand. This should be close to where the ax head and handle meet. Carry the ax on the downhill side of the path so you can easily throw it aside if you stumble or fall (figure 11–9).

Figure 11–8—A variety of axes covered in different types of sheaths.

Figure 11–9—Carrying an ax on the downhill side of a slope.

Sheath the ax whenever possible, particularly a double-bit ax, which always has one cutting edge pointing toward you. **Never carry an unsheathed ax over your shoulder.** At times, you may have to carry an ax on a backpack—always be sure to sheath and properly secure it.

When you are not using your ax, place it in a safe location where it will not be damaged and where it does not pose a danger to anyone in the area (figure 11–10). You should sheath the ax if you can. If you can't, place it where everyone can easily see it. Do not stick a double-bit ax into a log and leave one edge exposed. If you are unable to sheath a double-bit ax, lay it flat on the ground with the head next to the log. Remember, you are responsible for the safety of your ax, yourself, and the people around you.

Another safety concern is how to hand an ax to another person. Hand an ax to someone with the blade turned away from both of you. As you hand over the ax, ensure that the other person has a firm grip before you release it. The practice in the Forest Service is for the person receiving the ax to acknowledge it by saying "got it," or some similar statement.

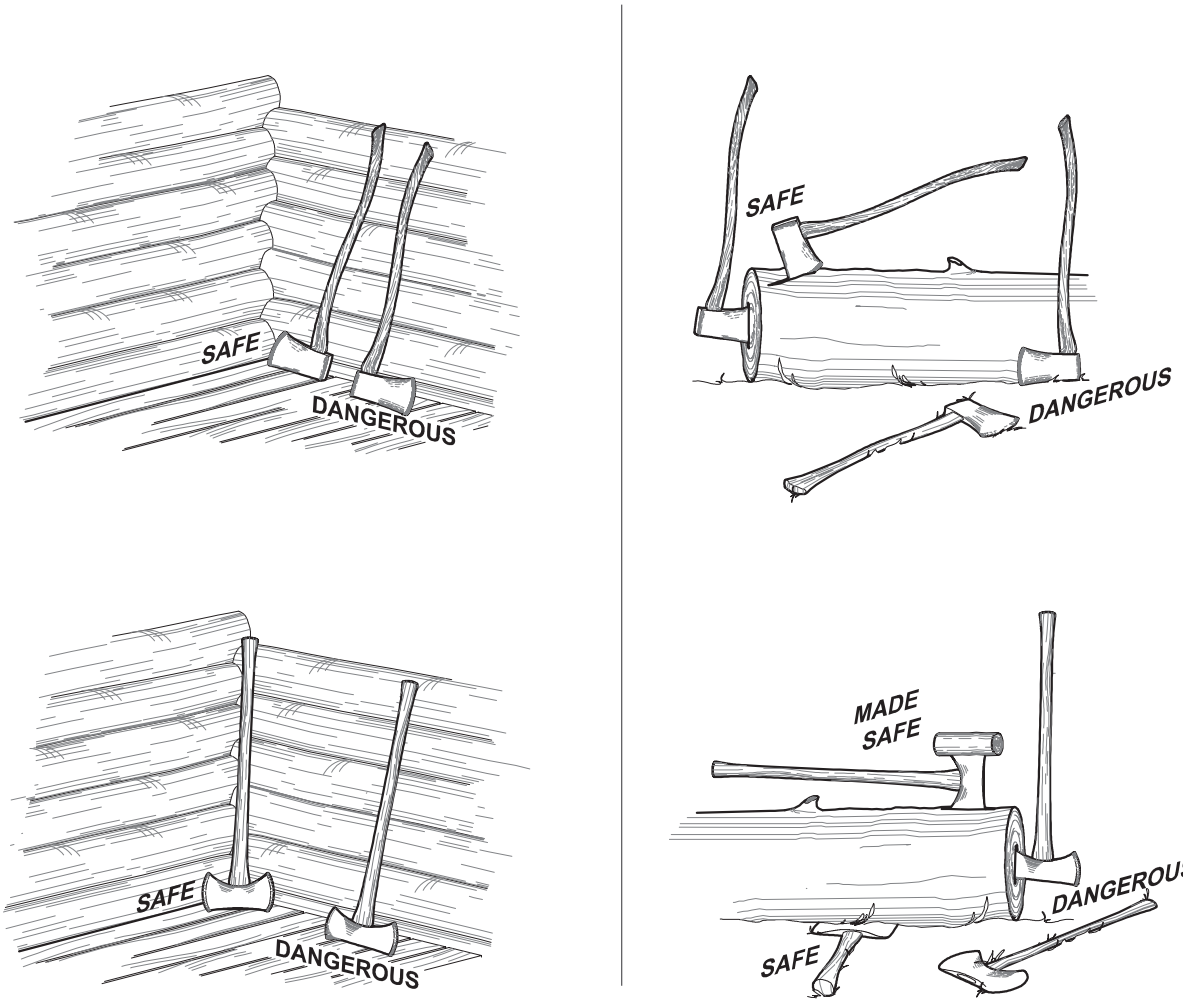
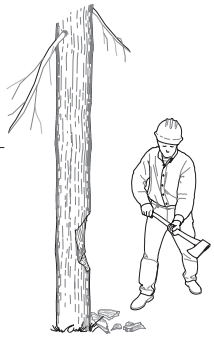


Figure 11–10—Place your ax in a safe location when you're not using it. This not only protects the people in the area, but also prevents damage to the ax.



Using the Forest Service Cutting Process

To maintain your safety, use the Forest Service's five-step cutting process (known as "OHLEC") for felling, bucking, limbing, and brushing. Incorporate this process into every cutting scenario you undertake. The five steps are:

- **O—**Determine your objective
- **H—**Identify hazards and obstacles
- **L—**Identify leans and binds
- **E—**Identify escape paths
- **C—**Develop a cutting plan

Objective

Regardless of the task, determine where you want the cut wood to end up. Some examples include:

- If felling, plan the most desirable placement or lay for the tree.
- If bucking, plan where you want the bucked log.
- If limbing, determine the sequence and direction in which to cut large branches so they do not fall on you or the next branch you intend to cut.
- If brushing, particularly in thick brush, plan how to remove the brush after you cut it.

Hazards and Obstacles

Identify hazards and obstacles. Some examples of what to watch for include:

- Overhead dangers (fire, rotten tree tops, widow makers, loose bark)
- The wood itself (fire, rot and hinge wood integrity, hollow trees/logs, saw length compared with the tree diameter, bees, poisonous plants)
- Spring poles
- Buildings, equipment, or other trees you do not want to damage
- Control of the cutting area
- Other people

Clear any hazards from the area where you will chop to ensure that you have good footing and a firm stance. Remove any branches or limbs that could trip you and clear an escape path that you can use if the tree or log unexpectedly moves or shifts toward you while cutting. Remember, the tree or log may be under a variety of forces that could cause it to move rapidly when you sever it.

Next, clear the area where you will swing the ax. Pay particular attention to the area of your backswing. You should be able to swing your ax in a 360-degree arc around you if the area is clear (figure 11–11). Clear away everything that is in the arc of your swing. Even small branches or twigs can deflect a blow, making a potential accident or injury more likely.

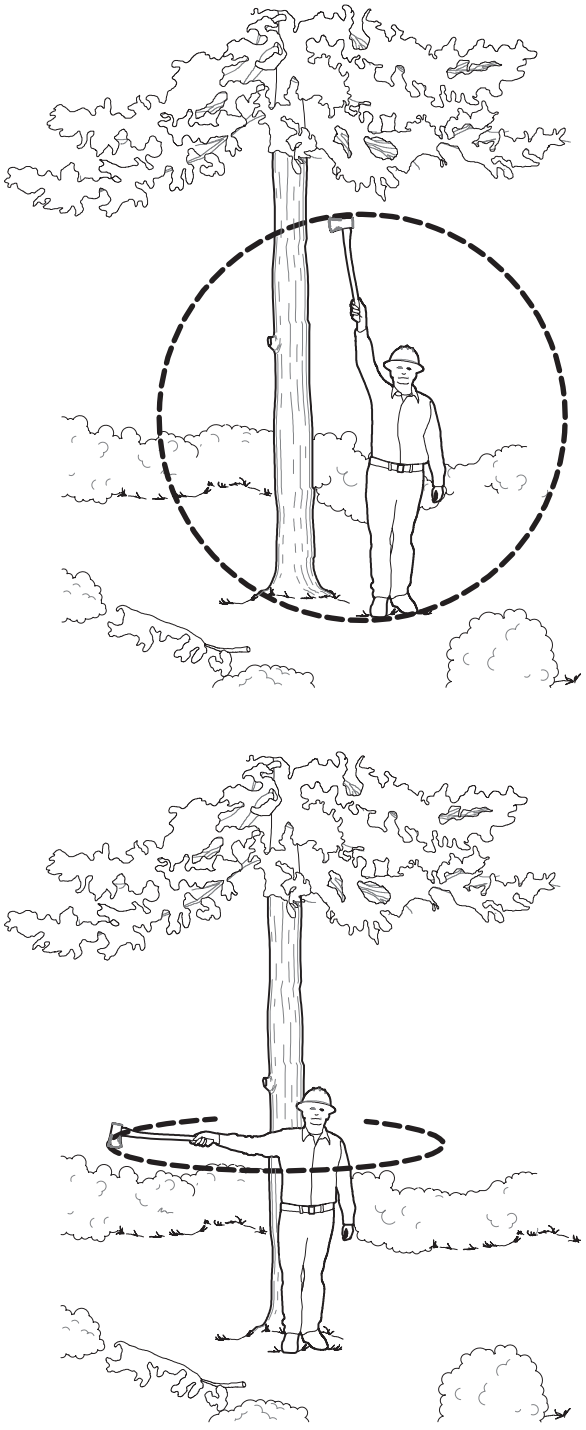


Figure 11–11—Checking to ensure an area is clear before beginning to chop.

Leans and Binds

To identify the forces acting on the tree or log you plan to cut, you should:

- Determine the lean of a standing tree. Does it have front lean or back lean? How much side lean does the tree have, and in what direction?
- Determine binds in logs, spring poles, limbs, or brush.

Escape Paths

After you determine leans and binds, you should:

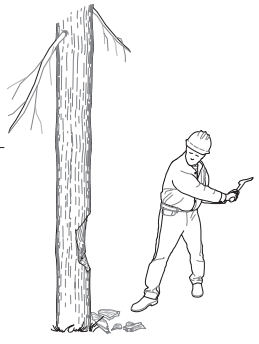
- Determine the safe and unsafe side of the tree, log, spring pole, limb, or brush.
- Choose and clear an escape path (or two paths, if necessary). The path(s) should lead diagonally away from the base of the tree , but should not be directly behind or in front of your objective (where you want the tree to fall). Your escape path(s) should take you a safe distance from the tree, or to a place of cover.

Cutting Plans

Cutting plans vary with every tree or log. Develop a cutting plan of techniques to use when removing wood fiber, including:

- Face-notch construction type (conventional, Humboldt, or open face)
- Hinge position, length of hinge, width of hinge, and amount of stump shot needed
- Back cut type (straight in from the back or angled in from the sides)
- Wedge placement, the number of wedges, and the placement of the ax

When working with a sawyer, you must also account for communication between crewmembers, the swamper, or the crosscut saw partner.



The Mechanics of Chopping

The following three sections (“Chopping Styles,” “Felling Trees,” and “Splitting Wood,”) explain how to cut wood.

Chopping and Splitting

There is a difference between chopping and splitting wood. When chopping, the ax chops at an angle across the grain of the wood. When splitting, the ax chops in line with the grain of the wood.

Other chopping techniques not discussed here are worth exploring but, for safety reasons, it is best to learn these through experience and practice, and not from a manual.

When it comes to chopping wood, some basic principles hold true. Understanding how the cutting edge of an ax and the shape of an ax head facilitate cutting and splitting wood makes you a safer and more efficient axman.

Remember, an ax must do three things:

- Cut or sever wood fibers
- Displace the wood chip after the fibers are severed
- Release from the wood

Cutting wood is a complex process that involves the three stages above, which occur almost simultaneously.

The profile of an ax head and the angle at which the ax head strikes combine to displace wood chips. The grain structure and presence (or absence) of knots are factors that determine the density of the wood. Whether the wood is green, dry, solid, or rotten also plays a part in determining density. All of the aforementioned factors, along with the leveraging and pivoting action of the handle, help determine whether the ax head releases from the wood.

Wood Fibers and Lignin

A piece of wood is really a bundle of individual cellulose fibers held together by lignin, which acts as a glue. Think of the wood fibers as a series of individual straws held tightly together. In hardwood species the fibers are densely packed. In softwood species the fibers are less densely packed. The lignin that holds the fibers together is less dense than the fibers and creates an avenue for splits in the wood to propagate.

The angle at which an ax enters wood is extremely important. Whether you chop vertically or horizontally, a 45-degree chopping angle is best for an ax to sever fibers, displace a wood chip, and safely release from the wood. If you chop at too steep an angle, directly against the grain of the wood, the ax only severs the top few layers of wood fibers before the compressed wood stops the ax's forward movement. Chopping at too steep an angle prevents a wood chip from breaking free. The ax severs fibers if you chop at an angle shallower than 45 degrees, but the ax head may slice or glance off the log, creating a dangerous situation. A strike at 45 degrees sinks the cutting edge safely into the log until it no longer severs, tears, or compresses fibers. Figure 11–12 shows the diagonal strike of an ax and illustrates what happens when the force of the ax strike exceeds the strength of the lignin, forming a split in line with the grain.

When people refer to the use of an ax, they call it chopping. However, the term "chopping" may not be completely accurate. An ax used properly actually slices and chops.

As an example, consider cutting a piece of fruit or a vegetable. If you chop an apple or tomato with a knife, the knife either sinks in and sticks or bounces off, depending on the sharpness of the knife, the density of the apple or tomato, and the amount of force you use. If you cut with a knife, starting at the heel and drawing it across to the tip, the knife slices rather than "smashes" its way through the apple or tomato. An ax blade should work the same way. Even though you use a chopping motion with the ax, it should slice through the wood fibers, similar to the way a knife slices through apple or tomato fibers. Just as a sharp knife does a better job of cutting through an apple or tomato, a sharp ax does a better job of cutting through wood fibers. Both an ax and a knife work best when you incorporate a slicing motion, where the cutting edge moves through a little at a time rather than all at once. The cutting edge initiates the cut and then the rest of the blade moves through (figure 11–13). The curved shape of the ax's cutting edge facilitates this slicing action.

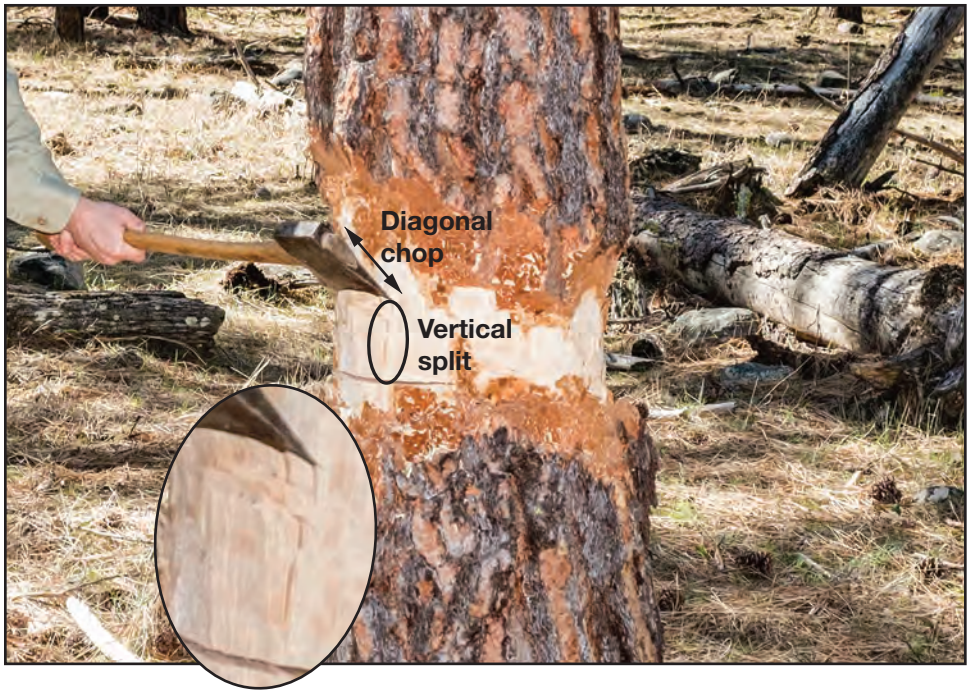


Figure 11–12—The initial chop of an ax forms a diagonal cut and a vertical split at the end of the cut. The inset shows a closeup of the ax blade embedded in the diagonal cut and the resulting vertical split.

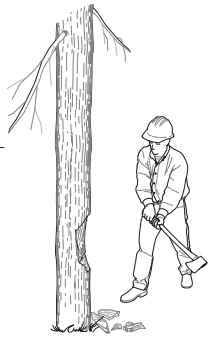


Figure 11–13—The arrows in this picture indicate how the cutting edge of an ax head slices through and severs wood fibers and how the driving force helps to pop out the wood chip.

Think of an ax blade as a wedge. The thicker the blade, the greater the displacement force for removing chips (figure 11–14). Of course, penetrating wood with a thicker blade requires more energy. Conversely, the thinner a blade, the less energy it requires to penetrate wood, but the less wood it displaces. Because a thinner blade penetrates deeper without displacing a wood chip, it encounters more friction and requires more effort to release. In other words, an improperly shaped ax head does not release easily from the wood because friction and the compressed wood fibers hold the head in place.

Figure 11–14—An ax blade penetrating deep enough into wood to cause wedging action and to displace wood chips. Note the size of the wood chips; they indicate a well shaped ax and proper chopping technique.

The Physics of Chopping

The concepts of energy, work, and fracture mechanics explain how chopping severs wood fibers and dislodges wood chips.

When you raise an ax to strike wood, you generate potential energy. When you swing the ax, the potential energy becomes kinetic energy. Upon impact with the wood, the kinetic energy becomes "work," which is defined as force multiplied by the distance the impacted object moves. The force at the cutting edge of an ax generates a critical stress that causes crack initiation in the wood. Note that stress is equal to force divided by area; therefore a smaller area impacted by a constant force results in higher stresses. Consequently, a sharper ax will achieve the necessary critical stress for crack initiation faster than a dull ax.

As an ax head plunges into the wood in line with a crack, the sides of the ax head generate a wedging force against the wood (figure 11–15). When the stresses induced by the wedging force exceed the fracture strength of the wood, the wood fibers fracture and a wood chip releases.

Proper chopping technique with the ax handle facilitates and can enhance the slicing action of the ax cutting edge, efficiently severing fibers and causing crack initiation in the wood. Just as importantly, the handle acts as a lever that helps to dislodge the wood chip and provides a pivoting mechanism to release the ax from the wood if a wood chip does not dislodge.

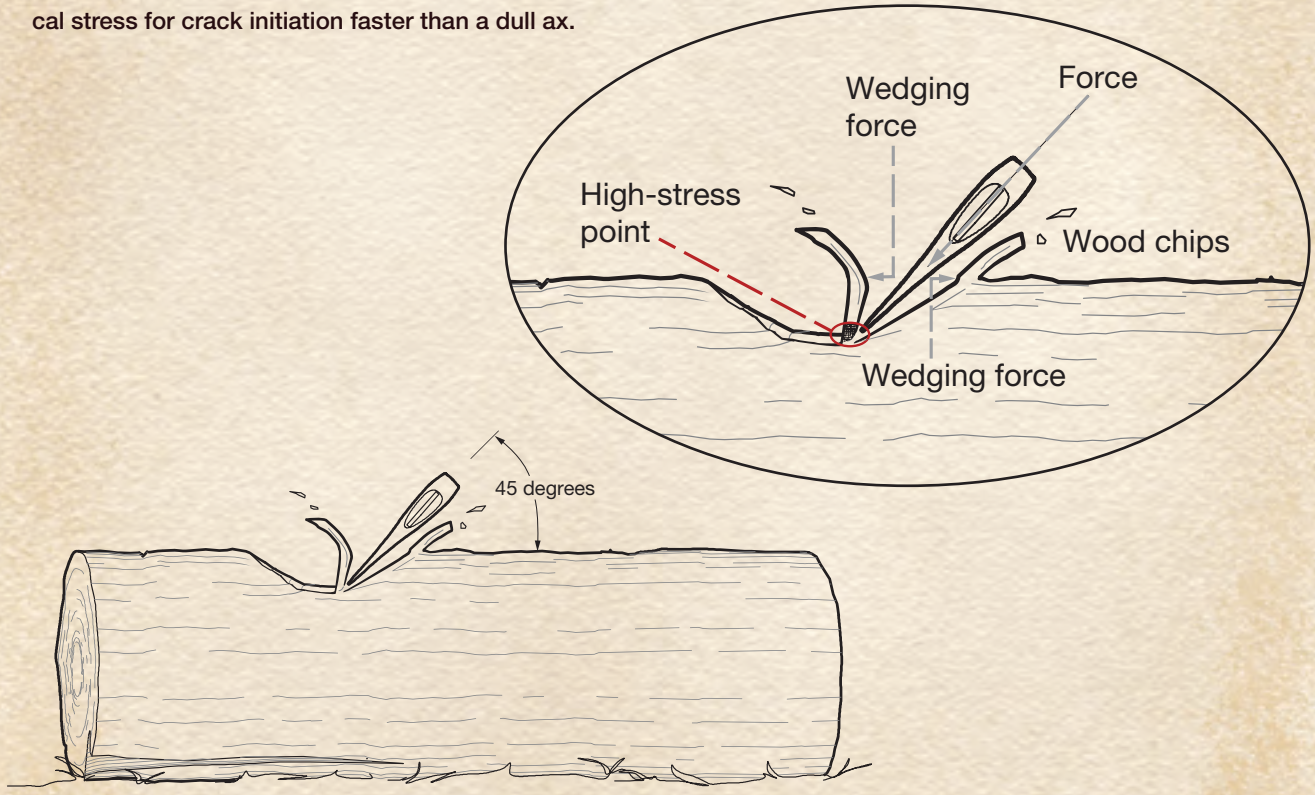


Figure 11–15—An ax head chopping at a 45-degree angle, severing wood fibers and releasing wood chips. A closeup view (inset) of the driving force of the ax head, the wedging force to either side of the ax head, and a high-stress point at the cutting edge of the ax head where the wood chips release.

Chopping Styles

There are two basic chopping styles: swinging over your shoulder or raising the ax directly over your head before beginning your downward swing. Use the over-the-shoulder style for felling or bucking and the overhead style for chopping logs lying horizontally. Base your preferred style on your comfort level and the types of chopping you do. The publication "An Ax to Grind: A Practical Ax Manual" (9923–2823P–MTDC) <https://www.fs.fed.us/t-d/php/library_card.php?p_num=9923%202823P> explains the over-the-shoulder style, which the Forest Service has taught for years. The Forest Service did not teach the overhead style until recently.

The overhead style works best for chopping horizontal logs because the power for swinging an ax is located in the center of the body. So, as you swing an ax down toward the wood, the overhead style delivers the most efficient and powerful chop. It is also the most accurate style because you are looking directly down at the wood you chop. However, if the terrain prevents you from safely positioning your body for the overhead swing, the over-the-shoulder style may work better.

The overhead style does not work when felling a tree. When felling a tree, you use the over-the-shoulder style. Though called "over the shoulder," this style uses both an over-the-shoulder, downward swing and an upward, "under-the-shoulder" swing. To master the use of an ax, you must master both the overhead and over-the-shoulder chopping styles.

Whether you chop from overhead or over the shoulder (figure 11–16), everyone has a dominant side. It is important to be able to chop either left or right handed, even though most people choose to use one side when chopping. While you may prefer to chop left or right handed, knowing how to chop from either side has its benefits. At some point, every axman confronts a situation where the angle of the tree, slope of the hillside, or other natural feature prevents chopping from his or her dominant or preferred side. Chopping limbs off a downed log is a common scenario where the ability to switch hands will make chopping both easier and safer.

Regardless of which chopping style you use, accuracy is more important than power. Practice accuracy and gradually add more power to your strokes. You can use a simple exercise to improve your hand-to-eye coordination when chopping:

- Identify a spot on a log and use the over-the-shoulder and overhead styles to try to strike that exact spot with the ax as many times as you can.
- Focus on a specific spot to help improve precision and accuracy.
- Aim directly between your arms when using the overhead style.

For this exercise, you are not chopping to remove chips and there is no power behind your stroke. You are just trying to hit the same spot as many times as you can.

Planar Motion

Whether you chop from overhead or over the shoulder, it is important to remember that proper chopping requires you to move the ax in two dimensions (called a "planar motion"). You should move the ax like a hammer, along the same line from the top of the swing until the head hits the wood. Some choppers mistakenly swing the ax in an arc, particularly when chopping over the shoulder. This improper form leads to inaccuracy.

Figure 11–16—Chopping from overhead (right) and chopping from over the shoulder (below).

Basic Chopping Styles—Over the Shoulder

You can learn basic chopping styles in a short time, but these same styles take years to master.

Chopping is a series of fluid movements, much like a dance. If necessary, take a few moments to warm up and stretch before you begin to chop so that your muscles are loose and relaxed.

Begin chopping by taking the ax in both hands. Place one hand on the throat of the handle, which is slightly above the swell of the knob (figure 11–17). Position the other hand on the shoulder, which is just beneath the ax head. Keep the hand on the throat fixed and the hand on the shoulder loose so that the hand on the shoulder slides down the handle on the downward stroke, meeting the fixed hand. Reverse this motion on the upstroke, sliding the loose hand back up the handle to the shoulder (figure 11–18). While the fixed hand always stays on the throat of the handle, the sliding hand may not reach all the way to the shoulder. The length of the handle and of your arm determine where your sliding hand lies. Overreaching with your loose hand could change your stance and affect your balance, safety, accuracy, and ergonomics.

Figure 11–17—Holding an ax with one hand on the throat and the other hand on the shoulder.

Maintain the ax at a 45-degree angle when striking a log lying horizontally in front of you. A properly sharpened ax easily sinks into a log at 45 degrees. Strike at too steep an angle and the ax does not properly penetrate the wood. Strike at too shallow an angle and the ax could scoop or glance off the log. Many axmen flick or twist their wrists as the ax strikes the log. This motion helps dislodge the wood chip and prevents the ax from sticking in the wood. Be aware that flicking or twisting your wrist could reduce power to your stroke and also puts sidewise torque on the ax handle. If the chip does not release, this technique

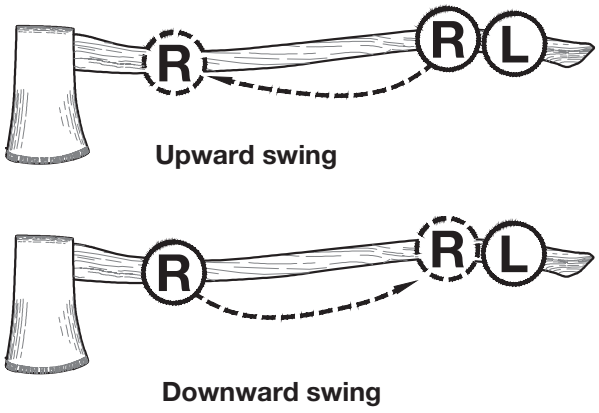


Figure 11–18—Proper hand placement for upward and downward swings.

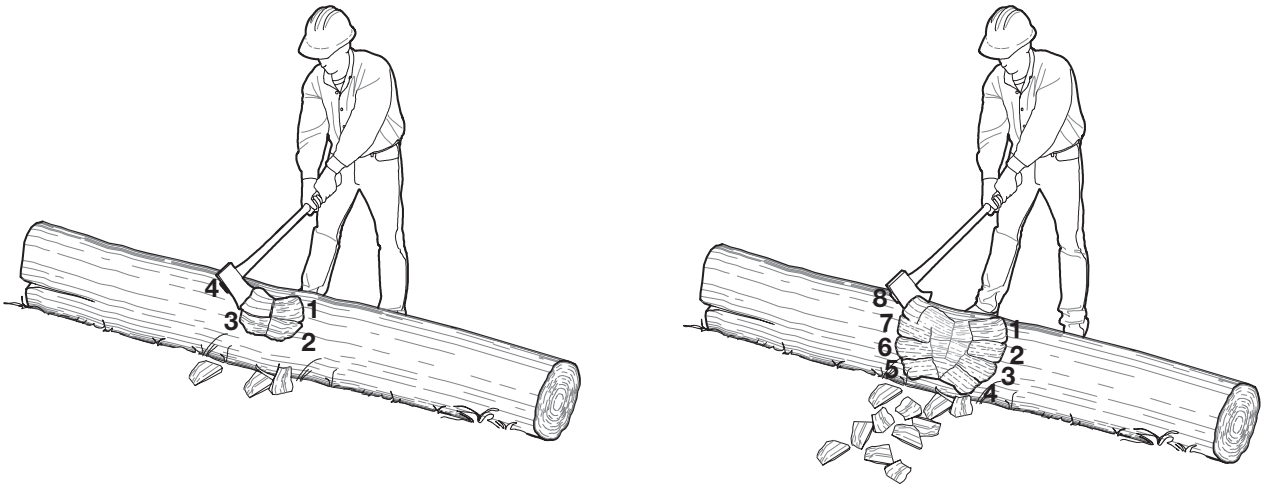
could crack or break the handle, especially if the wood grain in the handle has cross grain or runout grain (see figure 6–16).

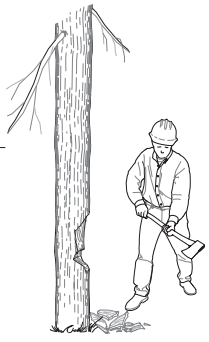
Another method to help release a wood chip is to snap your hands and wrists as the ax strikes the log. This snapping motion provides better penetration and extra wedging power at just the right moment to help pop the wood chip free. If you are a novice axman, focus on accuracy and develop your basic ax skills before incorporating new techniques into your work.

When chopping a log lying horizontally, make sure to start with a wide enough cut. If you chop the log on both sides, each V-shaped notch will be about equal to the diameter of the log. When chopping the sides of the log, make your cuts to remove chips from the top portion of the log before chopping the bottom portion of the log. Because the log is cylindrical, the bottom is not visible as you start to cut. Clearing chips from the top portion of the log enables you to see the bottom portion clearly (figure 11–19), and reduces the chance that you will strike the ground with your ax. When you can see the bottom portion of the log clearly, you can cut more easily in a circular pattern from top to bottom.

For more information about chopping patterns, refer to the "Chopping Patterns" section later in this chapter.

Figure 11–19—Chopping in either sequence shown will clear chips from the top portion of the log, making the bottom portion visible and reducing the chance of striking the ground with the ax.





If you chop the log from only one side or from the top down, make the cut twice the diameter of the log (figure 11–20). The notch becomes narrower as you cut through the log. If you make the notch too narrow when you begin the cut (figure 11–21), the resulting angle will be too steep, making it difficult to remove chips farther down into the log. If necessary, make the notch wider. Do not continue to cut into a narrow notch.

Figure 11–20—When chopping from only one side of a log, make sure to cut the notch twice the diameter of the log.

Figure 11–21—This notch is too narrow to continue removing big chips; it must be wider to enable the ax to cut through to the bottom of the log.

An excellent technique for making a wider notch is to chop two notches close to each other and then use the ax to remove the center portion along the grain (figure 11–22). You can also simply rechop one or both sides of a narrow notch to make it wider (figure 11–23).

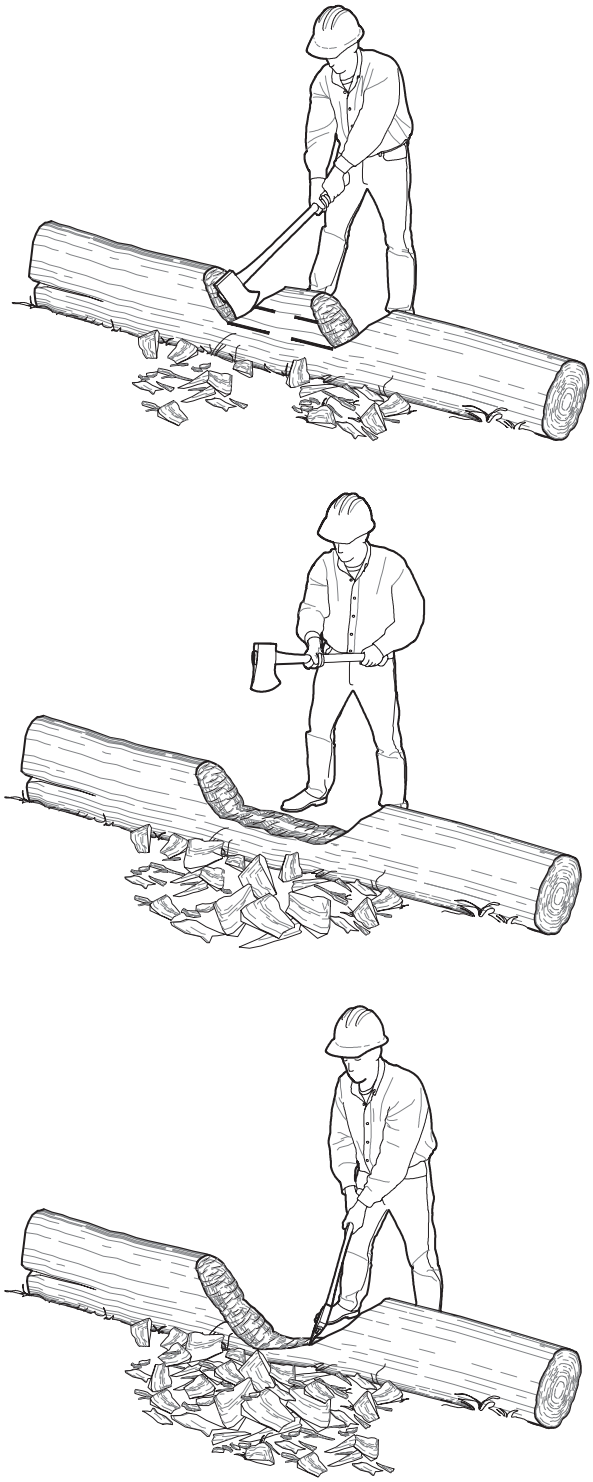


Figure 11–22—Using a horizontal chop to remove the center section between two notches; this is more efficient on larger logs.

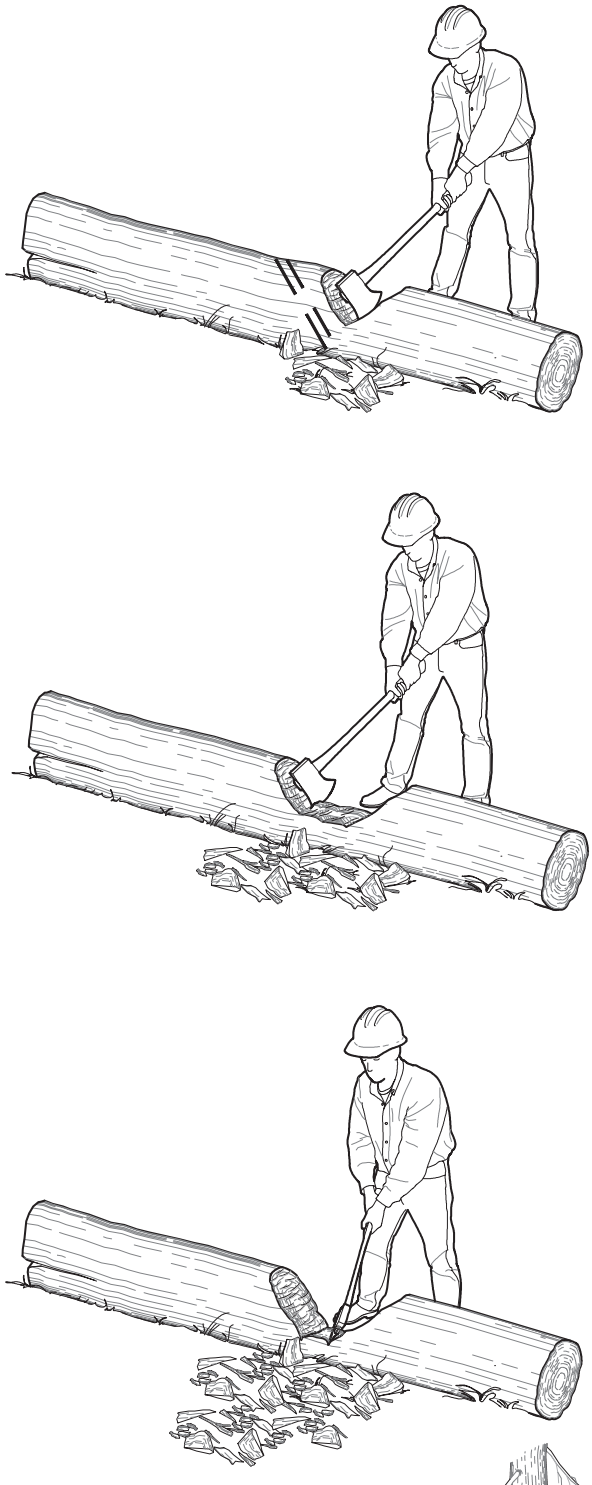
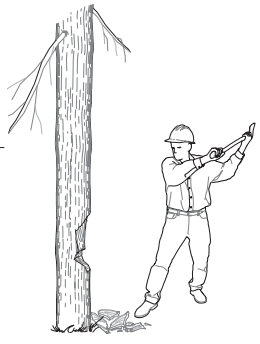


Figure 11–23—Rechopping the side of a notch to widen it; this is more efficient on smaller logs.



Look for knots while you decide where to cut. Extremely hard knots can damage the cutting edge of an ax, especially if the ax blade is thin. If a knot lies within a cut, be sure to work around it (figure 11–24).

Figure 11–24—Cutting around a knot in a log.

Basic Chopping Styles—Overhead

Your body and feet should face a log when you chop it. Square your hips with your shoulders so that your body aligns with the log as you swing the ax. After you cut one side, shift your body position to align with your ax stroke as you cut the other side (figure 11–25). Do not just turn your upper body; move your feet and upper body together to keep them aligned. Misaligning your body can lead to scooping or glancing blows, reducing the power of your stroke and your accuracy, and increasing your fatigue.

With your feet and shoulders aligned, raise the ax straight up over your head with your wrists and ax at a 90-degree angle—this is the proper position for striking. The ax should not point straight up, nor should it be so far back that the eye points toward the ground.

While standing up straight with the ax in the proper overhead position, tuck in the elbow of the arm holding the throat of the ax handle so that it aligns with your nose. As you follow through with the stroke, this position keeps your ax and arm aligned with your body and with the point that you strike. Another way to think of this is to keep your nose aligned with the back of the ax head on the downward stroke. As you begin your downward stroke, try to keep your wrist at a 90-degree angle through the natural arc of the stroke. Add power to the stroke by snapping your wrists just before the ax contacts the log.

Many novice axmen have a bad habit of looking off to the side or around the ax to gauge accuracy. To prevent this, envision resting your chin on the center of your chest during the downward stroke. If you align your body correctly from your feet through your hips and shoulders, you will raise the ax properly and follow through to cut on your mark, preventing a glancing blow that might injure you.

Along with aligning your body properly, another way to avoid cutting yourself while chopping is to bend your knees slightly as the ax strikes the log. With your knees bent, the ax is never aligned with your legs and will fall to the side if you strike a glancing blow. Bending your knees works best on smaller logs, when you are chopping closer to the ground. Larger logs provide a greater margin for error; a glancing blow is more likely to strike wood instead of your shins. However, bending your knees does take some power away from your stroke. Experienced axmen snap their knees straight just as the ax strikes the log, adding more power to the stroke.

This technique only works when you chop vertically from over your head or shoulder down onto a log. When you chop horizontally, you must position your feet so that the ax strikes far enough in front of you that it cannot contact you.

Figure 11–25—Squaring the shoulders and hips in line with the ax stroke. Note that the axman in these pictures has turned his body to be in line with his chop.

The length of the ax handle (figure 11–26) also plays a significant role in chopping safely. The longer the handle, the farther the blade is from your body. The farther the blade is from you while you chop, the less likely you are to cut yourself. A few inches of handle can be the difference between striking your shin and striking the ground. However, there are tradeoffs to consider when choosing handle length. The longer the handle, the more you need to practice for accuracy. The better your accuracy, the less chance you will deliver a glancing or scooping blow. This is an example of why you need to practice and develop your skill as you find the handle length that works best for you.

You should use a choked grip (figure 11–27) when cutting brush or other thin material in tight spaces. Because of the close proximity, you grip the ax close to the ax head and make small, tight, controlled chops.

Figure 11–26—Various sizes of ax handle, ranging from 26 inches to 44 inches.

Figure 11–27—A choked grip makes it easier to cut brush, though there may be other tools that are more appropriate for the job, such as lopping shears or a small pruning saw.

If the object you chop requires some stability to keep from moving, but allows you to keep your hand far enough away from the cut, you can use a one-handed swing (figure 11–28). This cut is common for small saplings. For a one-handed swing, you hold the ax around the middle of the handle and hold the object with your hand out of the strike zone. Holding the sapling has two benefits: you stabilize the trunk so it does not bend when you strike it, and you apply tension to the trunk, which adds stress to the fibers and makes them easier to sever. Holding the ax in the middle of the handle allows a fuller swing than a one-handed, choked grip. Try to maintain a 45-degree cutting angle.

When using these modified chopping techniques, pay careful attention to where you place your hands and feet. When chopping in tight spaces, you may not have enough room to swing, or may have to kneel instead of standing. Identify the risks before beginning to chop and adjust your technique to prevent injury.

Figure 11–28—Using a one-handed swing to cut a small sapling.

Remember, you may be able to use tools other than an ax to more easily cut small brush and saplings (figure 11–29).

Figure 11–29—Using a Swede ax to cut a dead sapling.

Chopping During Cold Weather

Regardless of the type of chopping you do, be mindful of your ax when you work in cold weather. Cold steel is brittle and can easily chip or break. Do not chop knots or frozen wood with a cold ax. If possible, warm your ax before chopping. A simple way to do this is to tuck the ax head under your arm inside your coat (figure 11–30). Alternatively, chop slowly for a few minutes to enable friction to warm up the metal.

Figure 11–30—Warming up an ax head before chopping.

Ax Strokes

Cutting a log requires two basic strokes: the forehand swing and the backhand swing. For a right-handed person, the forehand swing refers to a cut on the right side of the log and the backhand swing refers to a cut on the left side of the log. Reverse the instructions for a left-handed person.

Forehand Swing

While holding the ax firmly at the throat and loosely at the shoulder, raise it over your right shoulder or over your head. Grip the throat of the handle tightly with your left hand. Grip the shoulder of the handle (or wherever your hand is comfortable) loosely with your right hand. As you swing the ax down into the wood, slide your right hand down to meet your left. As the ax releases from the wood, use both hands to raise it to the starting point of your next swing, sliding your right hand back to the shoulder and keeping your left hand fixed at the throat.

Backhand Swing

The backhand swing is similar to the forehand swing, but you use it to cut the other side of the notch. The difference is in your body position. Turn your body in the direction that you chop. Your hands remain in the same position; the left remains fixed on the throat of the handle and the right stays loose to slide along the length of the handle. The backhand swing feels awkward at first, but feels more natural with practice.

Chopping Patterns

Chop a log using a circular pattern. The notch has a "V" shape. While there is no set rule, many ax users cut in a clockwise pattern while others cut in a counterclockwise pattern. Some ax users prefer to start on the close side of a log, while others prefer to start on the far side of a log. It is a matter of personal preference and style.

Some people chop horizontal logs from the top while others chop from one or both sides. Top-chopping patterns are different from the side-chopping patterns discussed earlier in this section (see figure 11–20).

When chopping a horizontal log from the top (figure 11–31), the first stroke cuts the far side of the log at a 45-degree angle, with the toe of the cutting edge sticking out of the far side of the log about an inch (some axmen refer to this as "hanging an edge"). The second stroke extends the cut into the center of the log, with the toe of the cutting edge in a portion of the first cut. The third stroke cuts the near side of the log, with the toe in a portion of the second cut and the heel sticking out the near side of the log about an inch.

The fourth stroke begins the other side of the notch. This stroke cuts the near side of the log at a 45-degree angle, with the heel of the cutting edge sticking

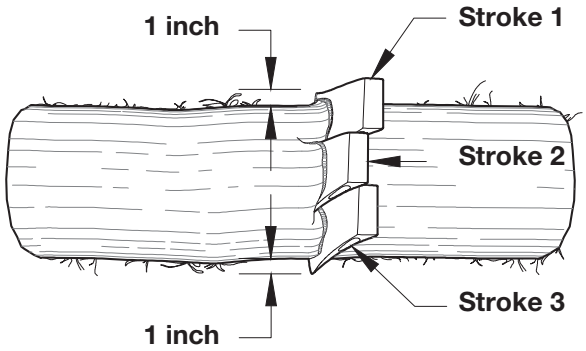
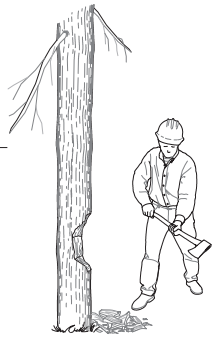


Figure 11–31—Chopping the top of a log lying horizontally. The first stroke chops the far side of the log; the second stroke chops the center of the log, overlapping the first stroke; and the third stroke chops the near side of the log, overlapping the second stroke.



out of the near side of the log about an inch. The fifth stroke cuts in the center of the log, with the heel of the cutting edge in a portion of the fourth cut. The sixth stroke cuts the rest of the way across the log, with the heel of the cutting edge in a portion of the fifth cut and the toe sticking out of the far side of the log.

Larger logs require the same sequence with more strokes on each side. Smaller logs may only require one or two strokes per side. When you have almost cut across the log, it is common to add a few more strokes to the bottom of the "V" to clean it out and match it with the top of the cut. When you have nearly severed the log, be careful that the cutting edge does not travel through the wood and strike the ground. To prevent the ax from striking the ground, finish the cut with the stunt edge of a double-bit ax or the poll end of a single-bit ax if the wood is thin enough to break without additional chopping (figure 11–32).

Chopping patterns always depend on the log. Every log is different, and every lay of a log is different. You will chop some logs from the top. Other logs you will chop out the near and far sides. Whenever possible, chop in the arc of a circle (see figure 11–19).

When Chips Fly

When chopping, one side of the cut is the "drive side." This is the power stroke, and the goal is to reach a little past the centerline of the log. The other side of the cut is the "chip side," where you lift the wood chips out of the wood. This does not mean that wood chips only pop out of one side of the cut. Wood chips pop out of both sides of the cut, but most chips pop out on the opposite side from the power stroke.

As you remove wood chips from the log, an open face develops. As the open face expands, the energy from your swing becomes more efficient. The ax sinks deeper and removes bigger pieces of wood.

Planning a cut and properly swinging an ax are only part of chopping ergonomically. Body position is important, and it begins with proper foot placement. As you move your feet, move your body. Place your feet firmly and try to keep them as level as possible to maintain proper balance.

Figure 11–32—Using the poll of an ax to break through a log.

Removing Branches (Limbing)

When removing smaller branches on a downed log (i.e., branches you can sever with one chop), be sure to use a horizontal chop from the back side of the branch and not into the crotch (figure 11–33). Chopping into the crotch can cause the branch to fall back on to the ax or on to you.

Removing larger branches may require a series of cuts. Use a vertical chop followed by a horizontal chop, as shown in figure 11–34. This removes a wood chip and enables you to sever the branch with a subsequent horizontal chop.

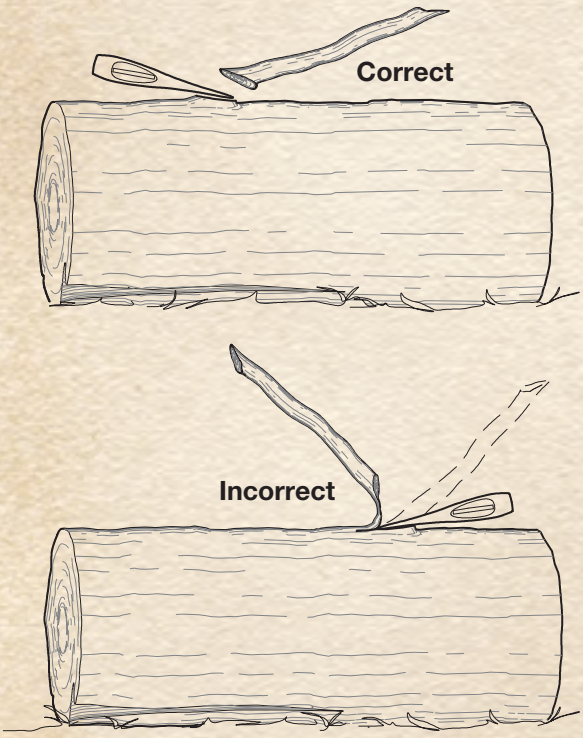


Figure 11–33—The correct and incorrect methods for limbing small branches.

Be careful when chopping branches that are embedded in or are resting on the ground; they may be holding the log in place. Once you sever the branches, the log could move or roll.

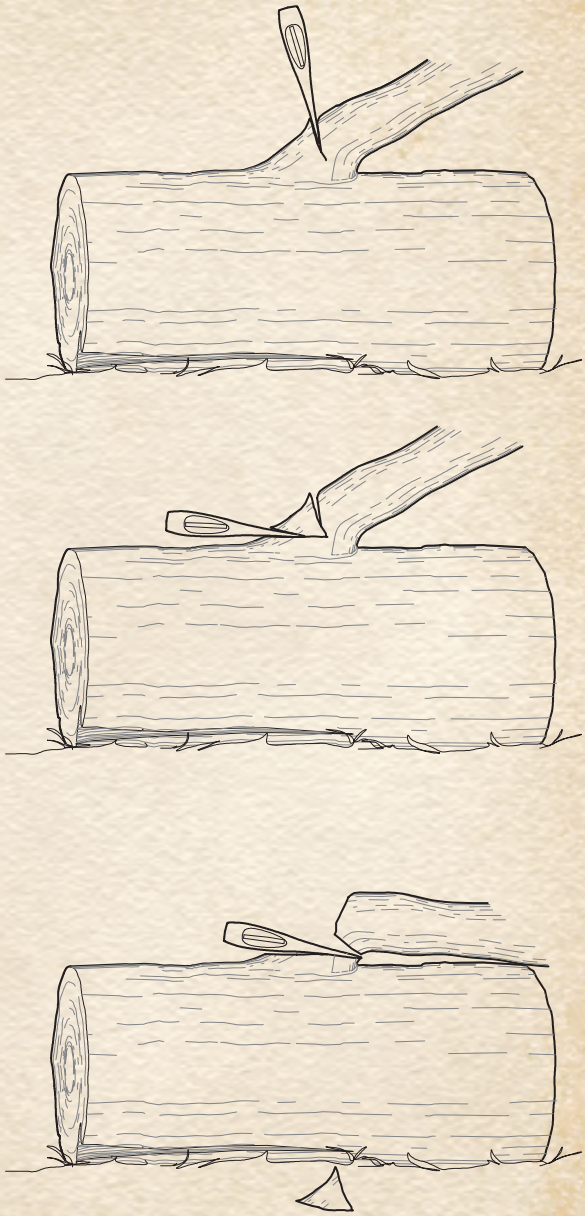
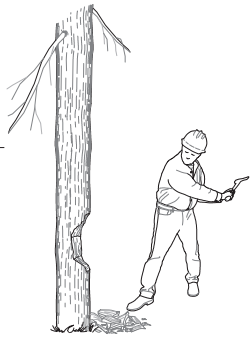


Figure 11–34—Limb large branches by starting with a vertical chop. Follow this with a horizontal chop to remove a wood chip.



Standing on a Log While Chopping

You may have to stand on top of a log to chop it properly and safely. In this case, cut out footholds on the log so you have a flat place to stand (figure 11–35).

Standing on a log to chop it is an advanced chopping technique; novice axmen should not attempt it.

Figure 11–35—Flat footholds cut into a log (left). Standing on top of the log to chop it (below).

Felling Trees

Felling trees for the Forest Service requires training and certification. You must receive training and certification before attempting to cut a standing tree. Size up the tree and develop a cutting plan, as explained in the "Using the Forest Service Cutting Process" section earlier in this chapter. Focus on the complexity (lean, tension, compression, defects, or damage) of the tree and not its size. The complexity of small trees is harder to identify, often making them more dangerous to fell than big trees.

This manual focuses on how to use an ax, but a saw can make the job of felling trees easier and safer, especially for novice axmen. This section covers the use of an ax in conjunction with a crosscut saw. While people often use an ax as a standalone tool, it is actually a companion tool to a crosscut saw. When you use a crosscut saw, you should also use the appropriate ax and felling or bucking wedges. The five-step process from the "Using the Forest Service Cutting Process" section earlier in this chapter comes into play here.

"As a scout, you are the guardian of the woods. A scout never damages a tree by hacking it with his knife or axe. It does not take long to fell a tree, but it takes many years to grow one, so a scout cuts down a tree for a good reason only, not just for the sake of using his axe. For every tree felled, two should be planted."

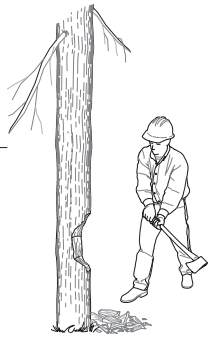
—Lord Baden-Powell

Sizing Up and Analyzing the Tree

Felling a tree begins with thoroughly sizing up and analyzing the tree, and identifying its dangers. There may be hidden dangers, such as rot inside the tree. Keep in mind that not all dangers are in the tree itself. Take into account the topography in the area as well as the wind and weather conditions. Do not attempt to cut trees that have complexities beyond your ability to mitigate. If you have any doubt about your ability to fell a tree safely, walk away or seek the help of a more experienced feller.

To determine the lean of a tree, plumb the tree from the intended lay and 90 degrees off the intended lay. Stand far enough away from the base so that you can see the tree's entire height. A tree can have more than one lean. Many timber fellers use a plumb bob and string to judge lean, but you can also use an ax. Loosely hold the ax by the knob of the handle with the head pointing down. The ax becomes a straightedge that helps you determine the lean of the tree.

The poster "Visual Danger Tree Indicators" <https://www.fs.fed.us/t-d/php/library_card.php?p_num=1167%202M13> (figure 11–36) can help you identify the main hazards a tree may contain. You can order printed copies of the poster by contacting the National Technology and Development Program at 406–329–3900.



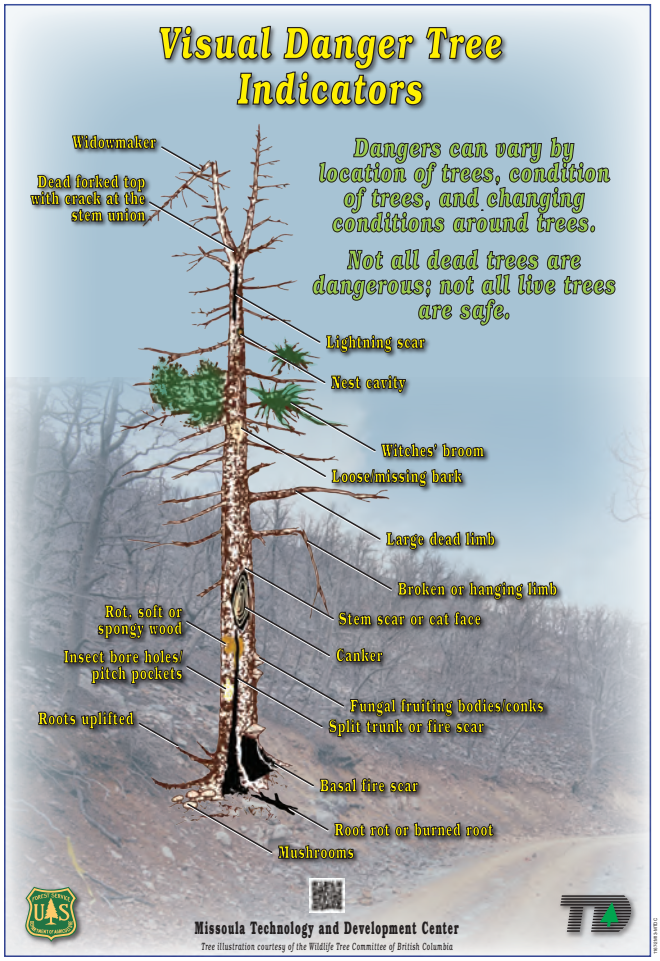


Figure 11–36—The "Visual Danger Tree Indicators" poster.

Every tree has a safe and an unsafe side. Position yourself and plan your cutting activities to take place on the safe side of the tree. Do not put yourself at unnecessary risk, and do not position yourself under the lean of the tree or any overhead hazards that may fall on you.

Once you thoroughly analyze the tree and determine the direction of fall, plan your escape paths. Escape paths should not be located in front of the tree or behind the tree, but diagonally a safe distance away from the tree or to a place of cover (figure 11–37). Before you begin to cut, clear everything from the escape paths that could cause you to trip, fall, or that might otherwise hinder your escape.

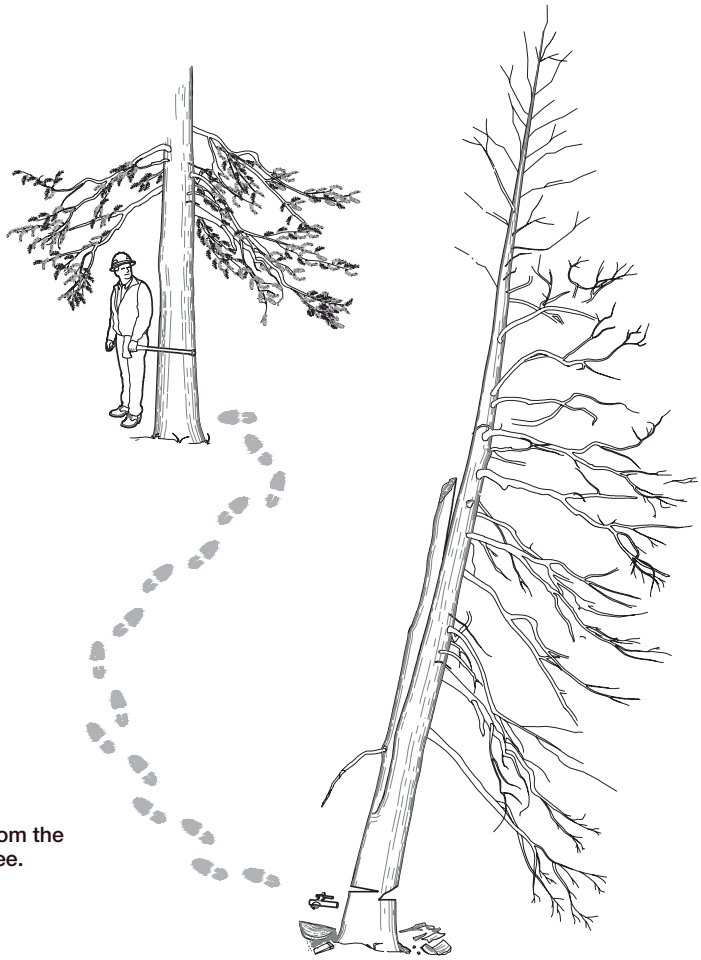


Figure 11–37—An escape path at an angle away from the back of a falling tree, but not directly behind the tree.

With the escape paths cleared, examine the site where you will chop. Ensure that you have good footing and that the area is clear for swinging an ax. Remember, even a small twig can deflect the blow of an ax, causing it to change direction midswing.

Never attempt to fell a tree against its lean when you only use an ax. Be wary of trees with a heavy lean; they are more likely to split lengthwise up the stem during felling. This is known as a "barber chair" (figure 11–38). Barber chairs are extremely dangerous because a portion of the tree may split off and could come back and strike you as you chop. Some tree species are more prone to barber chair. Learn the characteristics of the types of wood you cut. Wood species and their characteristics vary from region to region.

Aside from heavy leaners and the characteristics of certain tree species, an improperly aligned undercut (also known as a "Dutchman") is another common cause for a tree to barber chair (figure 11–39).

Figure 11–38—A tree split lengthwise up the stem during felling, known as a "barber chair."

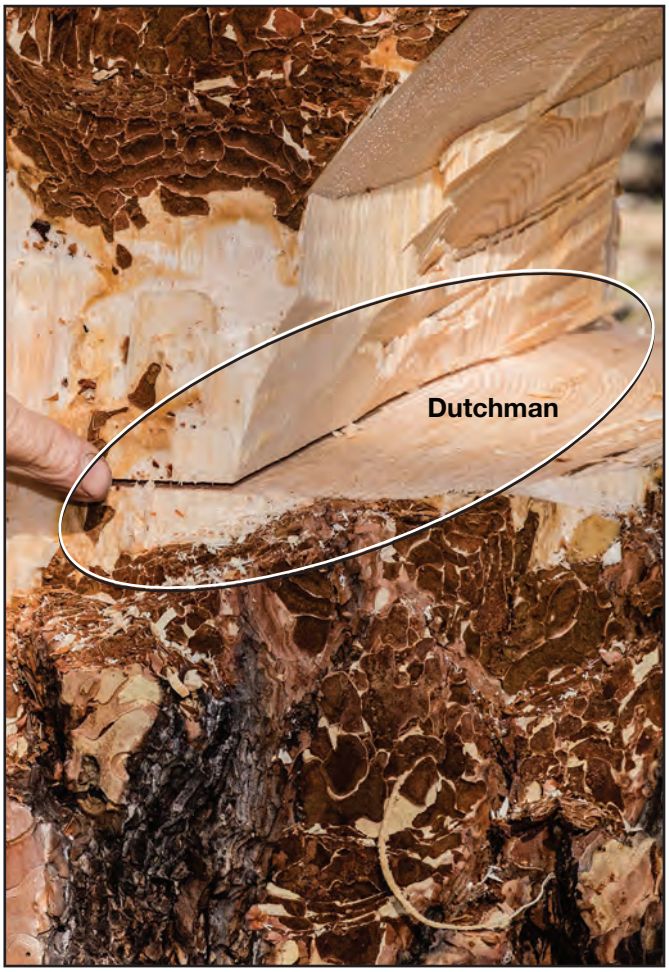


Figure 11–39—An undercut with a "Dutchman."

The intersection of the horizontal and the sloping cuts must line up exactly (figure 11–40). If the cuts do not line up, the tree could barber chair as it begins to fall. If you create a Dutchman in your undercut, correct it with an ax or saw before starting the back cut. The following section, "Making the Initial Cuts," provides information about undercuts and back cuts.

Felling a tree in a direction away from its lean or compensating for its lean typically involves the use of wedges placed in the saw kerf or back cut. The inability to use standard wedging techniques when felling with only an ax makes it very difficult, even for experienced fellers, to manipulate a tree away from its natural direction of fall. There are techniques to accomplish this, such as the use of cables to provide directional tension and some complicated wedging or leveraging systems, but these techniques are best left to highly skilled and specially trained fellers.

If there is another tree in the intended direction of fall that could cause your tree to hang up, you may need to fell that tree first. Trees that hang up can be extremely dangerous. They require special training to remove safely.

Because felling trees is one of the most dangerous tasks in the Forest Service, the information given here serves as a baseline for fellers to understand the general principles of cutting down trees. With every swing of an ax or pull of a saw, you change the dynamics and the forces of a standing tree until your actions bring the tree to the ground. If you do not fully understand the forces at play, do not cut the tree. The same applies to bucking downed logs, which can often be more hazardous than felling standing trees.

Green trees are generally safer than dead trees to work around and fell, but all trees can pose hidden dangers. The nature of green wood allows you to manipulate it more easily. Dead wood can be stiff and brittle. Be especially wary of dead and defective trees, trees that are broken, and trees that show signs of rot, insects, or nesting cavities. Check to ensure the tree is sound by thumping it with the poll of the ax. Check from several different positions around the base of the tree. If the tree sounds hollow, it may be rotten. Keep in mind that not every green tree is safe and not every dead tree is immediately dangerous.

Figure 11–40—An undercut where the sloping and horizontal cuts line up perfectly.

A tree must have solid wood for the hinge. The hinge controls the fall. Once you break or sever the hinge (figure 11–41), the tree is no longer attached to the stump and you are no longer in control. Before the hinge breaks, your goal is to commit the tree to the direction in which you intend it to fall. Ideally, the hinge breaks when the undercut closes. A shallow-angle undercut closes sooner than a wider-angle undercut (here we are talking about the angle of the undercut and not its depth). Rotten wood makes a weak or nonexistent hinge. A tree should have a minimum of 30 percent solid wood to cut. Do not cut it if it does not have 30 percent solid wood. An increment bore is ideal for determining the solidity of the wood, but most axmen don't carry one into the woods. Many experienced axmen sound a tree using the poll end of a single-bit ax. If the tree sounds hollow, they do not cut the tree.

Storm- or fire-damaged trees pose unique and often hidden dangers. Every log may have multiple binds with varying degrees of tension and compression that pose challenges for both bucking and felling activities.

Figure 11–41—Two stumps showing a hinge. The stump to the right was cut with a crosscut saw and ax combination. The stump below was cut with an ax alone.

Making the Initial Cuts

The initial cut in the tree is the undercut (figure 11–42). Make your cut so that the tree falls in the direction you intend. If you only use an ax to fell, your typical undercut is about one-half of the tree's diameter. Your cuts should be at a 45-degree angle and should form a large, horizontal "V" (also known as a "bird's mouth"). If you use a crosscut saw to fell, your typical undercut is about one quarter of the tree's diameter. When you use an ax and a crosscut saw, make the 45-degree sloping cut using the ax and a flat, horizontal cut with the crosscut saw.

Once you make the undercut, you can use a double-bit ax to judge the direction of fall. Place the ax head in the cut and sight down the handle (figure 11–43). The handle points in the direction of fall. A single-bit ax usually does not work for this type of sighting because the handle is typically curved.

Figure 11–42—Making a 45-degree sloping cut with an ax. Note the horizontal crosscut saw cut.

Figure 11–43—Sighting down an ax handle to determine the direction of fall.

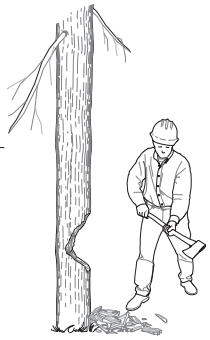
Perform the back cut on the opposite side of the tree (figure 11–44). It is very important not to cut all the way through the tree. Leave a strip of wood to serve as a hinge. As noted earlier, the hinge controls the direction of fall. The thickness of the hinge varies, depending on the size of the tree. Big trees require more hinge and smaller trees require less hinge. The tree can fall in any direction if you cut through the hinge.

Felling With a Crosscut Saw and Ax

Felling a tree with a crosscut saw and ax allows you to adjust your cuts easily and increases safety. Using a crosscut saw and ax also allows you to use conventional wedging techniques to assist with felling. If the tree has a dedicated lean, wedging may not be necessary to commit a tree to a direction of fall. However, a wedge placed lightly in the kerf (figure 11–45) will fall out once the tree starts to move. This serves as a visual indicator that the tree is beginning to fall.

Figure 11–44—Performing a back cut on a tree using a crosscut saw.

Figure 11–45—Placing a wedge lightly in the kerf of the tree will help alert you when the tree begins to fall.



Felling techniques when using an ax and crosscut saw together are essentially the same as when using an ax alone. Use the crosscut saw to make a horizontal undercut about one quarter the diameter of the tree and use the ax to make a sloping cut that meets up with the horizontal cut.

Use the crosscut saw to make the back cut 2 inches above the undercut. This helps prevent the tree from sliding back across the stump as it falls. Use wedges to prevent the tree from sitting down on top of the saw while cutting. Again, be sure to leave a hinge in place to help guide the tree to the ground.

Make your cuts at a comfortable height for you. Cutting too high on the stump leaves less wood in the log, but cutting too low may make it more difficult to chop and saw.

Using an ax and crosscut saw to fell a tree provides unique insight into the felling process that may elude chain saw users. The chain saw cuts fast. While a sawyer using a chain saw can power through wood fibers that would cause a crosscut saw to bind, a sawyer using an ax and crosscut saw may need to apply more finesse. When using an ax and crosscut saw, the sawyer spends more time identifying the tension and compression of a tree before cutting. Taking the time to evaluate a tree's dynamics makes the process of cutting down a tree safer.

The University of Montana's School of Extended and Lifelong Learning provides the online interactive training course "The Crosscut Sawyer" <http://www.campusce.net/umextended/course/course.aspx?c=335> for people who want to learn more about using crosscut saws. This course helps Forest Service employees and volunteers to prepare for a crosscut saw training and certification course.

As a Tree Begins to Fall

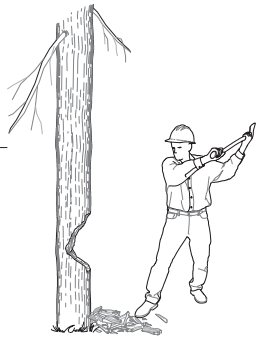
As you chop or saw, look up frequently to watch for signs of movement or for hidden hazards that you may have overlooked. You will notice movement in the treetop first when the tree is close to falling. Step away from the base of the tree into your escape path, look up for falling debris, and watch the tree as it commits to its direction of fall. Be aware of hazards that may result from the tree you cut striking other trees on the way down, or when the tree hits the ground. While some people may, the author would never turn his back on a falling tree. Remember that most injuries and fatalities that occur during the felling process happen within 10 feet of the stump.

"Cutting" by Claire Leighton. —*Collection of the Illinois State Museum. Courtesy of the Fine Arts Program, Public Buildings Service, U.S. General Services Administration. Commissioned through the New Deal Art Projects*

Crosscut Saw Variations

Be aware of crosscut saw variations. As with axes, not all crosscut saws are intended for the same types of work. There are felling and bucking saws (figure 11–46), as well as different tooth patterns for cutting different types of wood. Generally, felling saws are more flexible and have a concave back while bucking saws are heavier, stiffer, and have a straight back. Felling saws typically have one hole in each end to accommodate the handle. Bucking saws typically have two holes in each end for the handle. The two holes in each end of the saw provide a pivot point to make it easier for a sawyer to cut in different positions and to apply cutting force to different points on the log.

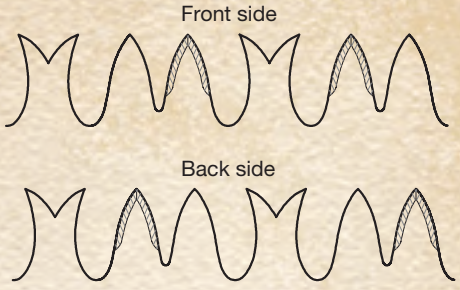
Figure 11–46—A felling saw (top) and a bucking saw (bottom).



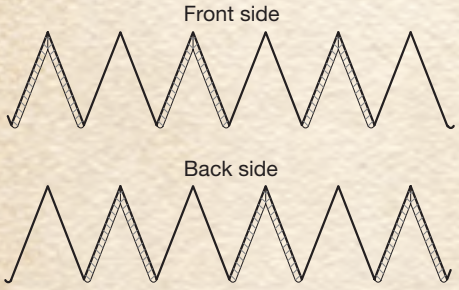
Crosscut Saw Variations (continued)

Generally, saws with four cutting teeth per raker are better for cutting softer wood while saws with two cutting teeth per raker are better for cutting hard or frozen wood (figure 11–47).

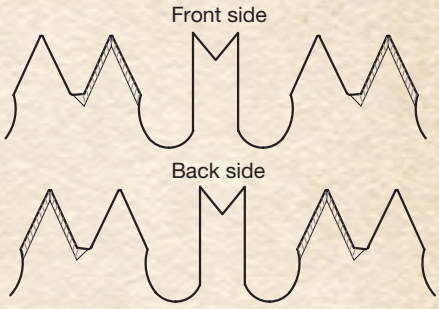
Figure 11–47—Crosscut saw tooth patterns.



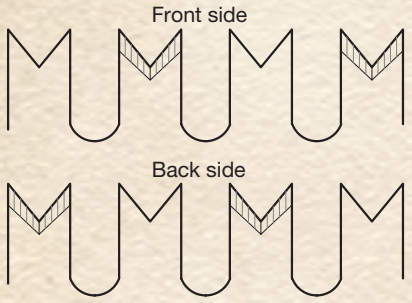
Champion Tooth



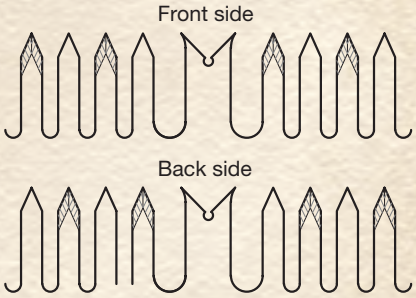
Plain Tooth



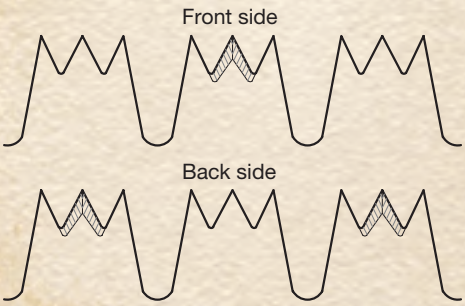
Tuttle Tooth



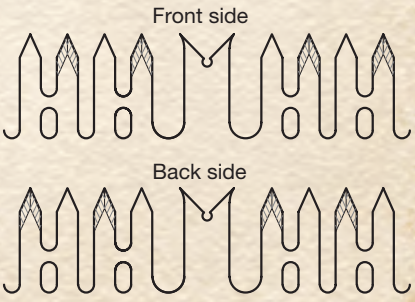
M Tooth



Lance Tooth



Great American Tooth



Perforated Lance Tooth

Crosscut Saw Variations (continued)

Good crosscut saw handles can be more difficult to find than a good crosscut saw. Most sawyers prefer the western handle pattern, which provides added protection for hands and knuckles. Be aware that some handles are designed for bucking and others for felling (figure 11–48). Bucking handles traditionally have a longer wooden shaft, while felling handles have a shorter wooden shaft. The shorter shaft on felling handles is a safety measure. Typically, you pull the saw parallel to your body while bucking and pull the saw horizontally toward your body while felling. The short shaft of a felling handle prevents the handle from catching on clothes or suspenders while cutting and allows you to keep the power of your stroke in line with the saw. The longer shaft of the bucking handle allows you to adjust your hand position to apply force on different parts of the log.

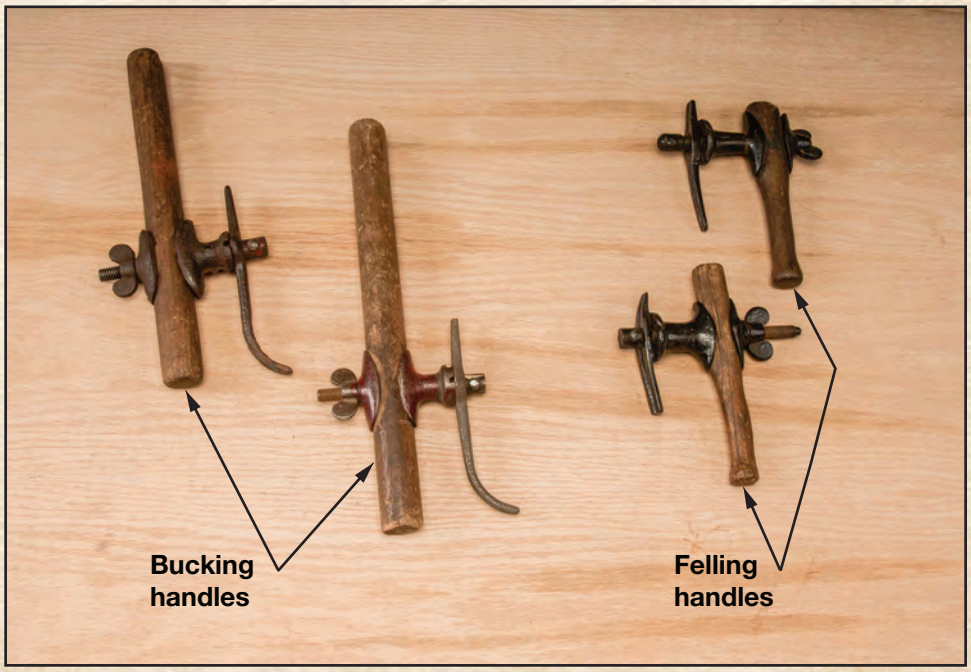


Figure 11–48—Crosscut saw felling and bucking handles.

When using an ax and crosscut saw, it is best to use your ax to clear away the bark from the area you intend to cut (figure 11–49). The bark of a tree holds dirt, which can quickly dull a crosscut saw. Clearing the bark helps keep the saw sharp and cutting well. A sharp, well-tuned crosscut saw is easy to use. Sharpening a crosscut saw is time consuming; it is an art unto itself.

The publication "Saws That Sing: A Guide to Using Crosscut Saws" (0423–2822P–MTDC) <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0423%202822P> provides detailed information about using crosscut saws.

The publication "Chain Saw and Crosscut Saw Training Course, Student's Guidebook" (0667–2805–MTDC) <https://www.fs.fed.us/t-d/php/library_card.php?p_num=0667%202805> provides detailed information about Forest Service chain saw and crosscut saw training.

Simply reviewing instructional materials about felling, bucking, and the use of saws is insufficient. Proper training requires classroom instruction and field exercises led by certified trainers.

Wedges

Wedges are useful for felling trees and for bucking logs when using a saw. Sawyers typically use an ax to drive the wedges. There are different types of wedges for different purposes. Wedges can make felling and bucking easier and safer. Do not underestimate the importance of this simple, basic tool.

Most wedges today are made of hard plastic (figure 11–50). Some plastic wedges contain a steel insert in the end cap. The steel provides better durability while the plastic body absorbs the shock, preventing damage to the poll of the ax. It is against Forest Service policy to use wooden wedges because they have a tendency to split. Wooden wedges also tend to be

Figure 11–49—Clearing bark from an area on a tree before using a crosscut saw.

thicker and do not easily fit in a kerf. The Forest Service allows the use of steel wedges (figure 11–51), but the wedges must be in good condition. Be aware that a steel wedge can damage an ax or saw, whereas a plastic wedge will not.

Figure 11–50—Plastic felling wedges.

Figure 11–51—A steel wedge (top) and a wooden wedge (bottom).

Some companies make aluminum wedges (figure 11–52) that are acceptable because the softer metal does not damage an ax or saw. Never use a broken or damaged wedge, especially if the back edge is mushroomed (figure 11–53). Mushroomed pieces can break off and cause injury. Wedges come with smooth, textured, or ridged surfaces (figure 11–54). Wedges with smooth surfaces are easier to drive, while wedges with textured or ridged surfaces provide friction that helps to hold the wedges in place.

Figure 11–52—Aluminum wedges.

Figure 11–53—Mushroomed and damaged felling wedges.

Figure 11–54—A wedge with a ridged surface.

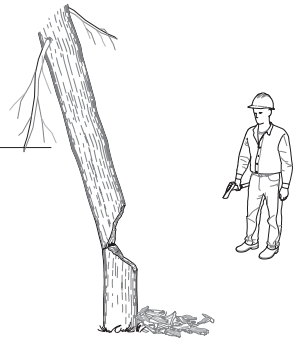
Wedges come in different lengths. Make sure to use a wedge that is appropriate for the size of the wood you cut. You may not be able to drive a long wedge deep enough into a small tree to provide the lifting power you need, and you may run up against the back of your saw.

Felling and Bucking Wedges

Felling wedges are tapered on one side and flat on the other side, giving them lifting power. Bucking wedges have a double taper, meaning they taper on both sides. They are better for keeping the kerf open when cutting a downed log in two. The forces on bucking wedges spread out equally between the two sides as you drive the wedge in, preventing the saw blade from binding or pinching.

Felling Wedges

Felling wedges generally have a gentle taper. If they taper too much, they create resistance when you drive them into the kerf. Felling wedges are either single taper, double taper, or triple taper on one side only. Single-taper wedges are easier to drive because they have a lower profile. Double- and triple-taper wedges can provide better lifting capacity. Double- and triple-taper wedges are similar to single-taper wedges, but their tapers increase around the middle of the wedge. Be careful not to confuse the taper of felling and bucking wedges. Felling wedges are always flat on one side to provide lifting power when felling trees, whereas bucking wedges taper on both sides to keep a kerf open while cutting a downed log into segments. You place the flat side of the felling wedge on the bottom of the kerf with the tapered side facing up to lift the tree.



Using a Felling Wedge With a Crosscut Saw

Wedges lift a tree so the tree falls into the undercut. They also prevent the tree from sitting back on the crosscut saw and pinching the blade. When you set the wedge lightly into the back cut, it drops out when the tree starts to move (see figure 11–45). When felling a tree, the sawyer should watch the top of the tree and the back cut for any indication that the tree is moving or about to fall.

Properly placing wedges can have a major effect on the direction a tree falls, but understanding the gravitational dynamics involved requires special training. Do not attempt to fell a tree against its natural lean without proper training.

Bucking Wedges

Use bucking wedges to keep the kerf of a log open while you cut the log (figure 11–55). An 8-inch, double-taper wedge is a good general purpose wedge for most bucking situations. An open kerf is important for preventing a crosscut saw from being pinched, stuck, or possibly bent. Bucking wedges may be made of softer material than felling wedges because bucking wedges do not endure the extreme forces and compression that felling wedges do. Many people use felling wedges for both felling and bucking.

Using a Bucking Wedge with a Crosscut Saw

Drive the bucking wedge into the kerf as soon as the saw allows it. Reset the wedge as necessary to keep the kerf open and the saw running freely.

Figure 11–55—Using a wedge to hold a kerf open on a log.

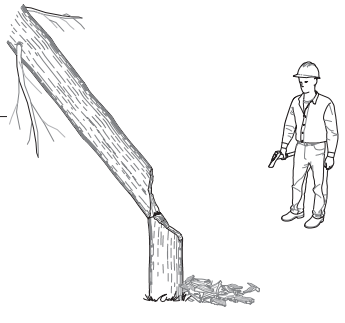
Holding Wedges

A holding or hanging wedge is another type of specialized wedge used for bucking. People also refer to these types of wedges as tie wedges. Drive these smaller, thinner wedges across the kerf of the log you are bucking. The wedge holds the log in place and keeps it from shifting or twisting as you cut it. These wedges have an eyehole near the top where you could link two wedges together with a lanyard. Sawyers typically use these wedges in pairs and drive them into the log across the kerf at the 10 o'clock and 2 o'clock positions.

It is difficult to find holding wedges today. Newly manufactured holding wedges are made of aluminum and may be too thick to penetrate deeply across the kerf of a dry log. You can sand or grind the sides of holding wedges to create a thinner profile for wedges that are too thick.

Vintage holding wedges (figure 11–56) have the proper thickness for driving across the kerf of a log that you are bucking, but they are made of steel and the tops of the wedges roll or mushroom after repeated use. Rolled or mushroomed ax polls or wedges can be dangerous. Do not use them.

Figure 11–56—Newly manufactured aluminum holding wedges (foreground) tend to be thicker than vintage holding wedges (background).



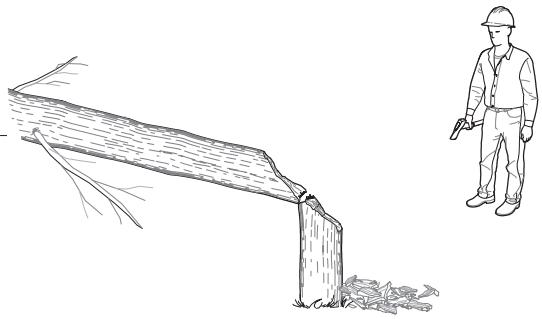
When bucking, a sawyer drives holding wedges (connected by a lanyard) horizontally across the kerf. The sawyer uses the poll end of a single-bit ax to drive the wedges. The sawyer then sinks the ax in the section of log that will not move after the log is cut and places the lanyard connecting the wedges over the back of the lodged ax head (figure 11–57). As the sawyer continues to cut and the end of the log drops away, the wedges remain on the lodged ax head (figure 11–58). This prevents the wedges from dropping and possibly damaging the saw.

Figure 11–57—Driving wedges into a log (left). Note the lanyard placed over the back of the ax head (below).

Splitting wedges (figure 11–59) are thick, heavy, metal wedges for splitting wood. The "Splitting Wood" section later in this chapter provides information about splitting wedges.

Figure 11–58—With the lanyard connecting the wedges over the back of the lodged ax head, the wedges remain fixed on the log after the cut end of the log drops away.

Figure 11–59—Splitting wedges.



Moving the Wood

A little preplanning can make moving a log after chopping or sawing safer and easier. You may need to first cut other logs and brush, or move obstacles that would prevent you from moving the log you plan to cut.

Spring Poles

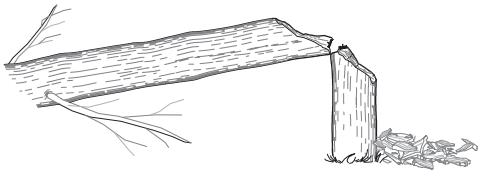
Be careful around spring poles (figure 11–60)—bent branches or small saplings held in place by a downed log. They can be under considerable tension and may release with tremendous force. Cut any spring poles before cutting the log that holds them in place. A series of small cuts on the underside (compressed side) of the spring pole releases the tension and reduces or eliminates its ability to spring up.

Figure 11–60—A spring pole.

If the log is partially or totally elevated off the ground, determine where it will fall after you cut it. Make sure that it will not dislodge or strike other material that could injure you. Correctly identify any areas of tension or compression and the types of binds you may encounter.

If you need to move the log after you cut it, place smaller logs or poles beneath the log (figure 11–61) and use them to roll or skid the log out of the way.

Figure 11–61—Using poles to roll or skid a cut log out of the way.



Log carriers (figures 11–62 and 11–63) provide a convenient way for two people to move and place a log if the log is not too large or heavy. A log carrier has two swinging, hooked tongs suspended from a stout pole. The two people secure the tongs to the log to lift and move it. More people can use two or more log carriers to move larger logs.

The log carrier is a useful tool, but people must provide the muscle to lift the log. Understanding and using mechanical advantage to increase leverage enables people to move heavier pieces of wood while reducing back strain and potential injury.

Figure 11–62—A log carrier designed for two people.

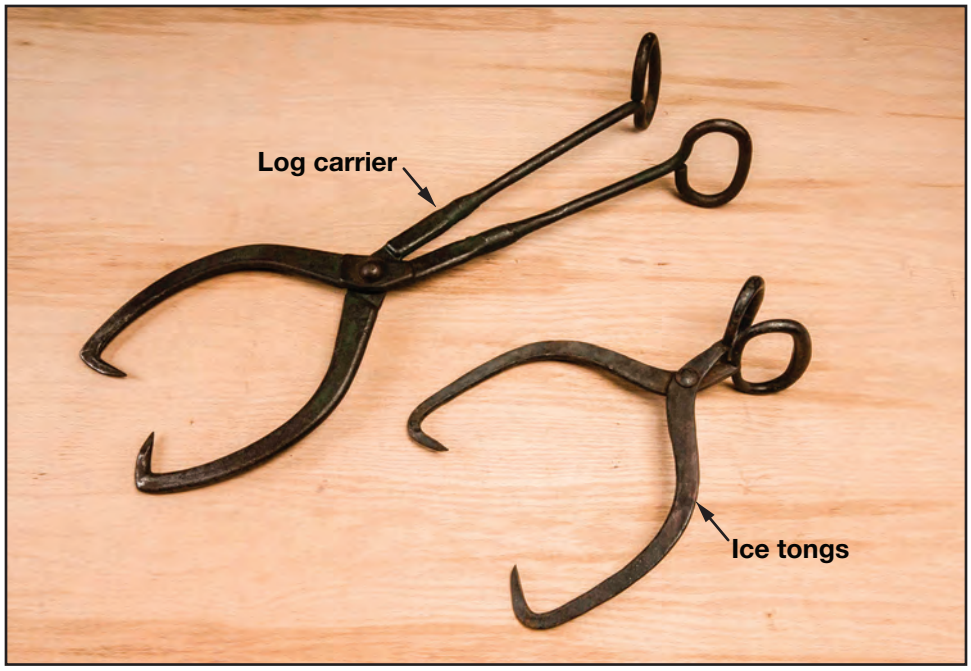


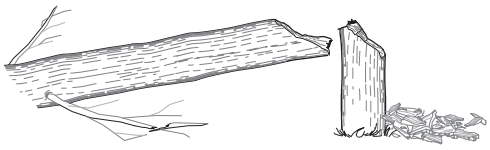
Figure 11–63—Tools used for carrying logs. Note that the "log carrier" on the right is actually a set of ice tongs.

A lever is the most common type of mechanical advantage for moving cut logs. A stout pole may provide enough leverage (figure 11–64), or you can use a cant hook (figure 11–65) or peavey.

A cant hook has a straight handle with a metal end cap and a swinging, hooked arm. The end cap typically has short dogs (teeth) to hold the log while the swinging, hooked arm grips the log. The long handle provides leverage. A peavey is similar to a cant hook, but it has a spike instead of an end cap (figure 11–66).

Figure 11–64—Using a lever to move a log.

Figure 11–65—Using a cant hook to move a log.



Cant hooks and peaveys typically have hardwood handles that range from 30 to 66 inches, though some have smaller handles for moving logs in close quarters, such as a sawmill.

Lightweight pickaroons or hookaroons (figure 11–67), commonly found in a sawmill or log yard, are useful for rolling or moving logs. The tools look almost identical and serve the same purpose, but pickaroons tend to have a straighter tang, similar to a pick, and hookaroons have a small hook or nub at the end of the tang.

Rigging and specialized equipment provide other methods for moving logs. The publication "Rigging for Trail Work: Principles, Techniques, and Lessons from the Backcountry" provides information about some of these methods. "Handtools for Trail Work: 2005 Edition" (0523–2810P–MTDC) <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0523%2028 10P> provides excellent information about handtools Forest Service employees use for trail maintenance and construction.

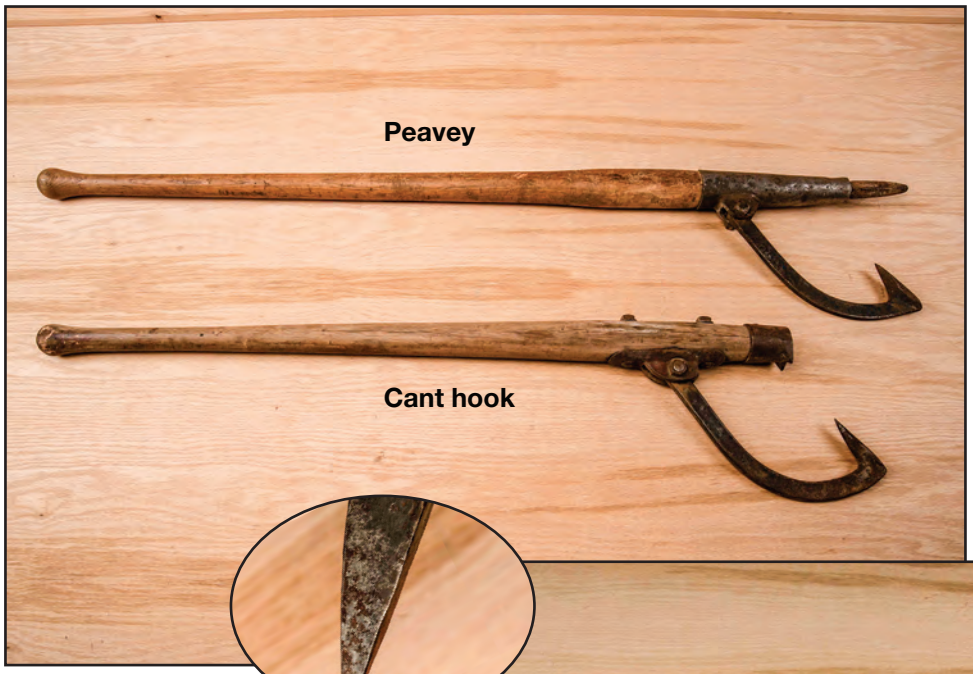


Figure 11–66—A peavey and cant hook. Note the spike on the peavey and the dogs (teeth) on the cant hook.

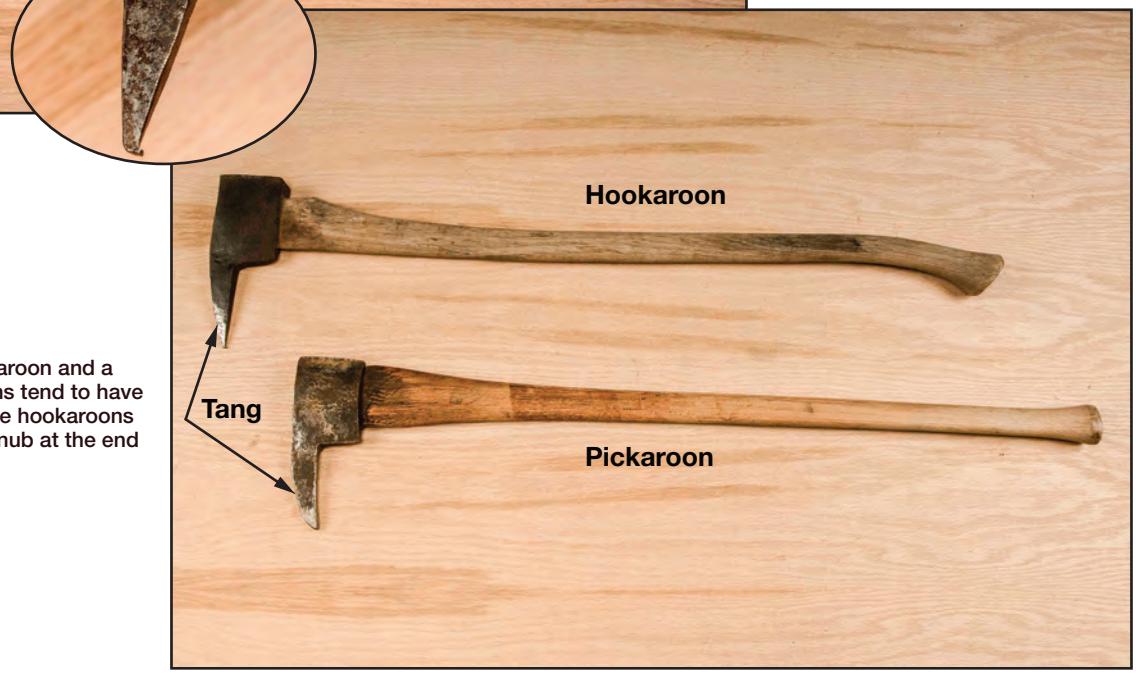


Figure 11–67—A pickaroon and a hookaroon. Pickaroons tend to have a straighter tang, while hookaroons have a small hook or nub at the end of the tang (inset).

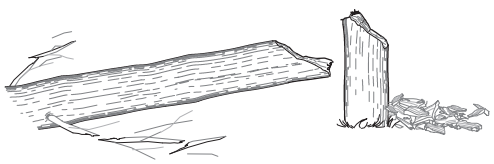
Splitting Wood

Chopping wood is the function of an ax. Splitting wood is the function of a maul and wedge (figure 11–68). You can split wood with an ax, but if you have large rounds or knotty wood, a maul and wedge are the proper tools to use.

Whichever tools you use, pay close attention to the grain of the round you split. Splitting, as the name implies, is when the split follows the grain. Chopping is done perpendicular to the grain. Some woods have curly or twisting grain, making them difficult to split. Other woods have straight grain, making them easy to split. If possible, avoid knots by splitting around them.

The ax you use for felling or bucking may not be the best ax for splitting. The ideal ax for splitting is a large, heavy, single-bit ax with a long handle. A hardened poll, such as the poll on a rafting-pattern ax (see figure 5–3), is the best choice for driving a splitting wedge. Remember, most axes do not have a hardened poll, and driving a steel wedge can damage the poll.

Figure 11–68—A maul and splitting wedges.



The Soft Sides of a Double-bit Ax

Do not use the side of a double-bit ax to drive wedges (figure 11–69). The sides of a double-bit ax are softer than the cutting edges and you could damage the ax or break the handle.

Figure 11–69—Driving wedges with a double-bit ax can damage the sides of the ax head.

When splitting wood, the cutting edge of an ax head should be sharp, and the sides should be thicker. This enables the ax to have greater splitting action once the cutting edge penetrates the wood. The longer handle enables you to generate more speed as you swing the ax.

For field use, the author uses a 4½-pound ax head on a 27-inch handle for chopping and a 5¾-pound head on a 44-inch handle for splitting rounds of firewood (figure 11–70). The long handle on the splitting ax makes the ax difficult to control for felling or bucking, but makes it ideal for splitting rounds of firewood.

A true splitting ax is different from a chopping ax. The splitting ax is heavier and often wider, causing greater wood separation through wedging action. Some manufacturers make modern splitting ax blades with small wings that spread the wood out during the strike and cause greater displacement (figure 11–71). Splitting axes, particularly ones with longer handles, do not make efficient chopping axes. The extra weight and longer handle often make them unwieldy, especially for horizontal strokes.

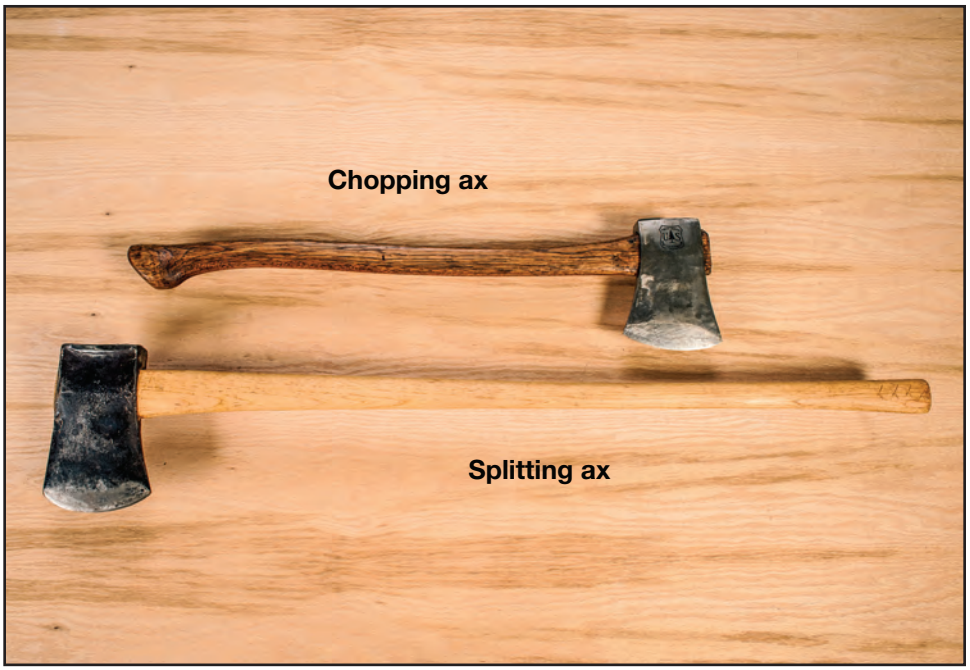


Figure 11–70—A 4½-pound Arvika 5-Star ax head on a 27-inch handle (top) and a 5¾-pound American Axe and Tool Company ax head on a 44-inch handle (bottom).

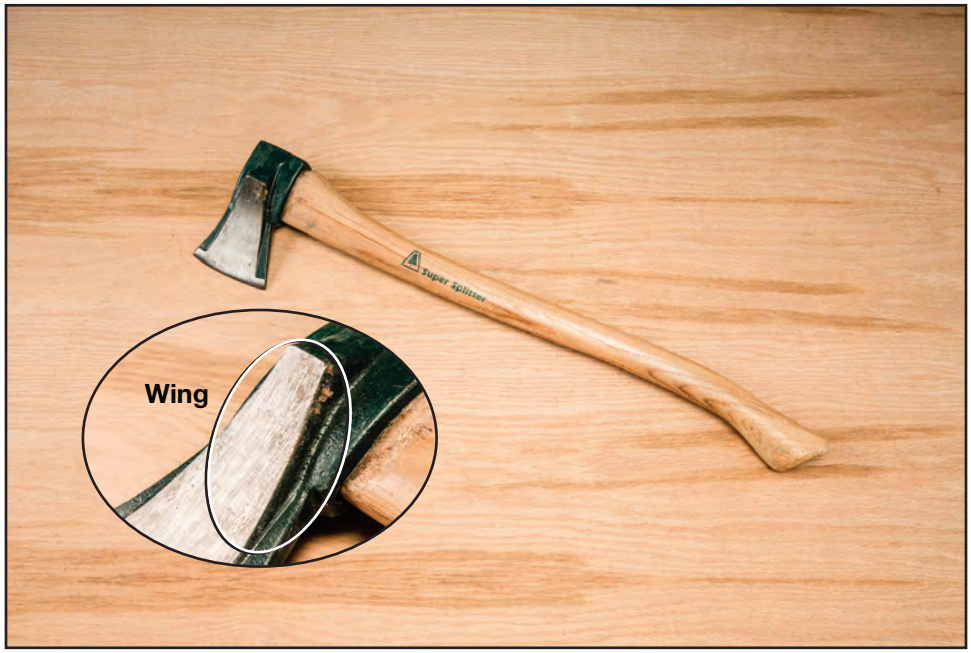
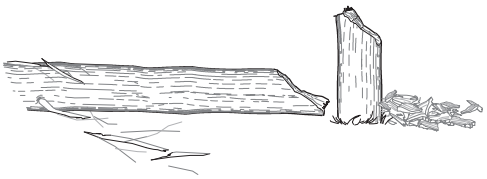


Figure 11–71—A modern splitting ax with wings that help spread and split the log. The inset shows a closeup of one wing.



If you split a round of wood with flat ends, place it on level ground, on another round, or on a chopping block. Take advantage of any splits or checks (natural cracks) in the wood; these provide easy points for splitting the round into pieces (figure 11–72). When splitting, flick or twist your wrist slightly as the ax strikes to help split the wood (figure 11–73). Keep in mind that flicking your wrist causes side torque on the handle that could potentially break it, especially if the handle is already damaged.

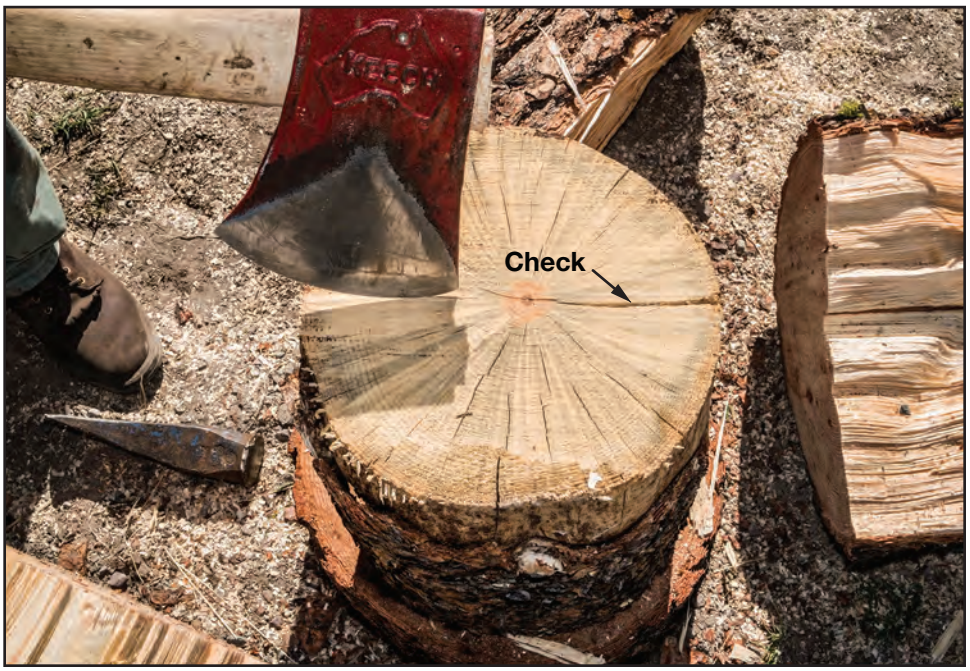


Figure 11–72—Use splits or checks in the wood when splitting a round of wood with an ax.

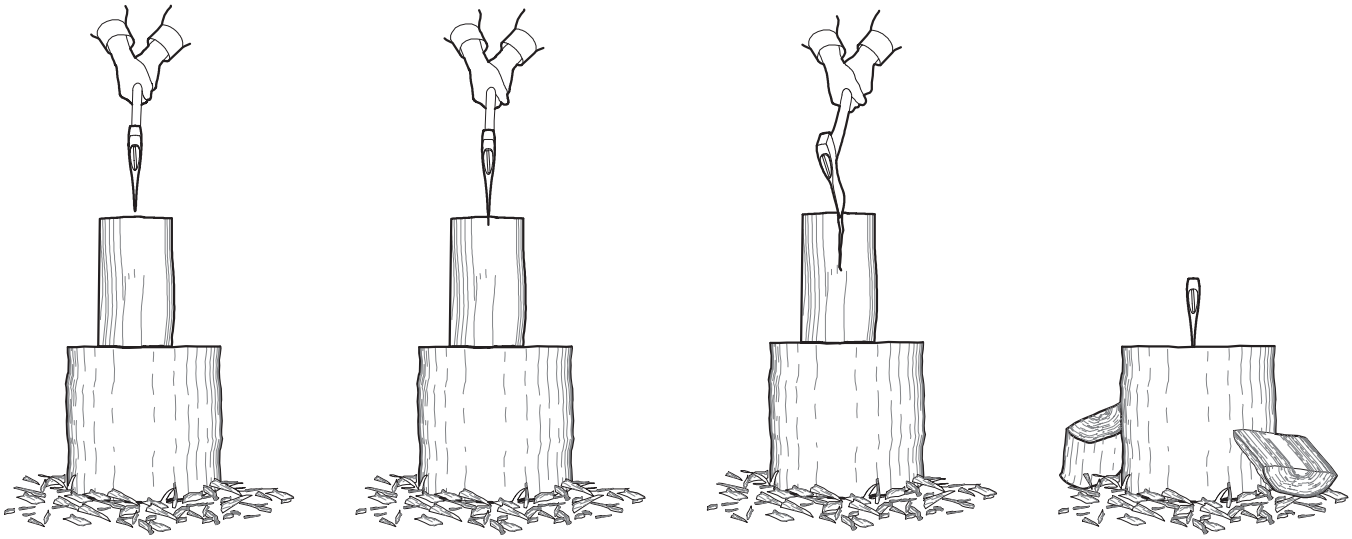


Figure 11–73—Flicking or twisting the wrist slightly as the ax strikes helps to split the wood.

If the ax sticks in the round of wood, be careful not to apply too much continuous force trying to free it. Applying too much continuous force may result in a broken ax handle.

To free an ax that is stuck, first bump or push the handle down and then up, repeating the processs until the ax starts to move, as shown in figure 11–74.

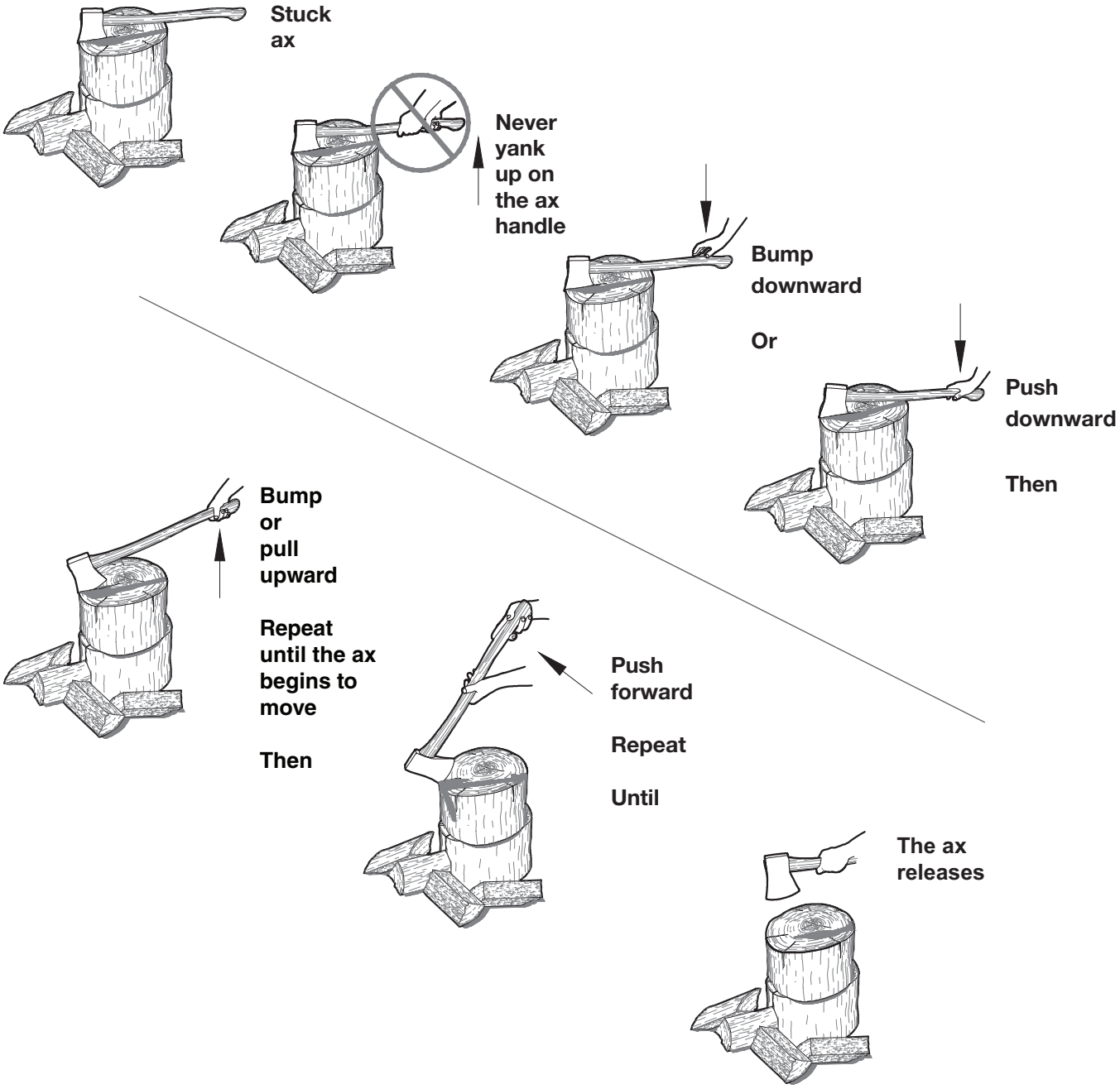
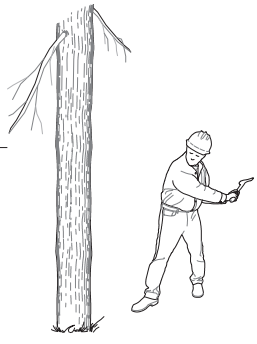


Figure 11–74—Freeing a lodged ax by first bumping or pushing the handle down and then up, repeating the process until the ax begins to loosen from the wood.



If you cannot easily remove an ax from a round of wood, use another ax or a maul and wedge to split the round and free the ax (figure 11–75).

If the round you cut does not have flat ends, it will not stand upright. In this case, instead of using a flat chopping block, find a forked section of log and secure the round into the fork (figure 11–76). If you are unable to find a forked section of log, try notching a log to give the round a stable place to rest. Because the round will not be upright, you will likely have to split it from the side. Strike as close to the top of the round as possible, using any natural cracks in the wood that you see and avoiding any knots. If you do not position your strike well, splitting from the side poses an added risk of a glancing or scooping blow. Knotty wood or wood with an uneven, curly grain can make the situation even more dangerous. If you split from the side, chop so that the wood splits away from you and not toward you. If you chop with the

Figure 11–75—Using a wedge and maul to split a round and free a bound ax. An ax is more likely to bind when striking the center of a round. Striking the edge of a round not only decreases the likelihood that the ax will bind, but also splits the round more easily.

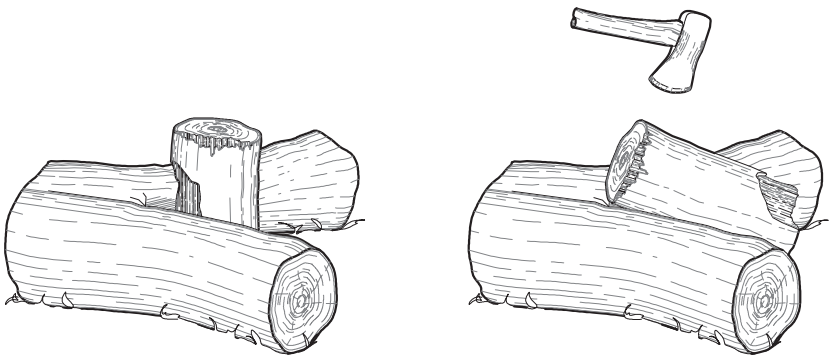


Figure 11–76—Using a forked section of log to secure a round that does not have flat ends.

wood splitting toward you, the head of the ax also is coming toward you. If you can stabilize the round with your foot, you are chopping in the wrong direction (figure 11–77). **Plan your cuts for safety.**

A maul is more wedge-shaped and heavier than an ax. You may be able to split many rounds without using a wedge, but for large rounds and rounds with twisted grains or many knots, using a splitting maul and steel wedge is the easiest and safest option. Ensure that the poll of the maul is made of tempered or hardened steel and always wear safety glasses.

Place the wedge about one-quarter to one-third of the way across the top of the round, closer to the edge than the center. Take advantage of any natural splits in the wood and avoid knots. Drive the wedge about three-quarters of its length into the round. Ideally, the round will split down and across its diameter. If the round splits, you can use the maul and a wedge to strike the side of the round opposite the first wedge to finish the cut (figure 11–78). If the round does not split sufficiently, you can use the maul to knock the wedge free and start the process again.

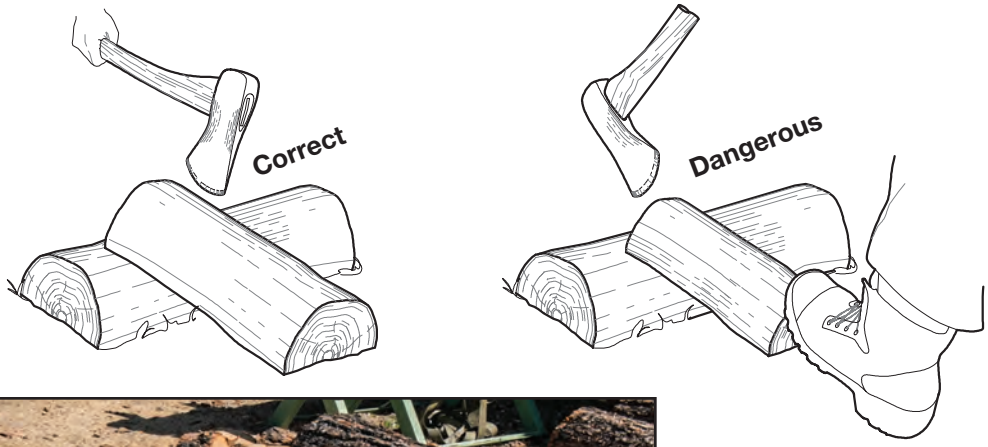
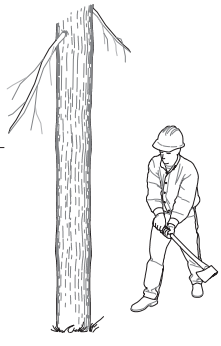


Figure 11–77—An alternative method for chopping a round that does not have flat ends.

Figure 11–78—Striking a wedge with a maul after driving a wedge into the opposite side of the round.



Never drive an ax by striking its poll with another ax or maul. The poll is not hardened and striking it can damage an ax. The poll could mushroom over (see figure 8–19) and consequently alter the shape of the eye. Striking a wedge with a mushroomed poll could cause pieces of the poll to break off and injure you.

Splitting is not just for firewood. You may have a need or an occasion to split a long length of wood into a rail. To do this, you need several wedges and a maul, or a sledge hammer and ax.

Start by taking advantage of natural cracks in the log. Use a sledge hammer or maul to drive a wedge into the end or top of the log to develop a split (figure 11–79). As the split develops, drive another wedge into the split and remove the first wedge (figure 11–80). Traditionally, an axman would use a wooden wedge ("glut") to "chase" the split down the length of the log. You can use either a steel spliting wedge or a glut for this task.

Figure 11–79—Using a sledge hammer and wedge to split a rail from a log.

Figure 11–80—As the split in figure 11–79 develops, drive another wedge into the split.

Repeat the process, alternating the wedges down the length of the log until the log splits (figure 11–81). As the split develops, it may move to a different grain. Use an ax to cut across the grain and get the split back in line with your intended cut. You can also perform this method by alternating two axes down the length of the log instead of using wedges. Using an ax requires more finesse and skill to maneuver the cuts accurately while not striking the other ax or its handle. With a little practice, you can use this method to split your own rails. Figure 11–82 shows hand-split Ponderosa pine rails. You can split other types of wood, such as cedar, more easily and cleanly.

Figure 11–81—Continue to drive wedges down the length of the log until the log splits.

Figure 11–82—Hand-split rails.

Removing Bark With an Ax

The best time to remove or peel bark with an ax is in the spring, when sap is flowing. When sap flows through the cambium layer that lies just beneath the bark of a tree, it is easy to remove the bark with a sharp ax. Other tools, such as a bark spud or draw knife (figures 11–83 and 11–84), can make the job easier, but an ax works well if these tools are not available.

Figure 11–83—A bark spud with a spur.

Figure 11–84—A draw knife.

Be cautious when peeling bark; you are not chopping to sever wood fibers, but are instead using the blade of the ax to lift the bark off the log. Traditional chopping methods cut too deep. Use a much shallower angle to remove bark (figure 11–85). Because of the shallow angle and because the ax does not sink into the log, there is a much greater risk of a glancing or scooping blow. Shave the bark rather than chopping it. If you do chop, choke up on the ax handle to make short, controlled chops.

The thickness of the bark and the flow of sap are key components in safely peeling logs. The thicker the bark, the more difficult the task. Rather than chopping, try to get the ax blade under the bark and slide or push to lift and remove the bark. You need to adjust your grip on the ax handle to find the right motion and leverage to remove the bark. You may often find yourself holding the ax head with one hand and the handle with the other, while using the blade like a drawknife or wood plane.

Even if the sap is not flowing, you may still be able to remove bark easily from green trees. Dry wood with tight bark can be difficult to peel on some tree species and easier on others. The wood shrinks as it dries and the bark pulls away from the wood naturally on some species.

Figure 11–85—Removing bark with an ax blade. Note the shallow angle of the blade in relation to the log.


NO CALKS OR
HOBNAILS

Chapter 12—Maintaining an Ax

If you use an ax properly, maintenance is fairly straightforward and simple. There are only two parts to maintain: the head and handle.

Assuming you have followed this manual's instructions and have properly fitted and tuned the ax to meet your needs, you have invested a considerable amount of time in your ax. Proper maintenance is key to proper performance.

Cleaning and Protecting an Ax

It is a good idea to run a fine whetstone over the cutting edge of your ax at the end of the cutting day (figure 12–1). A few swipes are generally all the cutting edge requires. Most experienced axmen carry a small whetstone to sharpen the cutting edge. If you chop a log, hone the edge as needed.

At the end of the day, clean any dirt or sap off the ax head. Loggers historically used kerosene to remove pitch. Any petroleum-based or citrus-based solvent or cleaner works. If you use a citrus-based cleaner, be sure to remove all residue of the cleaner before storing the ax long term. The acid from citrus-based cleaners can corrode an ax head and cause rust or pitting. If you do not want to use a solvent, you can use a razor scraper, steel wool, or sandpaper. You may only need a rag to clean the ax head if there is no sap to remove (figure 12–2). When working in wet areas, dry off the ax at the end of the day before you put it away.

Figure 12–1—Running a fine whetstone along a cutting edge.

Figure 12–2—Cleaning an ax head with a rag.

After cleaning an ax head, apply a light coat of oil to preserve the head and prevent rust. Petroleum jelly also helps to preserve an ax head and prevent rust, but it is more appropriate for long-term storage. Remember to dispose of oil- or solvent-soaked rags properly. Oil- and solvent-soaked rags thrown in the trash can build up heat and spontaneously combust.

Wax is another popular protectant for an ax head. A fine, paste wax used for furniture, floors, or cars is suitable for ax heads. A combination of linseed oil and beeswax is an old-time method for protecting an ax head.

Inspect the handle for cracks or splitting and replace the handle as needed. A wooden handle shrinks over time, which may cause some minor checking. This should not prevent you from using the ax, but watch checks if they continue to grow (figure 12–3) and replace badly damaged or cracked handles; they are dangerous. Hot, dry climates cause the wood to shrink more. Linseed oil helps prevent the handle from drying out. Use raw or boiled linseed oil to keep the ax handle well oiled. Some people drill a small-diameter hole several inches into the knob of the handle and fill the hole with linseed oil (figure 12–4). The author does not use this method, but some of his peers

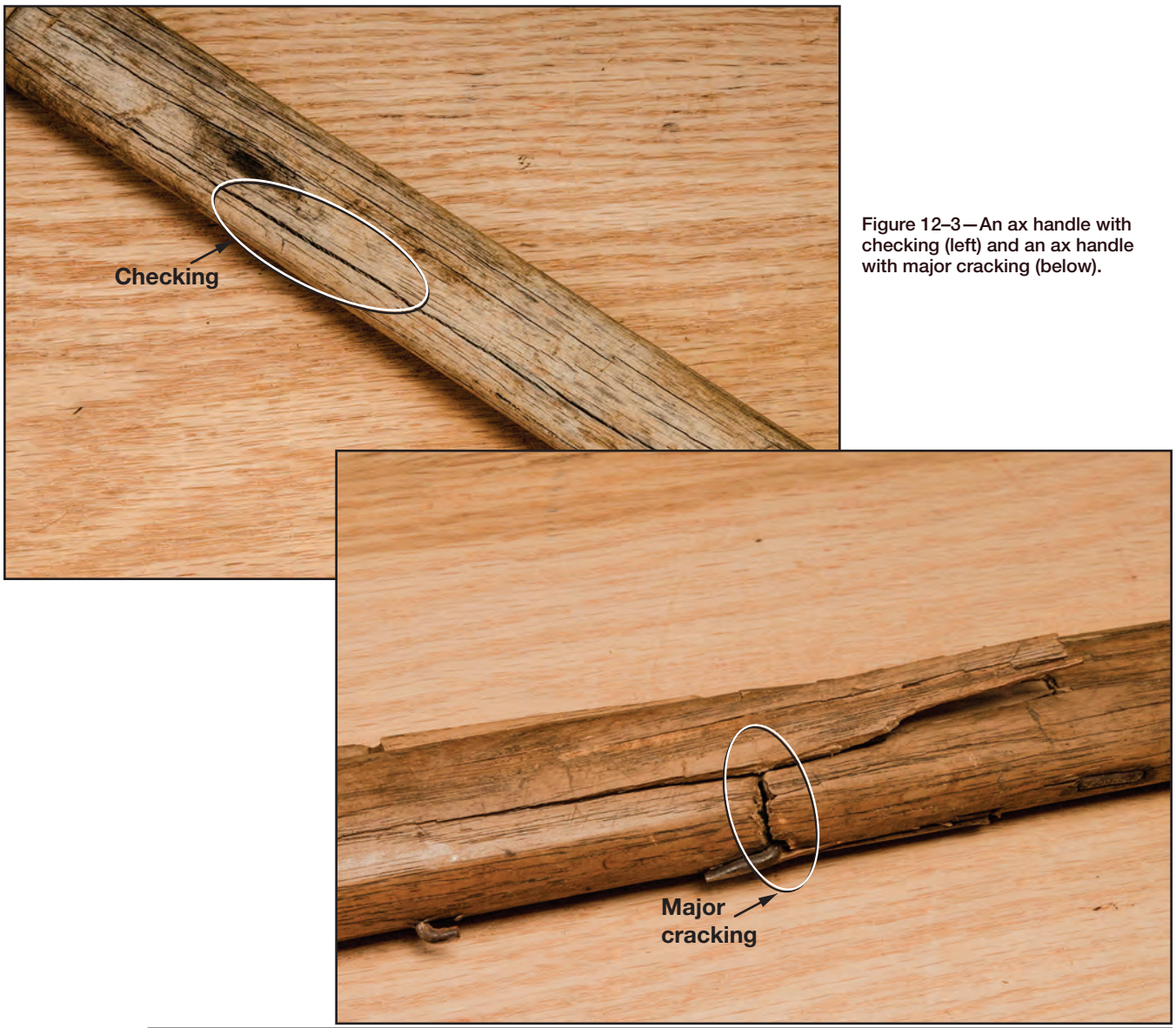


Figure 12–3—An ax handle with checking (left) and an ax handle with major cracking (below).

do. The handle eventually absorbs the oil. Use a short wood screw or wooden plug to cap the hole.

Sand an ax handle with fine grit sandpaper or steel wool as needed. Keeping the belly and back portions of a handle smooth helps prevent splinters or blisters on your hands. A smooth handle also helps to keep your ax stroke smooth because the handle glides more easily through your hands. You can leave the throat rougher where your fixed hand rests to help prevent the ax from sliding out of your hands (figure 12–5).

Figure 12–4—Drilling a small hole into the knob of an ax handle and filling the hole with linseed oil enables the handle to absorb the oil over time.

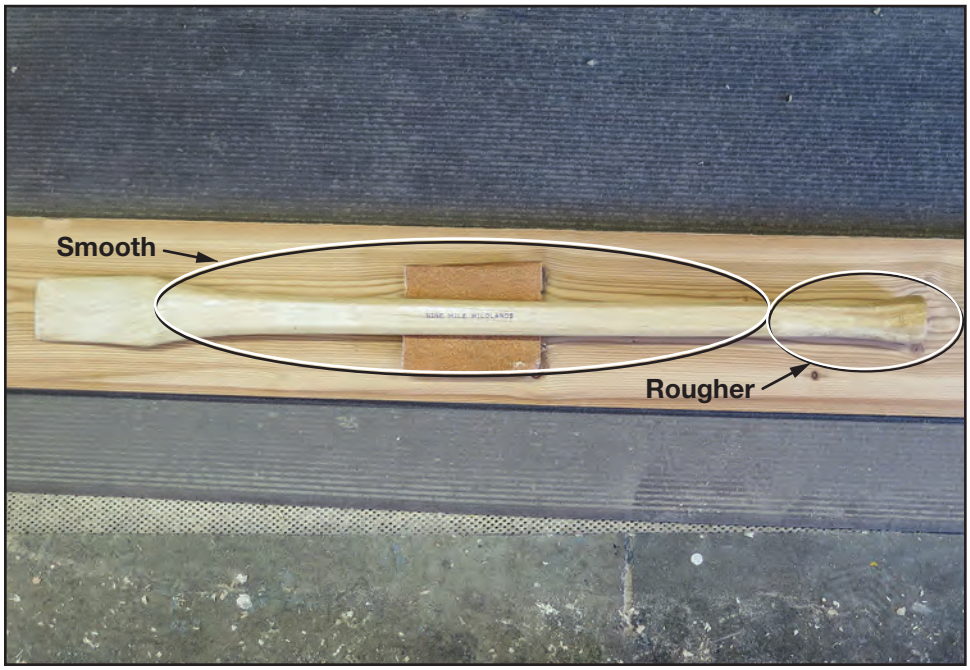
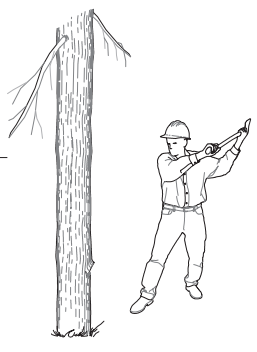


Figure 12–5—Smooth the belly, back, and sides of an ax handle and leave the grip and knob rougher.



Ensure that the ax head and handle are tight. If the head becomes loose, you may be tempted to soak the ax in water to make the handle swell. This temporary fix is ill advised. As the wood inside the eye of the ax head swells, the head constricts the handle, crushing wood fibers that never fully recover. After the handle dries out, the head will be looser than when you started.

The best option for fixing a loose head is resetting the wedge by giving it a few taps with a mallet, or you may have to remove it and replace it with a thicker wedge (figure 12–6). Keep in mind that metal wedges crush fibers and do not expand or contract with the handle, so you should always use wooden wedges. For safety, pin the ax head all the way through the ax handle (figure 12–7).

Figure 12–6—Using a new, thick wooden wedge and a mallet to tighten a loose ax head.

Figure 12–7—An ax head pinned to a handle.

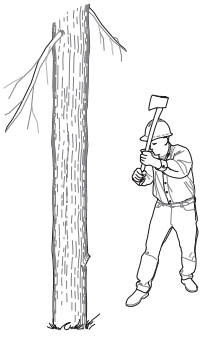
Storing an Ax

Store an ax in a dry (but not arid) environment. A garage, shop, basement, or closet is a suitable place for an ax. If possible, use pegs or hooks to hang the ax so that it hangs straight (figure 12–8). Store axes so that air circulates around the entire tool.

Leaning an ax against a wall may be acceptable for a short time, but is not appropriate for long-term storage. An ax handle leaning against a wall for extended periods can potentially bend due to fluctuations in humidity. If you must lean an ax against a wall for a short period, you should lean it as close to a 90-degree angle as possible (figure 12–9).

Figure 12–8—Axes hung on pegs.

Figure 12–9—Axes leaning against a wall at roughly a 90-degree angle (left) and an ax leaning against a wall at too great an angle (right).



Ideally, you should store an ax in the same environmental conditions in which you use it (e.g., an unheated garage). Some people use ax boxes (figure 12–10) for long-term storage in dry environments. A closed box in a wet environment may retain moisture, requiring a desiccant (moisture-absorbing pack). This may not be the best option in wet or humid areas, which can cause the head to rust. Storing an ax indoors next to a woodstove may be the best option for an ax head, but could cause the handle to dry out and shrink.

Use an ax box or other secure method when transporting axes to the field. In case of an accident or sudden stop, you do not want unsecured axes flying around or out the back of the vehicle. If you do not have an ax box, find another method to safely store or secure the ax for transportation. Also, make sure the ax has a sheath. Keep the sheath on the ax until you get to the worksite.

"Appendix B—Technical Drawings" provides drawings for a number of different sheaths.

Figure 12–10—Axes in an ax box.

Chapter 13—Purchasing an Ax

Buying a New Ax

As noted earlier, finding new, high-quality axes in a typical retail store is becoming increasingly difficult. Manufacturers still make good axes, but not in the same quantity or variety of patterns as in the past. Some small companies manufacture high-quality axes that are not available through large retail stores. You may need to contact these companies directly to purchase an ax or find a distributor. The "Additional Resources" section provides contact information for some ax distributors.

Be aware that internet sites change often and new products come on the market constantly. Do your research well and understand that not all axes are designed for working in the woods. Furthermore, ax quality varies. The time, energy, and expense required to purchase a good quality ax and customize it to fit your body and chopping needs is a sizable investment. Be sure you get the tool you need.

Buying a Used Ax

At one time, manufacturers in America made more than 300 different ax patterns. However, the market for axes today is limited, so the choice of ax heads is also limited. In addition, many ax manufacturers today use inferior metals compared to the metals used in vintage axes. Many people prefer a vintage ax because of the quality and style.

When purchasing a used ax, examine it carefully to ensure that it is suitable and worth the time and energy to restore. You may be able to purchase used axes at very reasonable prices, but you may have to invest a lot of time to get them back in good cutting condition. Most used axes contain dirt, rust, and grime, but this is no reason to reject them. You can easily remedy these conditions with a simple cleaning.

The telltale sign to look for in an ax is its overall shape. Is it symmetrical or does it show signs of excessive wear or abuse? Examine the heel and toe of the cutting edge. Have multiple filings rounded them excessively? Many used axes have toes that are overfiled (figure 13–1), putting the toe out of

Figure 13–1—Two double-bit ax heads. The toe of the ax head on top has been filed out of alignment with the heel.

alignment with the heel. In this case, you would need to reshape the head to bring the cutting edge back into balance. However, you might have to file so far back into the head that you lose the tempered edge. Filing this far back into the blade can also affect the balance of the ax.

Examine the cutting edge for chips (figure 13–2). Minor chipping on an ax head is generally not a significant problem if you still have ample hardened steel to work with. Large chips may require you to reprofile the entire cutting edge to return the ax head to its proper shape and balance.

Figure 13–2—A minor chip in an ax head (left) and a major chip in an ax head (below).

Look for the temper line in the ax head to determine how much life the ax has left (figure 13–3). The temper line (also known as the hamon line) represents the transition between the hardened cutting edge and the untempered portion of the ax. The temper line should be at least a couple of inches back from the cutting edge. The working edge of the ax must contain enough solid, tempered metal to perform as a good work ax. If previous users sharpened the ax too many times and the cutting edge is short, it may not have enough tempered metal left to make a good chopping ax after you sharpen or reshape it (figure 13–4).

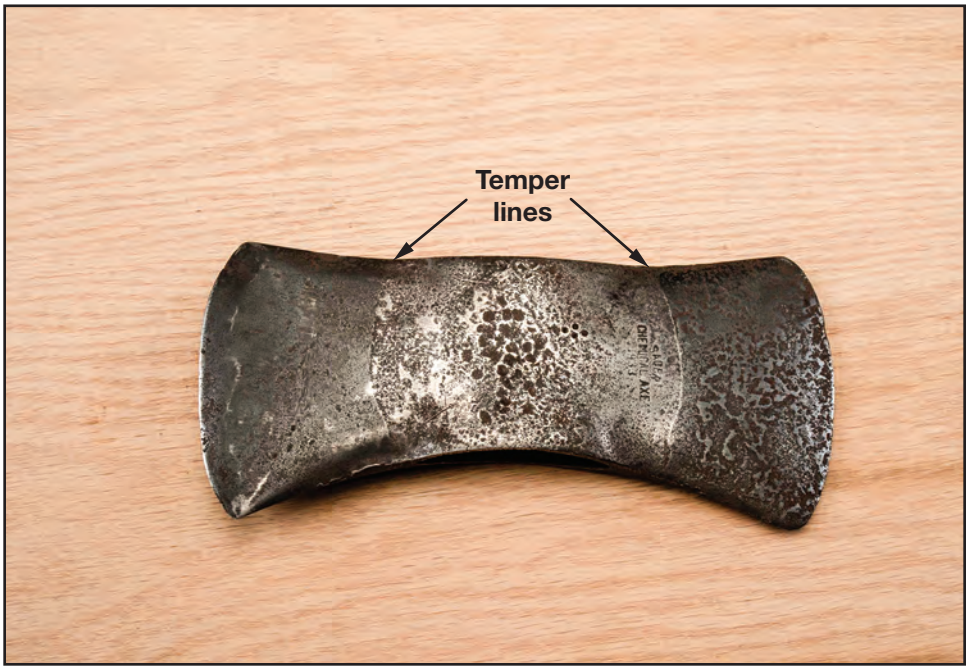
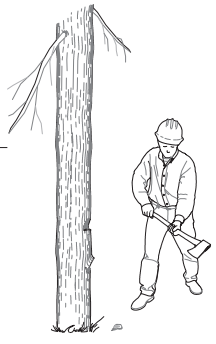


Figure 13–3—Temper lines on a 1933 Sager Chemical double-bit ax head. Note the pitting in the softer metal at the center of the head. Despite the pitting, this ax has ample hardened steel on both cutting edges and can be restored to a good working ax.

Figure 13–4—A Hubbard Lipincott double-bit ax head that has been filed past its temper line on both cutting edges. This head cannot be restored.



Examine the poll, if you are considering purchasing a used single-bit ax. If the poll is rounded or mushroomed, someone probably used the ax to drive steel wedges. You must grind a mushroomed poll back into shape. Remember, the poll provides weight and balance to the ax, so removing the mushroomed metal from the poll could change the balance of the ax, making work on the cutting edge necessary as well. Excessive mushrooming on the poll is dangerous. Never drive a wedge or other object with a poll that folds over (figure 13–5). As the poll mushrooms, the edges become thin and could break off when struck, potentially injuring you. If you grind the mushroomed edge off the poll, carefully examine for cracks afterward. Any cracks in an ax head are dangerous and indicate areas of structural failure.

Examine the eye of the ax, especially if the poll is rounded or mushroomed. If the eye is misshapen (figure 13–6) or shows signs of bulging on its cheeks or lugs, the handle will not fit properly. This is a common problem on single-bit axes when someone has used the poll to drive hard objects. Poll damage on a single-bit ax usually occurs because the poll is not hardened steel.

Figure 13–5—A mushroomed poll. Note the large chip broken off the poll.

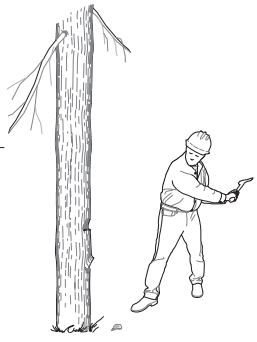
Figure 13–6—A properly shaped ax head eye (left) beside a misshapen ax head eye (right).

Examine the sides (also known as the cheeks or face) of a double-bit ax head. Because a double-bit ax has no poll, someone may have used the sides of the ax to drive or pound objects. Similar to the poll of a single-bit ax, the sides of a double-bit ax are not hardened steel and can easily be damaged. If the cheek of an ax shows signs of excessive pounding or damage, the shape of the eye may have changed. Rather than the bulging eye of a single-bit ax, the sides of the eye on a double-bit ax could be caved in. A caved-in eye (figure 13–7) could make the ax handle harder to fit. In addition, many manufacturers place their mark or logo on the sides of their axes. If you are a collector, the damaged mark could reduce the value of the ax.

Check the top and the bottom of the eye to ensure that no one has distorted the opening (figure 13–8). This typically occurs when someone tries to seat or remove the ax head on the handle with a hammer. If the distortion is not extensive, you may be able to correct it by filing it.

Figure 13–7—The eye of this Marshall Wells double-bit ax has caved-in sides.

Figure 13–8—Distortion around the bottom of an L&IJ White broad hatchet head eye. This kind of damage usually occurs when someone tries to remove a handle using a hammer.



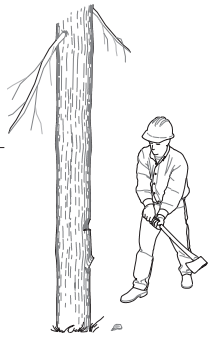
Cracks in the metal are defects that are often hard to spot, especially on a dirty or rusty ax head, but identifying them is critical. Carefully inspect the ax head for hairline cracks (figure 13–9). You may be able to weld a crack, but it may not be worth the effort. Examine the entire ax head closely, especially where you see other signs of damage or abuse. Cracks often appear in the thinnest parts of the ax head, such as the cheeks, or at high-stress points, such as the points of the eye on both single- and double-bit axes. Carefully search for cracks around the eye, the poll, and the cutting edge. Cracks can be difficult to detect, but they can have serious consequences if the ax head breaks while you chop.

Figure 13–9—A hairline crack in an ax head.

Surface rust is not a great concern, but be wary of axes with heavy pitting (figure 13–10). Pitting is typically more pronounced on the sides or cheeks of an ax where the metal is softer. Pitting on the cheeks of an ax is mostly superficial, but can contribute to friction while chopping. You can mitigate friction caused by pitting by filing flat over the pits to eliminate the high points and rough edges.

Pitting on the cutting edge poses a bigger problem. You may be able to file out pitting on a cutting edge while you sharpen the ax, as long as the pitting is not deep or excessive. Deep pitting on the cutting edge causes weak spots where the head could break or chip while you chop. You may have to reshape the entire ax head to get down to clean metal. An ax with excessive pitting may not contain enough good metal to restore.

Figure 13–10—Rust and pitting on an ax head. This ax head is not worth restoring.



Restoring a Vintage Ax Head

This manual covers shaping, profiling, and sharpening an ax head. These activities comprise the majority of work required to restore an ax head, but cleaning the head and correcting some common problems are also important. The common problems covered in this section are ones that an average person should be able to correct without specialized tools. This section does not cover serious structural problems (i.e., problems that require welding or other types of specialized equipment or skills). If an ax head is cracked or otherwise seriously damaged, the author recommends discarding it if you do not have the skills necessary to fix it safely and correctly.

Cleaning is the first step in restoring a vintage ax head. Be cautious about using powertools when cleaning or restoring an ax head. An electric grinder or power sander can quickly clean and reshape the head, but can also build up excessive heat and change the temper (remember, never contact the cutting edge with a powertool). The author prefers to begin cleaning with a razor blade scraper to remove loose dirt, grime, and surface rust (figure 13–11).

If the rust is not extensive, the second step is to use medium- or fine-grit sandpaper and a palm or finishing sander to sand the head. The grit you use depends on the condition of the head. The author typically starts with quality 100-grit sandpaper and finishes with 220-grit sandpaper. A sanding pad is also appropriate (figure 13–12). Depending on the ax head and the desired finish, the author may use a higher grit wet or dry sandpaper. Moving a palm sander continuously across an ax head does not build up excessive heat and produces a smooth finish for shaping and filing. You can use varying grades of steel wool or a wire brush or wheel in place of sandpaper. A brass wire wheel cleans well and scratches less than a steel wire wheel.

If 100-grit sandpaper and a palm sander are not coarse enough to remove the rust on the ax head, you may have to explore other methods. Disc and belt sanders provide power, but also generate more heat than a palm sander. Be careful when using powertools not to remove identifying manufacturer's marks on the ax head if they are important to you.

Figure 13–11—Using a razor blade scraper to remove rust from an ax head.

Figure 13–12—Using a sanding pad to sand an ax head.

Soaking an ax head in white vinegar is a low-cost method for removing rust. Find a pan or other similar container that fits the ax head and fill the pan with enough white vinegar to cover the head (figure 13–13). Soak the ax head until the rust dissolves. Check the head once or twice a day to monitor how much rust has dissolved. Depending on its condition, an ax head may have to soak for several days (or longer). Use a wire brush or steel wool to remove rust from the pitted surface after you remove the ax head from the vinegar. If the white vinegar does not completely clean the ax head, scrape or sand the head with appropriate grit sandpaper to remove any residual rust.

Figure 13–13—Soaking an ax head in white vinegar to remove the rust.

Wash and dry the ax head after you remove it from the white vinegar, then apply a light coat of oil (figure 13–14). The acid from the white vinegar removes any finish on the ax head and the bare metal can rust quickly when it is exposed to the air if you do not apply oil.

A word of caution: these cleaning methods are for a working ax. They might be too harsh if your ax is a collector's item, or if you wish to preserve the patina on the ax head.

Many people discard vintage ax heads because the eye is crushed or so deformed that it does not properly fit a handle. If you have access to a press, you may be able to salvage the head using a drift pin. Align the drift pin on the damaged eye and use the press to push the drift pin down through the eye. Because the cheeks of an ax are not hardened metal, a properly sized drift pin reshapes the eye as it pushes through (figure 13–15). If you do not have a press, use the jig you used to remove the handle. In some cases, an ax blade that is out of alignment could be the result of a misshapen eye. Reshaping the eye (also called redrifting) may help to realign the blade.

Vinegaroon and Rustaroon

Vinegaroon is a solution of vinegar and rust particles/steel filings. Applied to wood, the solution interacts chemically with lignin, turning the lignin black or dark gray, while the rust finds its way into the pores of the wood, turning the wood brown. Similarly, vinegaroon interacts chemically with tannin in leather, turning the tannin black. Alternatively, mixing linseed oil with rust particles/steel filings creates rustaroon, which primarily stains the lignin in wood and produces a lighter-colored result than vinegaroon.

Figure 13–14—Applying a light coat of oil to an ax head.

Figure 3–15—Using a drift pin to reshape an ax head eye.

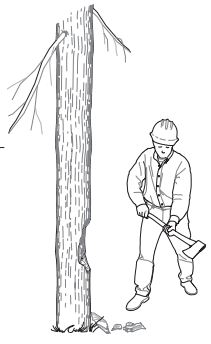
You can also reshape a mushroomed poll. You will likely use the poll to drive a wedge at some point. Always keep in mind that the mushroomed or fractured edge of a poll can break off and injure you—removing the mushrooming around the poll is a matter of safety. You can correct minor mushrooming with a file, but you may have to use a disk sander to correct major mushrooming (figure 13–16). Always remember to wear safety glasses. Secure the ax head in a vise to keep it stable when filing, but do not tighten the vise too much or you could damage the eye. If you have to grind the head to remove excessive mushrooming from the poll, be careful not to remove too much metal; you could affect the weight and balance of the ax. Remember that powertools can build up excessive heat and draw the temper out of the ax. Most ax polls are not tempered, but some, such as the poll of a rafting pattern ax, are.

Figure 13–16—The photo above shows major mushrooming on a poll. The top photo on the following page shows someone grinding down the poll using a disc sander. The bottom photo on the following page shows the reshaped (reprofiled) poll.

Mushrooming on the top or bottom of an ax head eye also commonly occurs when people try to seat or unseat the head. This mushrooming prevents the handle from fitting the eye properly. If the mushrooming is not too severe, secure the ax head in a vise and remove the excess metal with a file (figure 13–17).

After you correct any defects and clean the ax head, use the steps outlined in "Chapter 7—Files and Filing Basics" and "Chapter 8—Sharpening and Shaping an Ax Head" to shape and file it.

Figure 13–17—Filing off minor mushrooming on the inside of an ax head eye. Note that a flat file works best on the sides of the eye (right) and a round file works best on the rounded ends (below).



Collectable Vintage Axes

The ax is such an integral part of human heritage that people historically regarded it as one of their most prized possessions. Because of the importance of the ax, some manufacturers embossed or etched their products with identifying marks or designs. Many of these axes are now collectables. Collecting vintage axes is popular, especially collecting axes that display a manufacturer's artwork.

Some ax manufacturers displayed their own artwork on their axes, such as the Kelly Black Raven axes shown in figure 13–18 and the W.C. Kelly Perfect ax shown in figure 13–19. Other manufacturers produced axes with artwork specifically for a distributor, such as the Pioneer ax shown in figure 13–20 and the Johnston's Winner ax shown in figure 13–21. Manufacturers commonly made axes for specific hardware stores or similar companies that sold axes. These examples not only indicate the manufacturer's pride of workmanship, but also the axman's pride of ownership.

Figure 13–18—Vintage Kelly Black Raven double-bit axes. *—Photo by Paul Hillmer; courtesy of Greg Strayer*

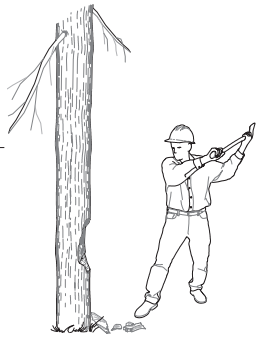
Figure 13–19—The front of a W.C. Kelly Perfect ax (left) and the back of the same ax (right). Note the story of the ax and its manufacturer are printed on the back. An advertisement from the Sears Roebuck & Co.,1897 catalog for the W.C. Kelly Perfect ax (below).
—Photo by Paul Hillmer; courtesy of Greg Strayer

Axes.

We offer you a line of Axes which are acknowledged by all to be the standard of the world. We know there is no better made.

No. 12685. The Kelly Axe. It's the shape and good cutting qualities which have made this one of the most popular axes in the market. It is made of the finest steel, hand-hammered, tempered, and tested before leaving the factory. The blade is so shaped it will cut deepest but will not bind in the timber. It will burst the chip, and will not become stubbed after grinding. It has a taper eye which binds the handle. We have them in all weights, from 3 to 5 lbs.

Price, each.....48c
Doz.....$5.62



Remember that the information in this manual covers sharpening, profiling, and restoring **working** axes. Restoring collectable or valuable axes using these methods would ruin the patina and lower the value and the collectability of an ax.

Figure 13–20—A vintage Pioneer ax. *—Photo by Paul Hillmer; courtesy of Greg Strayer*

Figure 13–21—A vintage Johnston's Winner ax. *—Photo by Paul Hillmer; courtesy of Greg Strayer*

Chapter 14—Conclusion

The ax is one of the fundamental tools that led to the development of the modern world. As society moves forward at an ever increasing rate, we move further and further away from the traditional skills and tools that helped to build this country.

The Forest Service, other land management agencies, and society as a whole still have a place for traditional skills (figure 14–1); they are not just the working skills that built the country, they are a link to our heritage and to the foundation of who we are as a people. Our ancestors did not lead the glamorous, romantic lives that history sometimes portrays. The work they performed was hard and often dangerous. Those today who choose to learn and master traditional skills help to preserve this heritage for future generations.

As you learn to properly use an ax, a crosscut saw, or any other traditional tool, you learn more than just how to use the tool; you also learn how to think analytically and to solve problems. While the benefits of modern technology are undeniable, they sometimes insulate us from the need to consider how to do a job safely and efficiently. Because axes and other traditional tools are not mechanized, perhaps the greatest benefit they provide is to force us to stop and think before we act. People historically used traditional skills through necessity, but they consequently developed techniques that maximized efficiency and minimized the energy it took to accomplish a task. By learning traditional skills, we gain a greater understanding of cause and effect. This understanding does not just correspond to the use of a tool, but to other aspects of our day-to-day lives.

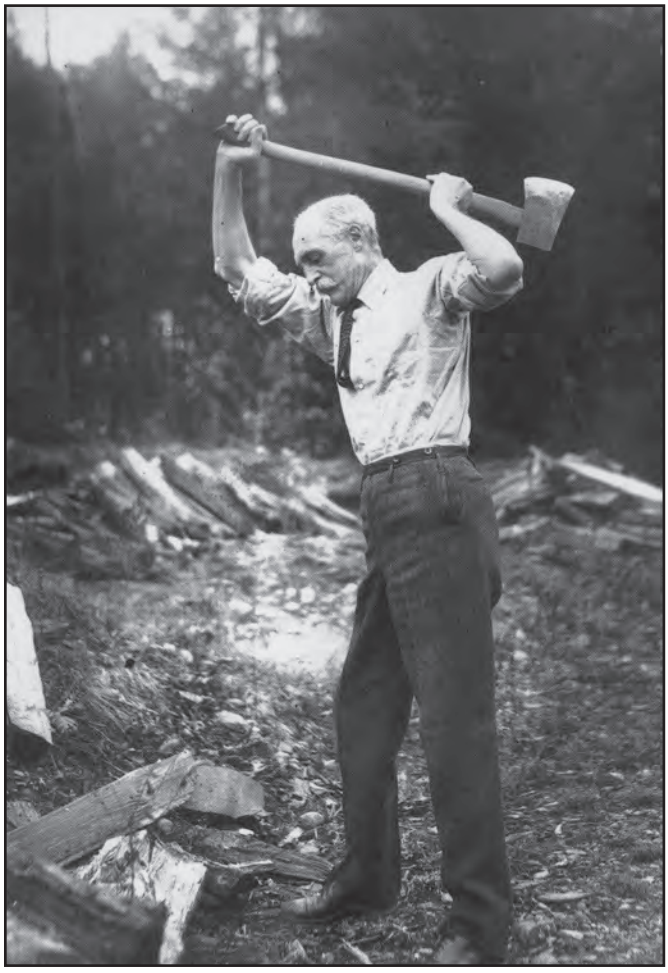


Figure 14–1—Gifford Pinchot, first Chief of the Forest Service, using a single-bit ax —*Courtesy of U.S. Department of Agriculture, Forest Service, Grey Towers National Historic Site*

A sharp, well-balanced ax, crosscut saw, or other traditional tool will do most of the hard work if you simply provide a guiding force. Chopping or sawing can be physically demanding, but it doesn't need to be difficult if you don't force the tool and simply allow yourself to become an extension of it. If you learn to develop a rhythm that enables you to move with the tool, focusing on smooth, fluid movements in conjunction with your breathing, you will find the work more enjoyable and rewarding.

Before enlightenment, chop wood, carry water.
After enlightenment, chop wood, carry water.
—Zen quote

Forest Service Traditional Skills Training

Hopefully this manual will assist you to further your interest and develop your skills in safely using axes and other associated tools. If you wish to learn more about using axes and traditional skills, the Ninemile Wildlands Training Center (figure 14–2) on the Lolo National Forest in Montana offers classes about ax and crosscut saw use. The classes are available to Forest Service employees and the public. The Ninemile Wildlands Training Center website <http://www.fs.usda.gov/detailfull/lolo/home/?cid=STELPRDB5085919> lists class descriptions and schedules.

Figure 14–2—An instructor at the Ninemile Wildlands Training Center presenting a course on ax use.

Glossary

For a more extensive list of terms associated with axes and edged tools, visit Yesteryears Tools "Glossary of Terms," available at <http://www.yesteryearstools.com/Yesteryears%20Tools/Glossary%3A%20Axes,%20Edge%20Tools,%20etc..html>.

b

barber chair—a tree with a heavy lean that splits lengthwise up the stem during felling.

bird's mouth—a large, horizontal "V" cut in the trunk of a tree.

buck—cut a log into sections.

c

calks (also known as caulks, corks, or corked boots)—boots with short metal studs in the soles that provide stability and gripping power, especially in wet conditions or when standing on a log.

cant—slope. Also a log with at least two riven or sawn sides.

cant hook—a traditional logging tool consisting of a wooden handle and a moveable metal hook. Used for handling and turning logs and cants.

checks—natural cracks in wood.

cheeks (or face)—the sides of an ax head.

chop—use an ax against the grain of wood to separate pieces.

d

desiccant—moisture-absorbing pack used for long-term storage of items.

f

file cut—the roughness or fineness of file teeth.

g

glut—traditionally, a wooden wedge used to “chase” a split down the length of a log.

grain side—the smooth side of a leather hide.

grind—the area just behind the cutting edge of an ax head.

h

hamon line—the temper line on an ax head.

heel of an adz—the end opposite the head.

k

keen edge—the sharper edge of a double-bit ax.

knob—the heel of an ax handle.

p

peavey—a wooden-handled steel tool with a sharp point and a hooked arm used to move logs.

pinning—metal shavings that build up and clog the cutting teeth of a file.

poll—the butt end of a single-bit ax head.

push filing—straightforward filing.

r

rasp—a type of file with a series of individual, very coarse teeth.

redrifting—reshaping the eye of an ax head.

runout or cross grain—grain that does not run the full length of an ax handle.

rustaroon—stain made from linseed oil and rust particles/steel filings. Rustaroon primarily stains the lignan in wood, resulting in a lighter color than vinegaroon.

S

shoulder—the portion of an ax handle where it flares to fill the eye of an ax head.

sound a tree—check to ensure a tree is sound by thumping it with the poll of an ax.

split wood—using a maul (or sometimes an ax) and wedge to separate pieces of wood along the grain.

spring poles—bent branches or small saplings held in place by a downed log.

stagged off jeans—jeans with the hem removed.

straightforward filing—push filing.

stunt edge—the thicker edge of a double-bit ax.

suede side—the flesh side of a leather hide.

swarf—particles of metal released through the stoning process.

T

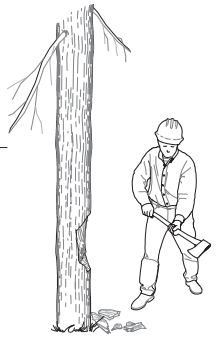
tempered edge—the hardened edge(s) of a single- or double-bit ax.

V

vinegaroon—a solution made from vinegar and rust particles/steel filings. The solution interacts chemically with lignan while the rust finds its way into the pores of the wood, turning the wood brown.

W

wedge kerf—the slot at the top of an ax handle.



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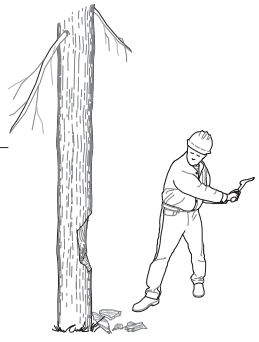

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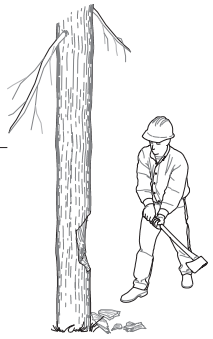

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Available at <https://www.fs.fed.us/t-d/php/library_card.php?p_num=0667%202C01>.

Wolf, J.; Whitlock, C. 2006. Chain saw and crosscut saw training course, student's guidebook. Report. 0667–2805–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 106 p.
Available at <https://www.fs.fed.us/t-d/php/library_card.php?p_num=0667%202805>.

y

Yesteryears Tools. 2018. Glossary of terms.
Available at <http://www.yesteryearstools.com/Yesteryears%20Tools/Glossary%3A%20Axes,%20Edge%20Tools,%20etc..html>.

Additional Resources

General Information

Abraham Lincoln Presidential Library and Museum
https://www2.illinois.gov/alplm/pages/default.aspx

The-Axe-Hole
http://theaxehole.com/

Early American Industries Association
http://www.earlyamericanindustries.org/

Forest Service Smokejumpers
https://www.fs.fed.us/science-technology/fire/smokejumpers

National Museum of Forest Service History
http://www.forestservicemuseum.org/

National Smokejumper Association
http://smokejumpers.com/index.php

Ninemile Wildlands Training Center
http://www.fs.usda.gov/detailfull/lolo/home/?cid=STELPRDB5085919

Smithsonian Institute, National Museum of American History
http://americanhistory.si.edu/

Stihl Timber Sports
http://www.stihlusa.com/stihl-timbersports/

Tuatahi Racing Axes and Saws
http://www.tuatahiaxes.com/

University of Montana: The Crosscut Sawyer training course
https://www.campusce.net/umextended/course/course.aspx?c=335

University of Washington Libraries Digital Collections: Kinsey Collection
http://content.lib.washington.edu/clarkkinseyweb/index.html

Yesteryears Tools
http://www.yesteryearstools.com/Yesteryears%20Tools/Home.html

Ax Handle Manufacturers and Suppliers

Beaver-Tooth Handle Company
http://beaver-tooth.com/

House Handle Company
https://www.househandle.com/

Omaha Knife
https://omahaknife.com/12-axes

Seymour Midwest
https://www.seymourmidwest.com/

Tennessee Hickory Products
http://www.tennesseehickoryproducts.com/

Ax Manufacturers and Suppliers

American Ax Manufacturers

Council Tool
http://counciltool.com/

Whiskey River Art and Trading
https://whiskeyrivertrading.com/

Foreign Ax Manufacturers

Australia

Keech (distributed by Carson Bosworth—email only)
carsonbosworth@yahoo.com

Snedden's Fencing Products
http://www.ruralfencing.com/

Canada

Magard Ventures, Ltd. (distributors of Arvika and Oxhead axes)
http://www.logbuildingtools.ca/contact.html

Germany

Helko North America
http://www.helkonorthamerica.com/

Ox-head Ax Company (distributed by Carson Bosworth—email only)
carsonbosworth@yahoo.com

New Zealand

Tuatahi Racing Axes and Saws
https://www.tuatahiaxes.com/

Sweden

Gransfors Bruk
http://www.gransforsbruk.com/en/

Wetterlings Axes
http://www.wetterlings.se/the/index.php?option=com_content&view=article&id=88&Itemid=57

Vintage Ax Restorer

Northwest Axe Company
https://www.nwaxeco.com/pages/about-us

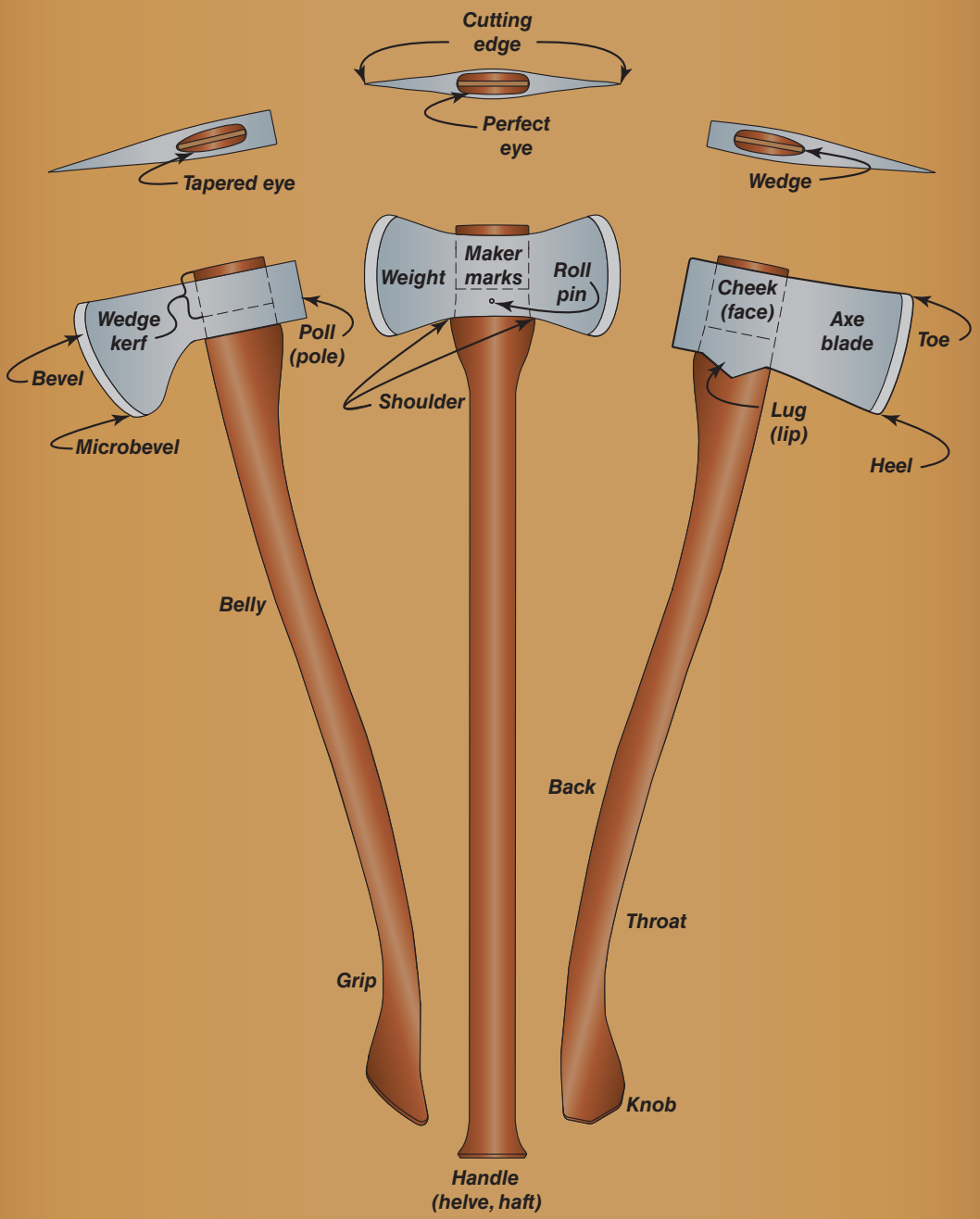
Wedge Manufacturer

Grandview Aluminum Products, Inc.
http://www.gapalum.com/chainsawwedges.html

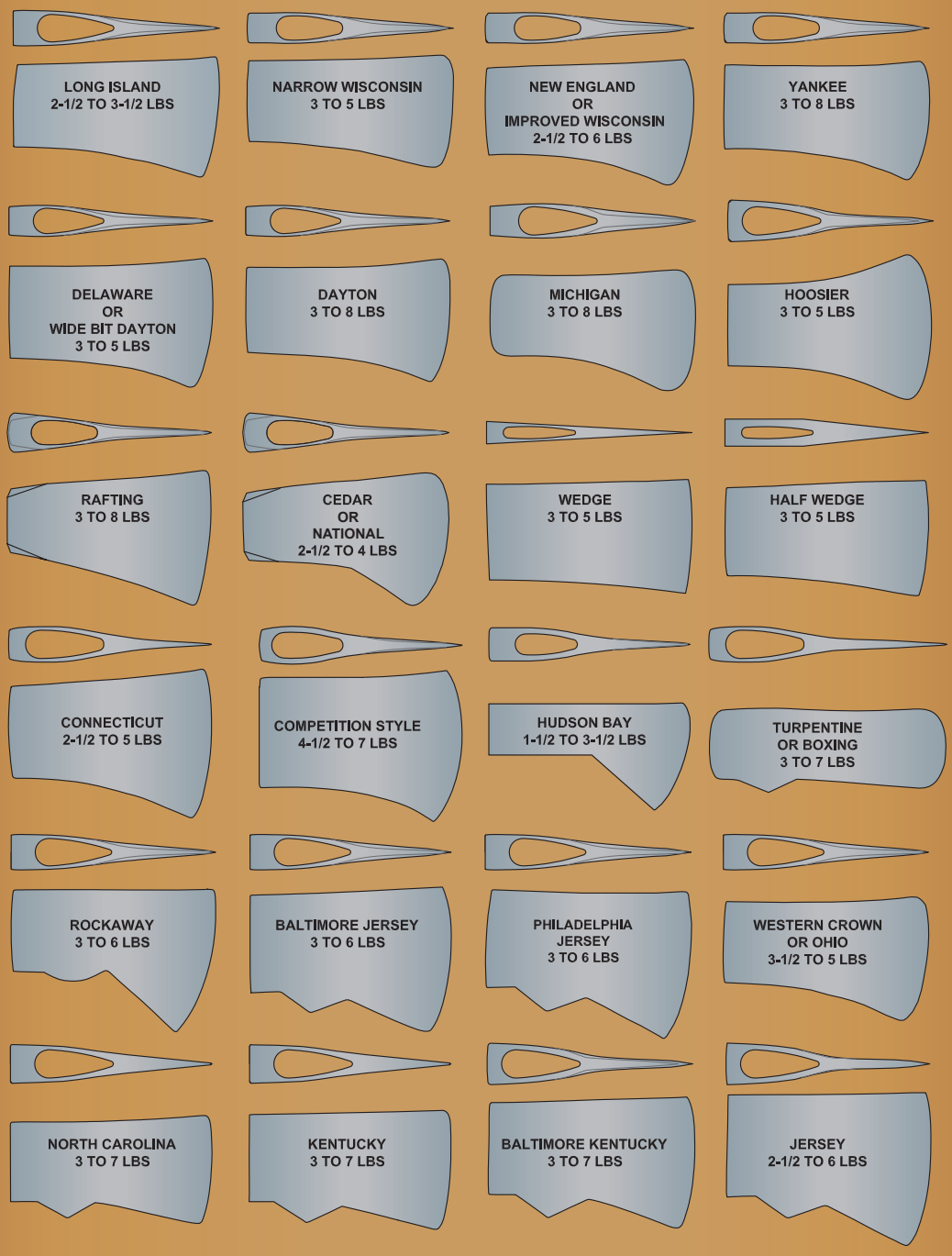
Appendix A—Full Page Ax Illustrations

Order full-size copies of the illustrations included in this appendix by emailing the National Technology and Development Program at wo_mtdc_pubs@fs.fed.us or by calling 406–329–3978.

Parts of an Axe

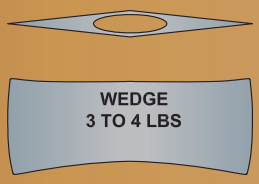


Common Single-Bit Axe Head Patterns

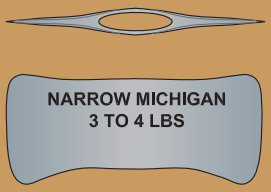


Produced by: U.S. Department of Agriculture • Forest Service • National Technology and Development Program • Missoula, MT • 1623–2M04–MTDC

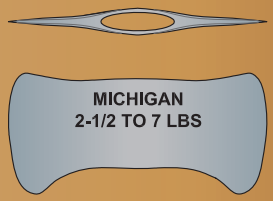
Common Double-Bit Axe Head Patterns



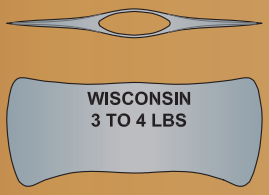
WEDGE
3 TO 4 LBS



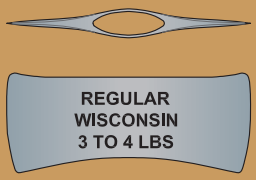
NARROW MICHIGAN
3 TO 4 LBS



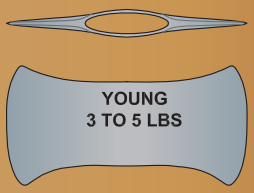
MICHIGAN
2-1/2 TO 7 LBS



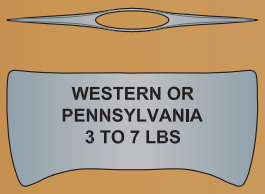
WISCONSIN
3 TO 4 LBS



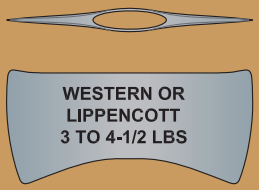
REGULAR
WISCONSIN
3 TO 4 LBS



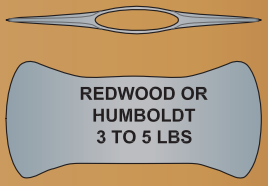
YOUNG
3 TO 5 LBS



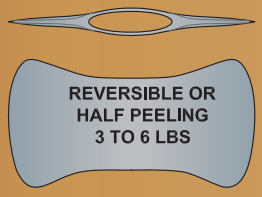
WESTERN OR
PENNSYLVANIA
3 TO 7 LBS



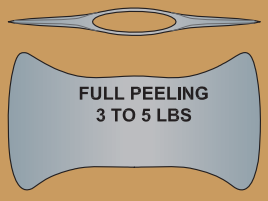
WESTERN OR
LIPPENCOTT
3 TO 4-1/2 LBS



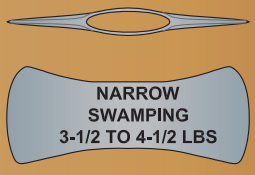
REDWOOD OR
HUMBOLDT
3 TO 5 LBS



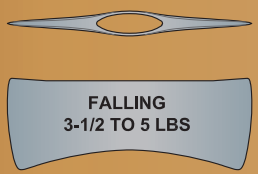
REVERSIBLE OR
HALF PEELING
3 TO 6 LBS



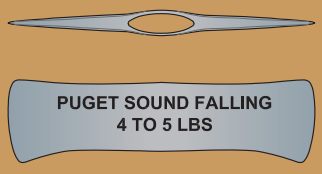
FULL PEELING
3 TO 5 LBS



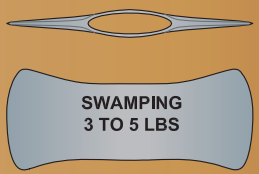
NARROW
SWAMPING
3-1/2 TO 4-1/2 LBS



FALLING
3-1/2 TO 5 LBS



PUGET SOUND FALLING
4 TO 5 LBS



SWAMPING
3 TO 5 LBS

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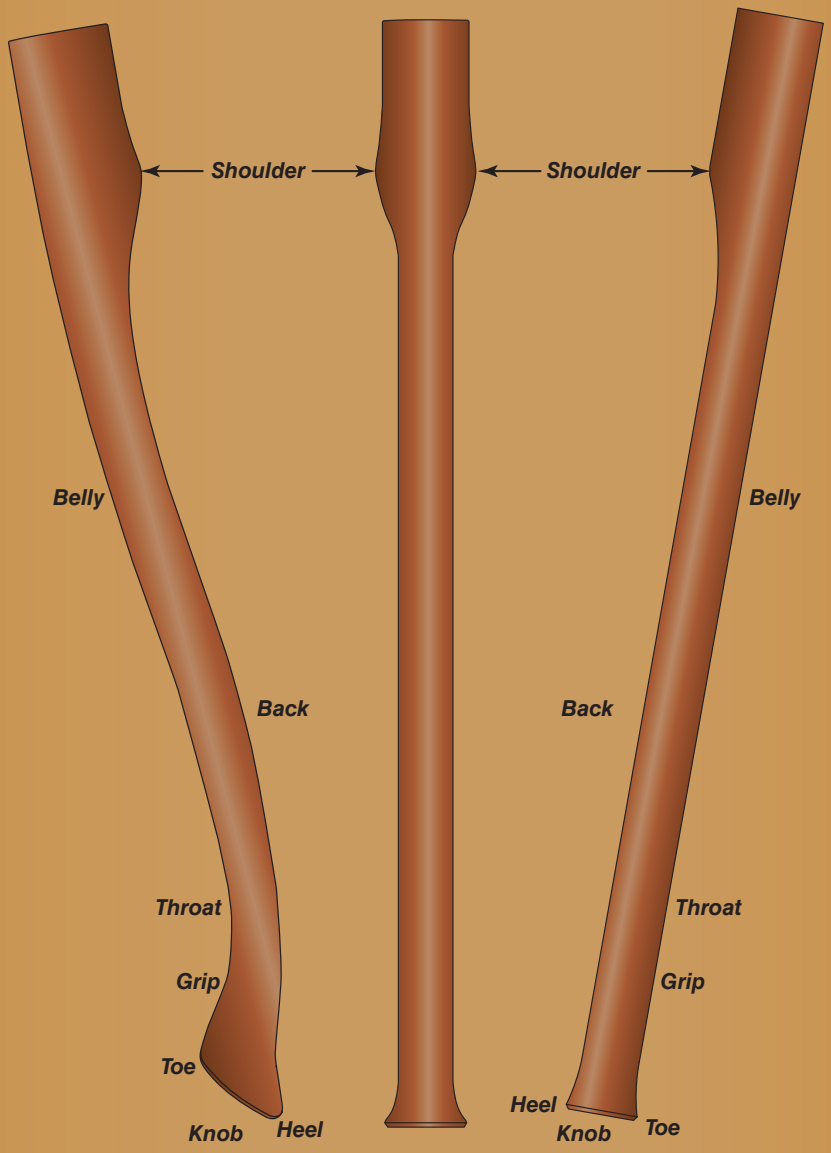
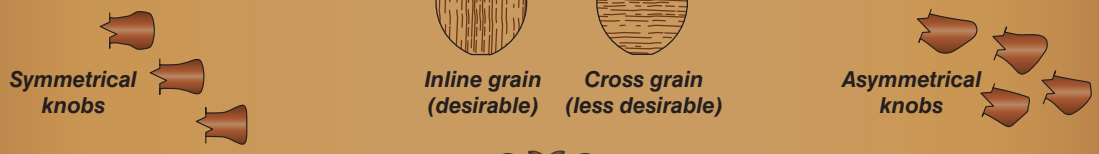
Axe Handles





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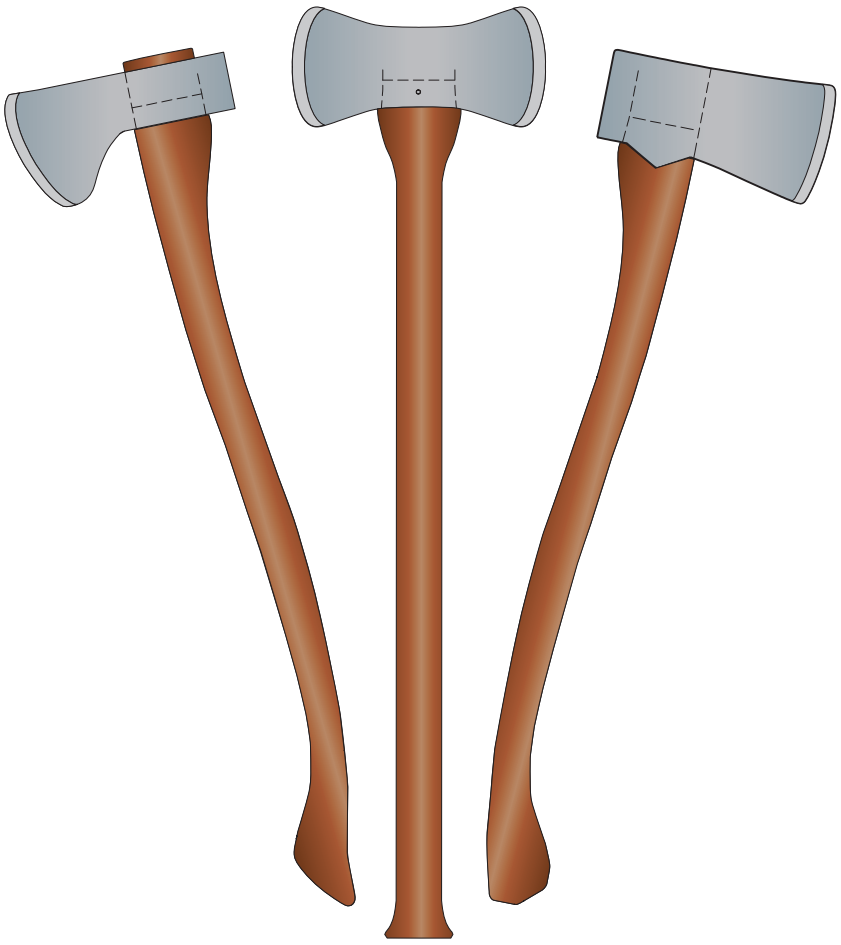
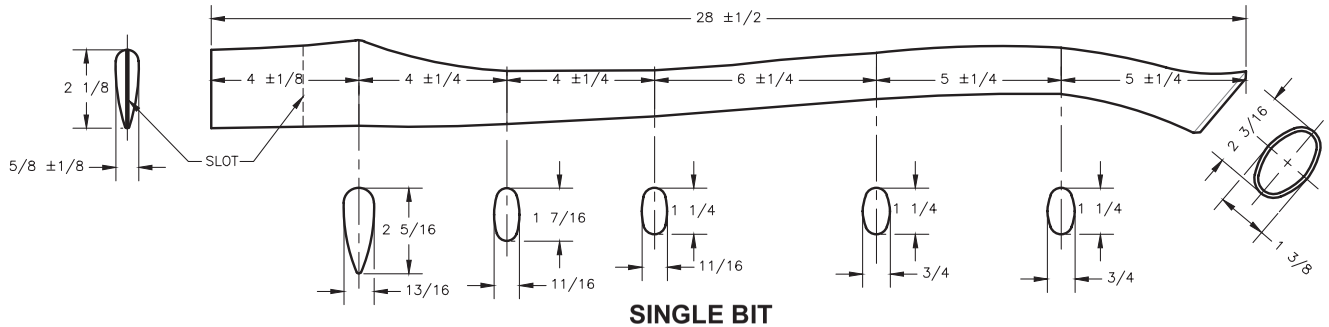


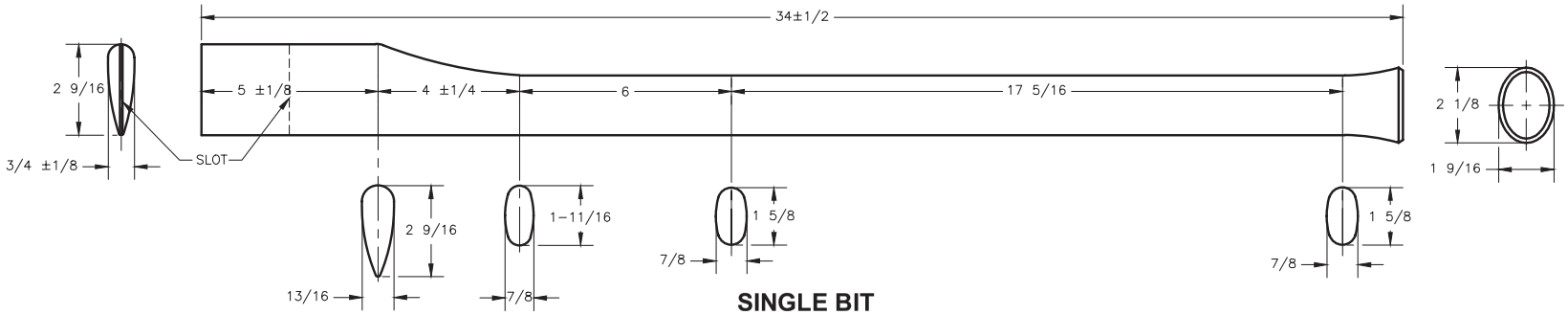
Appendix B—Technical Drawings

- Handles
  - Single Bit Curved 28" (Boy's Style)
  - Single Bit Straight 34"
  - Single Bit Curved-Octagonal 36"
  - Single Bit Straight-Octagonal 27" (Miner's Style)
  - Single Bit Curved-Octagonal 31"
  - Double Bit Straight 28" (Cruiser Style)
  - Double Bit Straight 36" (Western Style)
  - Double Bit Straight-Octagonal 44" (Felling Style)
- Sheaths
  - Leather Axe Sheath (Western)
  - Leather Axe Sheath (Cruiser)
  - Leather Axe Sheath (Boys)
  - Leather Sheath (Pulaski)
- Handle Jigs
  - Axe Handle Jig Assembly
  - Axe Handle Removing Jig (Steel)
  - Axe Handle Removing Jig (Primitive)
- Drift Pin Assemblies
  - Single Bit Axe Drift Pin Assembly
  - Double Bit Axe Drift Pin Assembly
  - Single Bit Boys or Camp Axe Drift Pin Assembly
  - Double Bit Cruiser Axe Drift Pin Assembly
- Gauges
  - Handtools Sharpening Gauge
  - Axe Sharpening Gauge



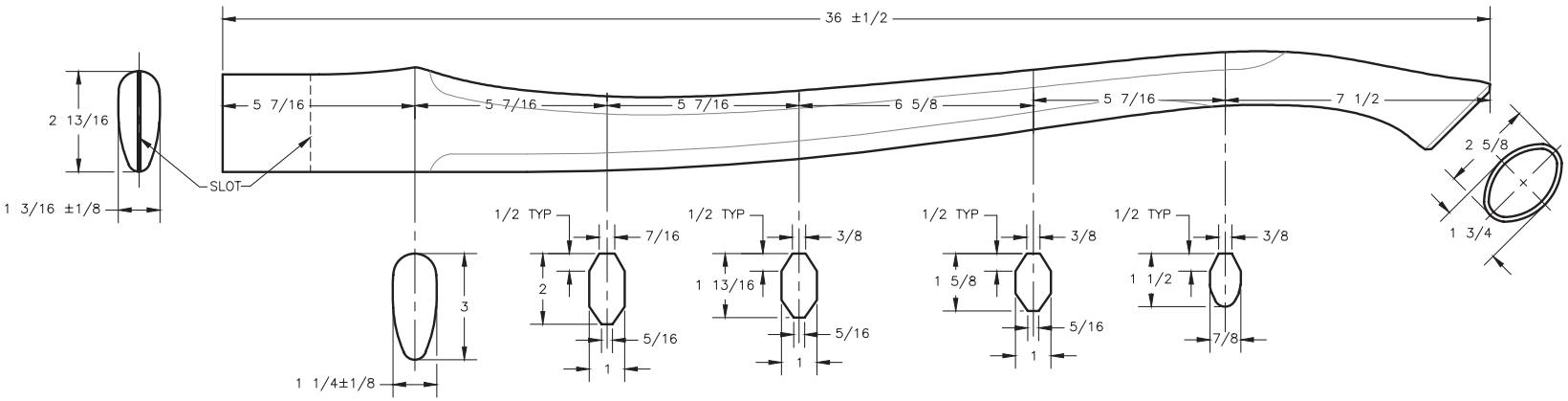
SINGLE BIT
CURVED 28"
(BOY'S STYLE)

NOT TO SCALE



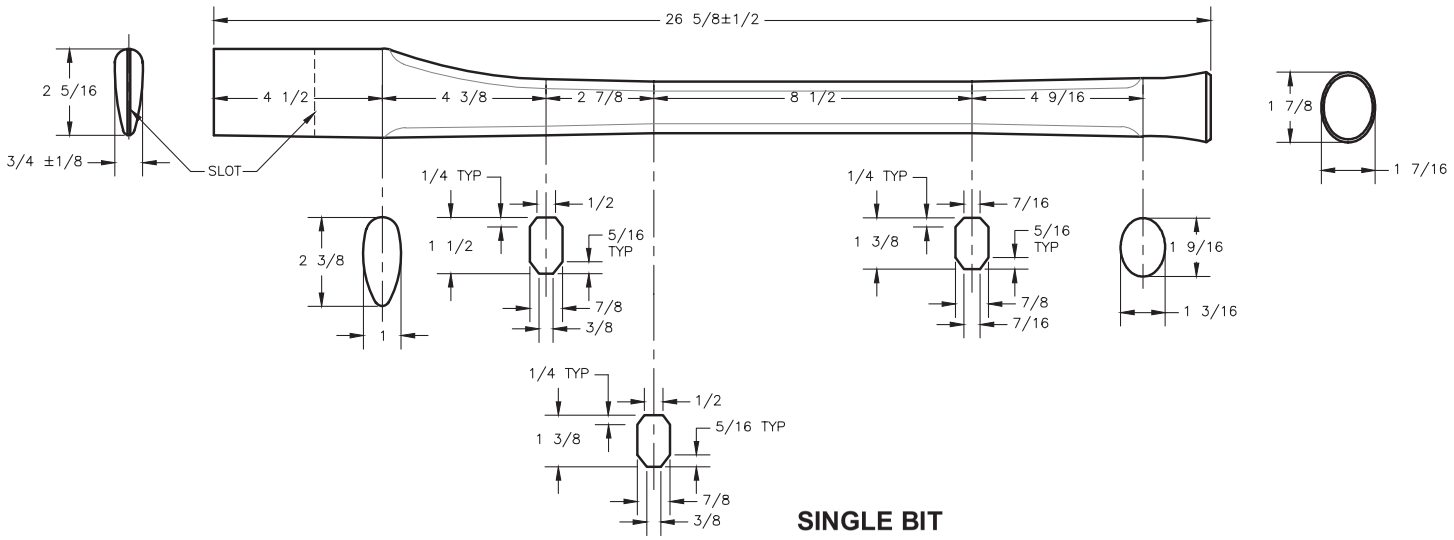
SINGLE BIT
STRAIGHT 34"

NOT TO SCALE

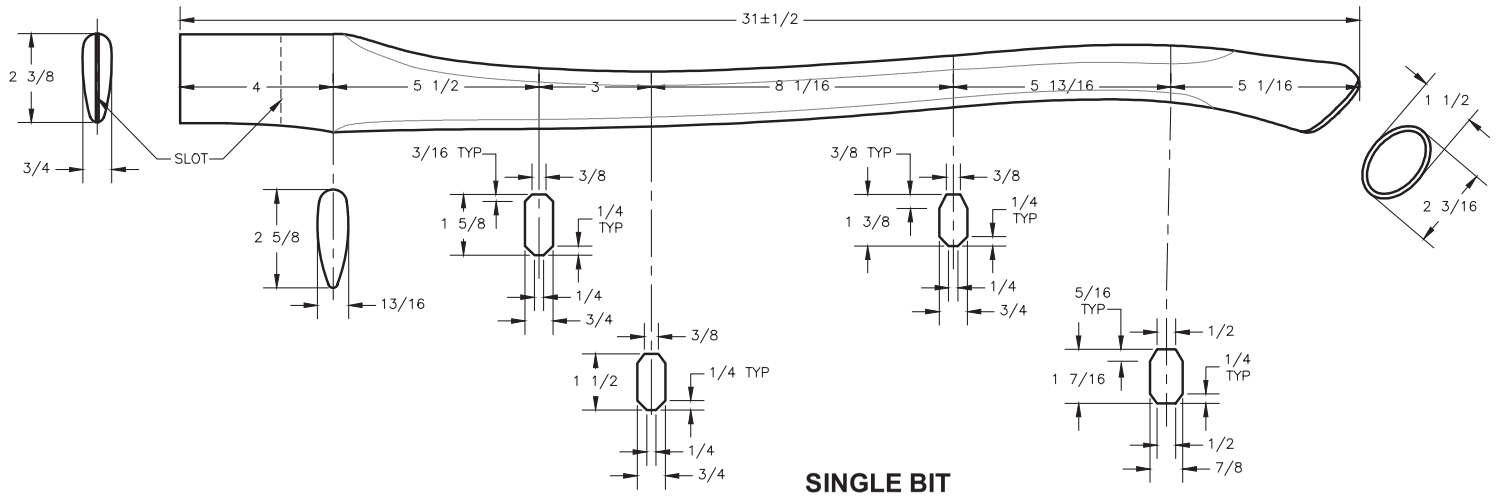


SINGLE BIT
CURVED-OCTAGONAL
36"

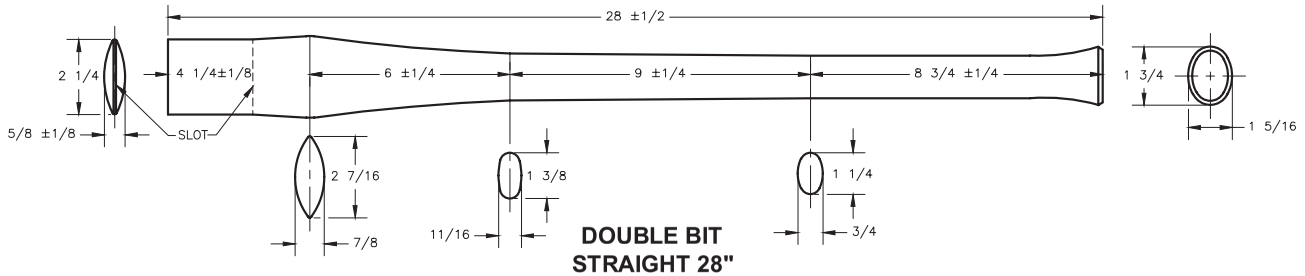
NOT TO SCALE



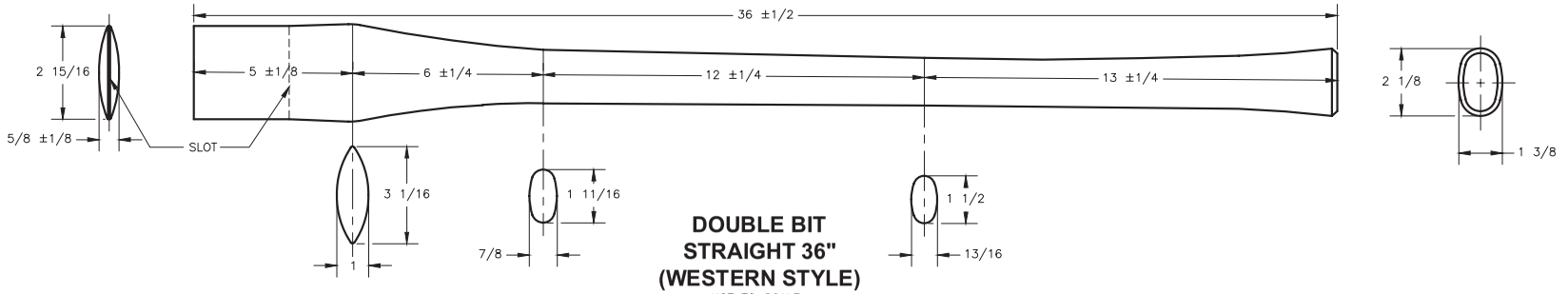
SINGLE BIT
STRAIGHT-OCTAGONAL 27"
(MINER'S STYLE)
NOT TO SCALE



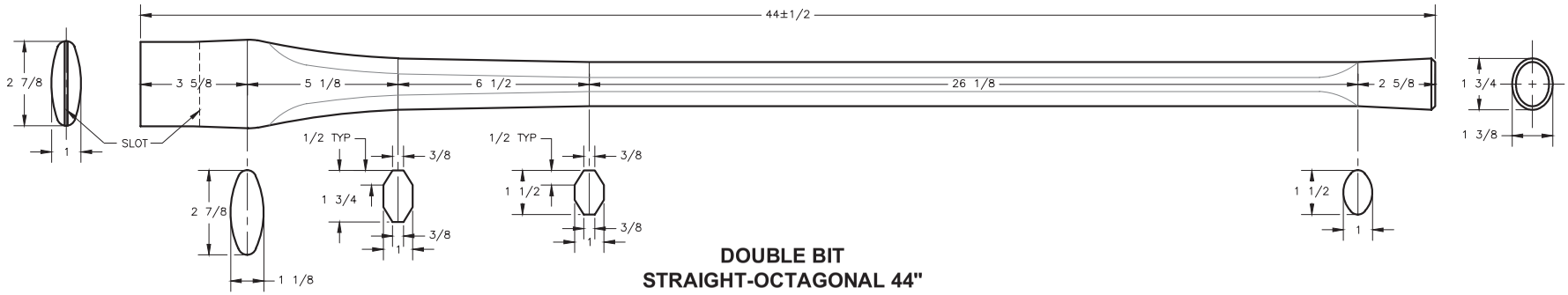
SINGLE BIT
CURVED-OCTAGONAL 31"
NOT TO SCALE



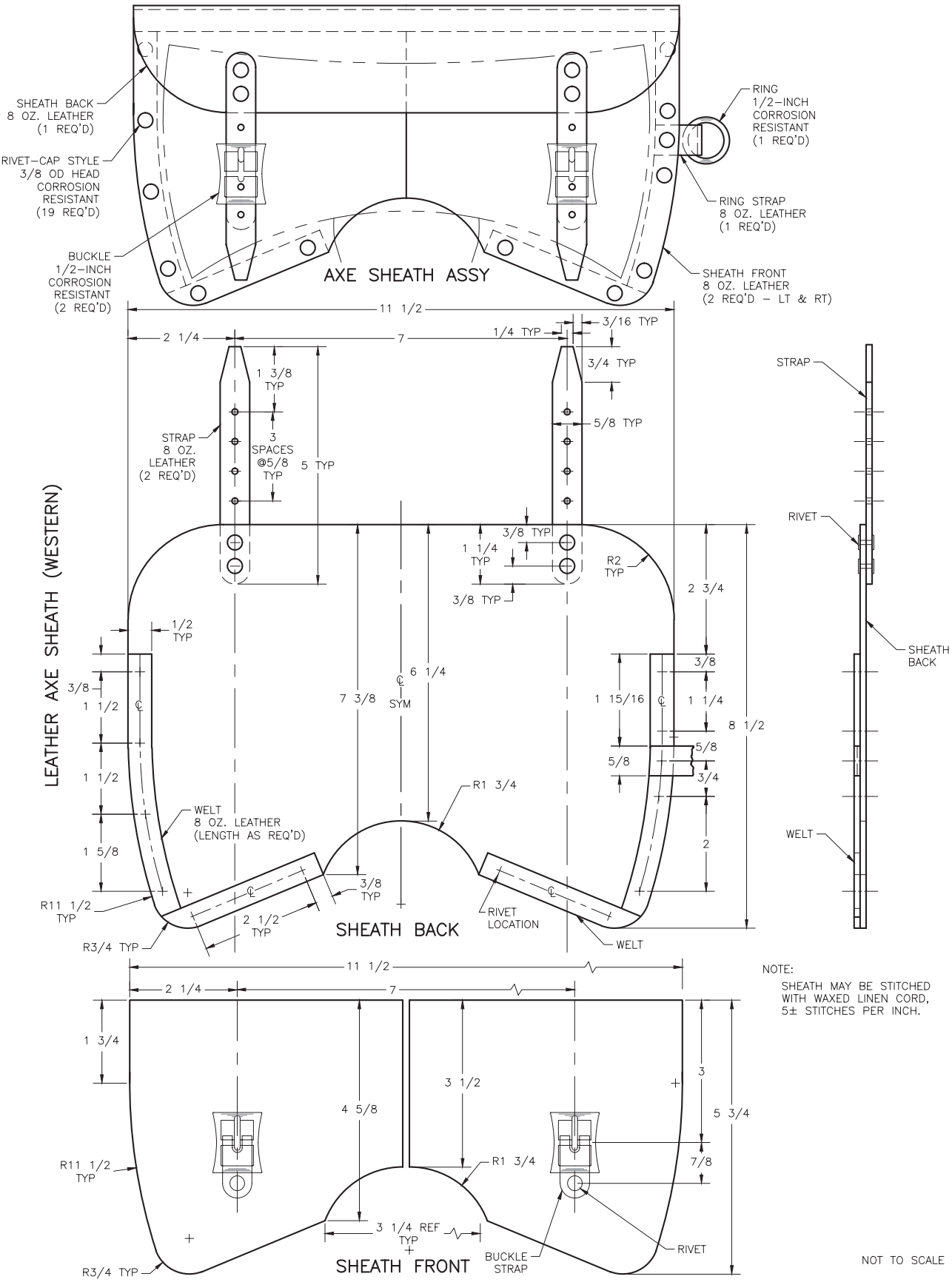
DOUBLE BIT
STRAIGHT 28"
(CRUISER STYLE)
NOT TO SCALE

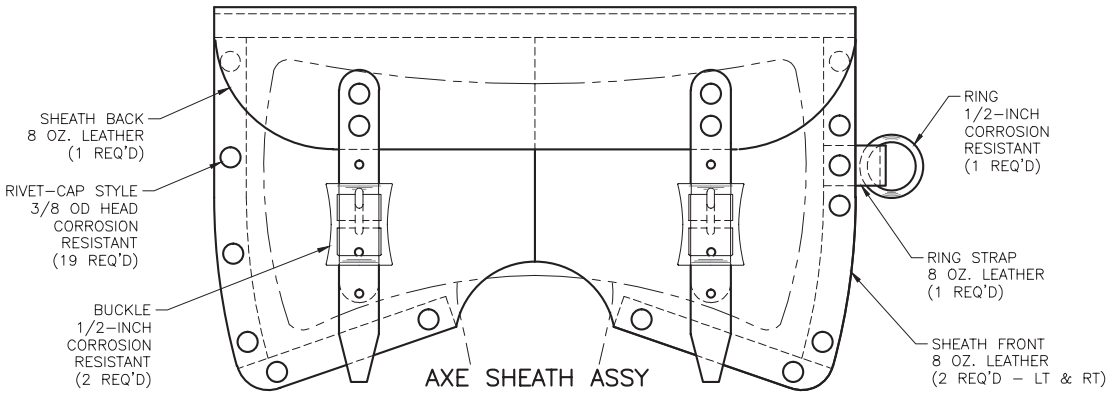


DOUBLE BIT
STRAIGHT 36"
(WESTERN STYLE)
NOT TO SCALE



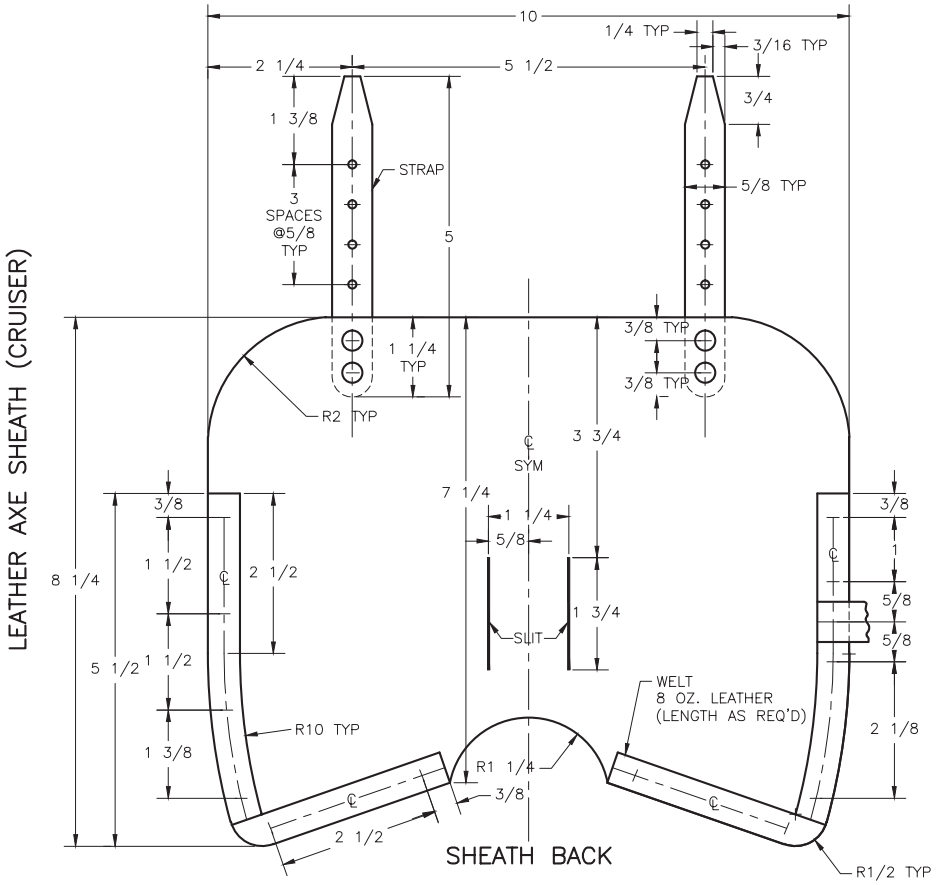
DOUBLE BIT
STRAIGHT-OCTAGONAL 44"
(FELLING STYLE)
NOT TO SCALE


LEATHER AXE SHEATH (WESTERN)
AXE SHEATH ASSY
SHEATH BACK
8 OZ. LEATHER
(1 REQ'D)
RIVET–CAP STYLE
3/8 OD HEAD
CORROSION
RESISTANT
(19 REQ'D)
BUCKLE
1/2–INCH
CORROSION
RESISTANT
(2 REQ'D)
RING
1/2–INCH
CORROSION
RESISTANT
(1 REQ'D)
RING STRAP
8 OZ. LEATHER
(1 REQ'D)
SHEATH FRONT
8 OZ. LEATHER
(2 REQ'D – LT & RT)
11 1/2
2 1/4
7
1/4 TYP
3/16 TYP
3/4 TYP
1 3/8
TYP
5/8 TYP
STRAP
8 OZ.
LEATHER
(2 REQ'D)
3
SPACES
@5/8
TYP
5 TYP
3/8 TYP
1 1/4
TYP
R2
TYP
2 3/4
1/2
TYP
3/8
1 1/2
6 1/4
SYM
7 3/8
1 15/16
1 1/4
8 1/2
5/8
3/4
1 1/2
1 5/8
WELT
8 OZ. LEATHER
(LENGTH AS REQ'D)
R1 3/4
2
R11 1/2
TYP
R3/4 TYP
2 1/2
TYP
RIVET
LOCATION
WELT
SHEATH BACK
STRAP
RIVET
SHEATH
BACK
WELT
11 1/2
2 1/4
7
1 3/4
4 5/8
3 1/2
3
5 3/4
7/8
R11 1/2
TYP
R1 3/4
3 1/4 REF
TYP
R3/4 TYP
BUCKLE
STRAP
RIVET
SHEATH FRONT
NOTE:
SHEATH MAY BE STITCHED
WITH WAXED LINEN CORD,
5± STITCHES PER INCH.
NOT TO SCALE

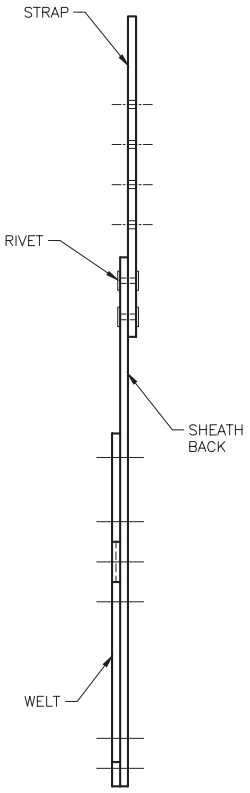


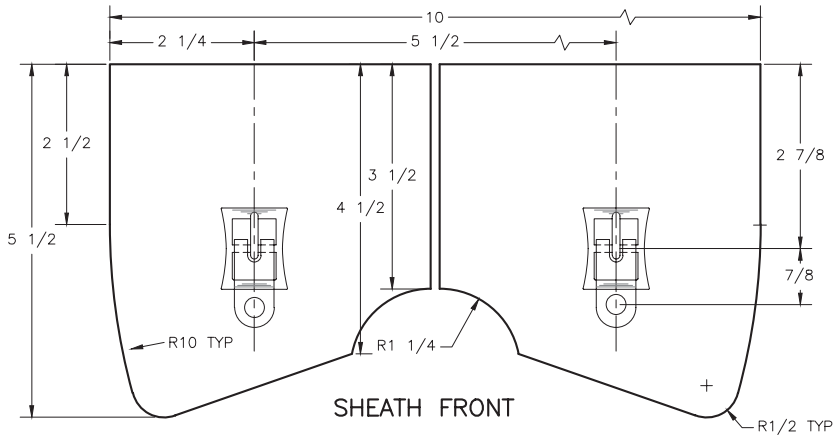
AXE SHEATH ASSY

LEATHER AXE SHEATH (CRUISER)



SHEATH BACK



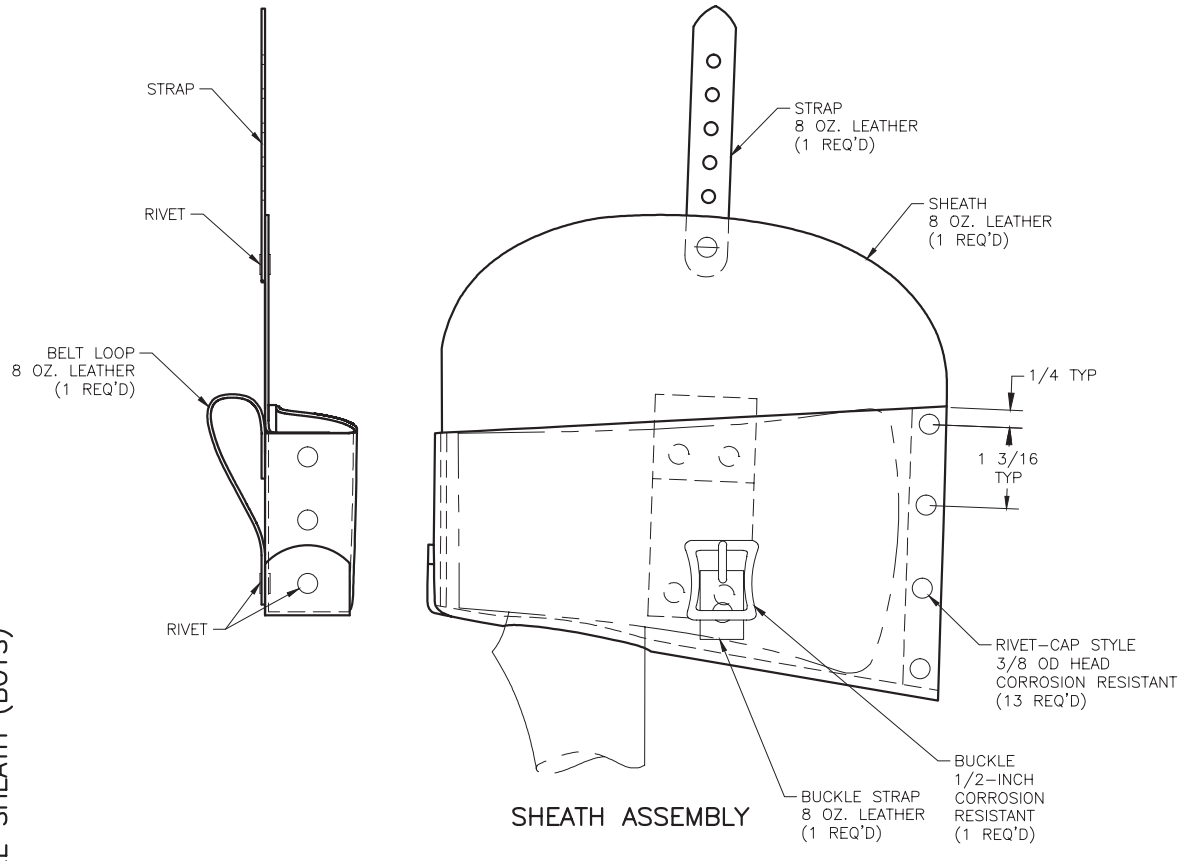


SHEATH FRONT

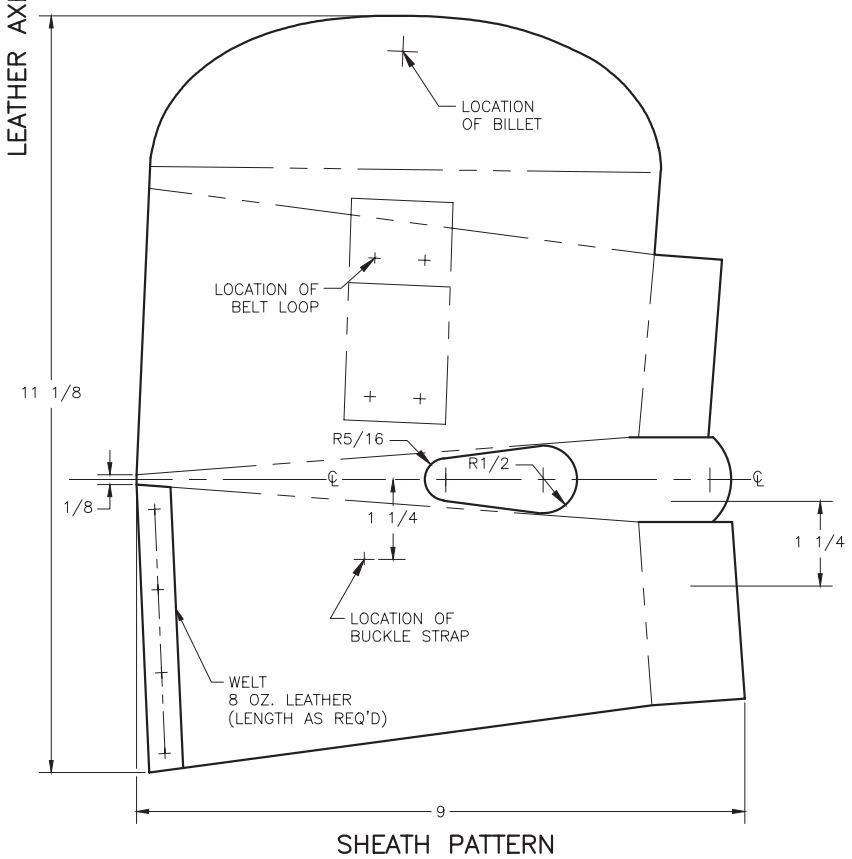
NOTE:
SHEATH MAY BE STITCHED WITH WAXED LINEN CORD, 5± STITCHES PER INCH.

NOT TO SCALE

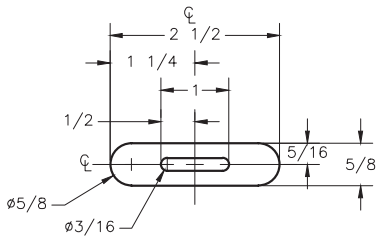
LEATHER AXE SHEATH (BOYS)



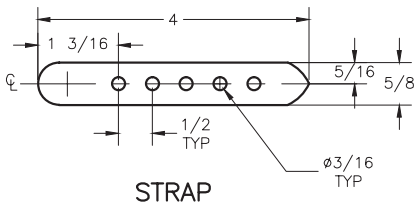
SHEATH ASSEMBLY



SHEATH PATTERN



BUCKLE STRAP



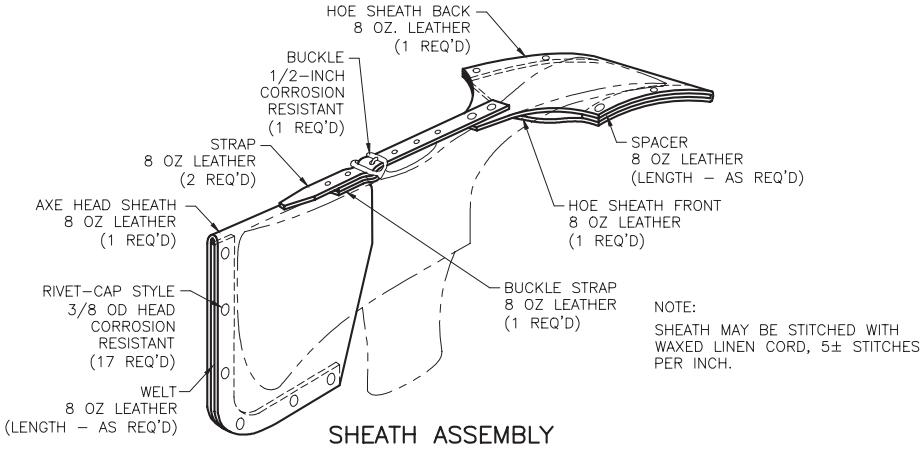
STRAP

NOTE:

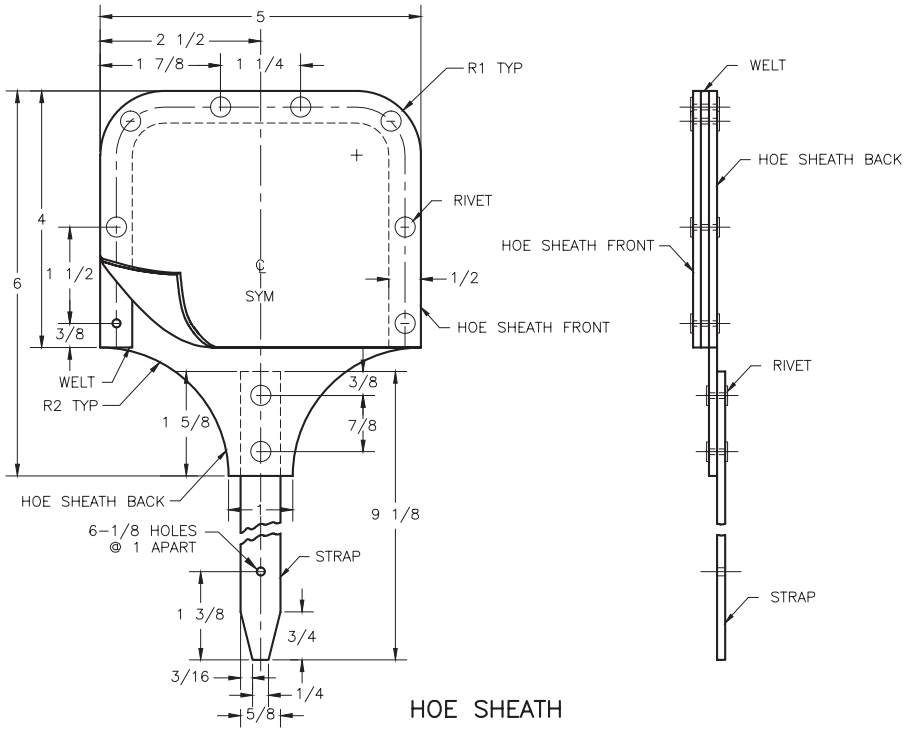
SHEATH MAY BE STITCHED WITH WAXED LINEN CORD, 5± STITCHES PER INCH.

NOT TO SCALE

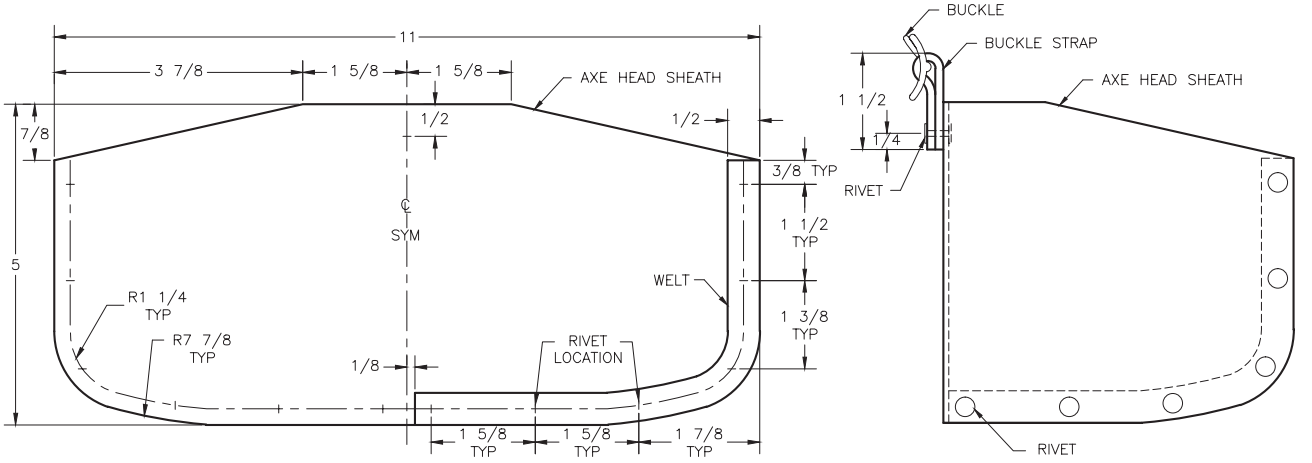
LEATHER SHEATH (PULASKI)



SHEATH ASSEMBLY

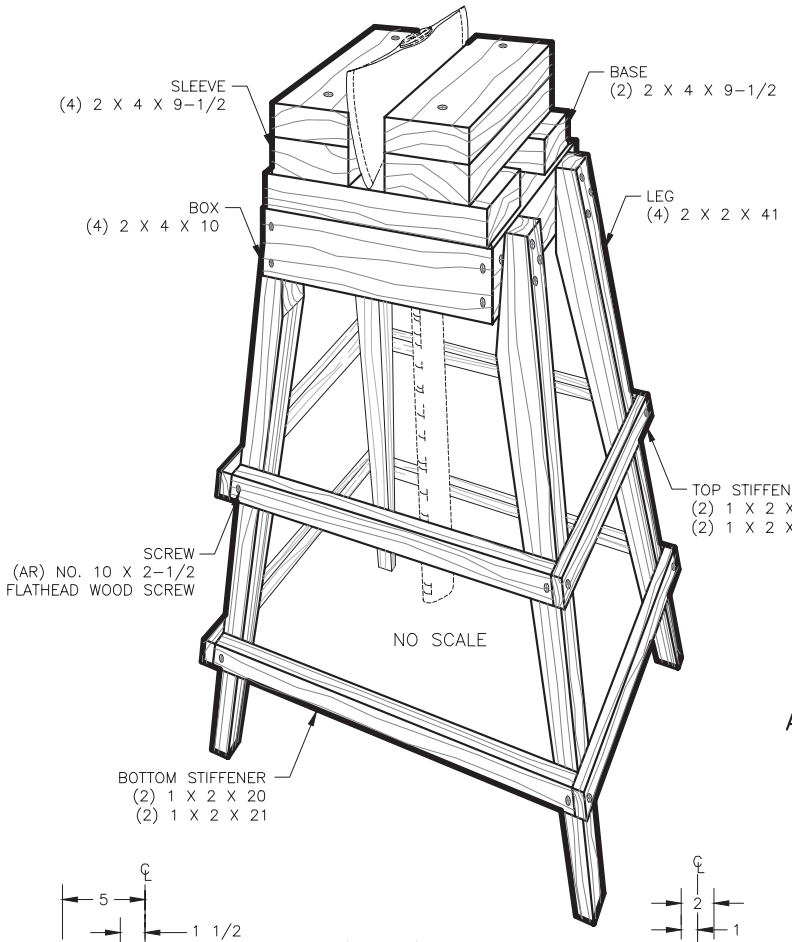


HOE SHEATH

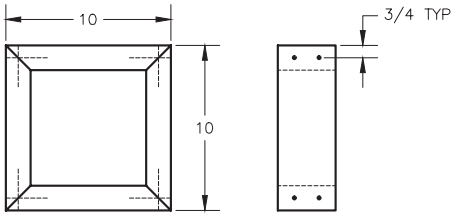


AXE HEAD SHEATH

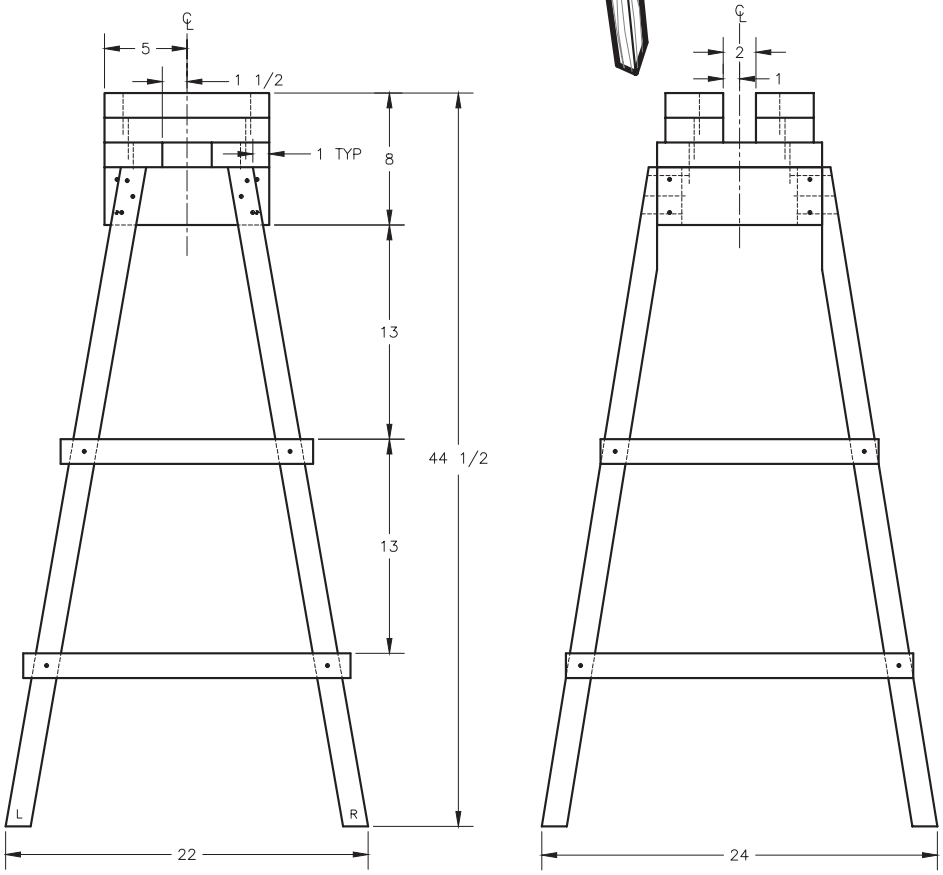
NOT TO SCALE



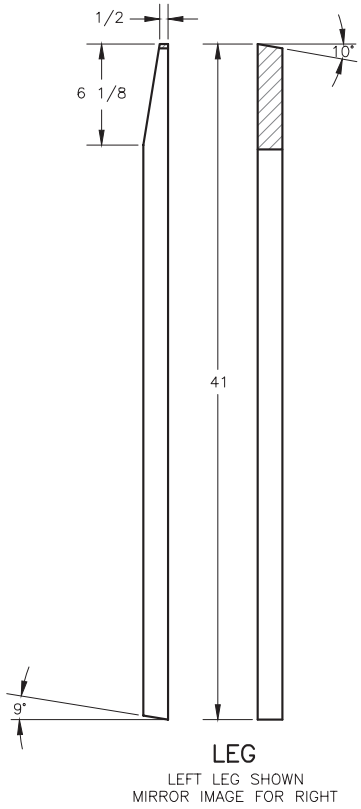
AXE HANDLE REMOVING JIG (WOOD)



BOX ASSEMBLY



AXE HANDLE JIG ASSEMBLY



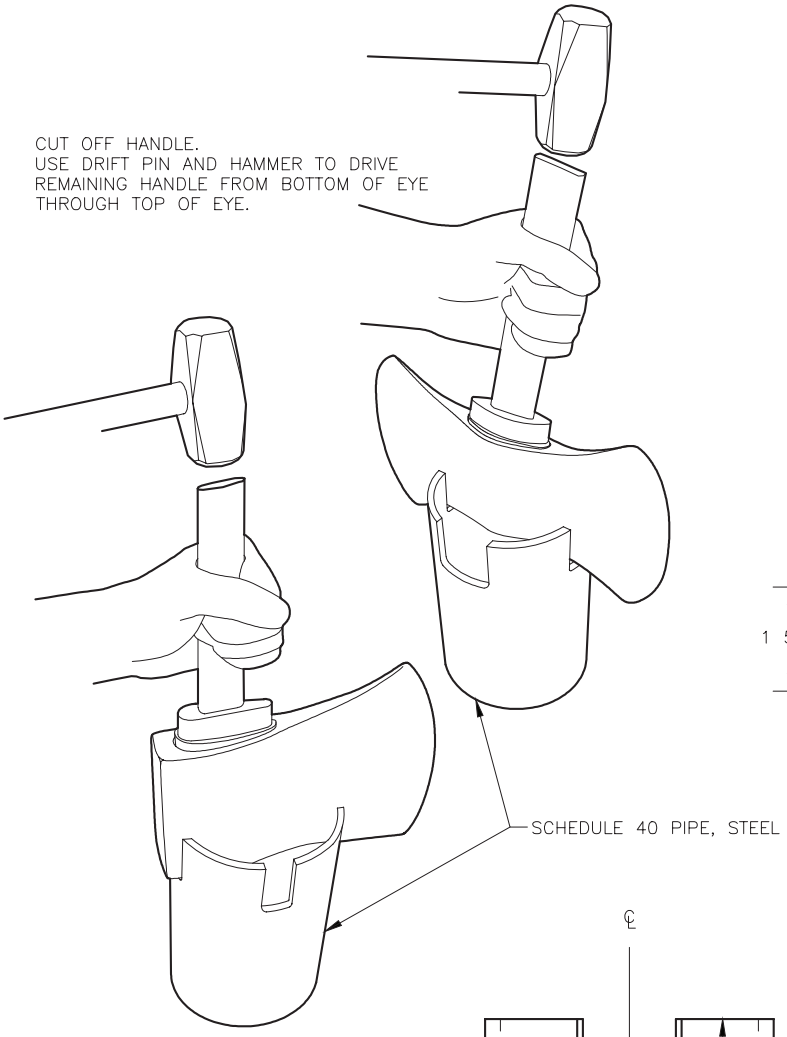
LEG

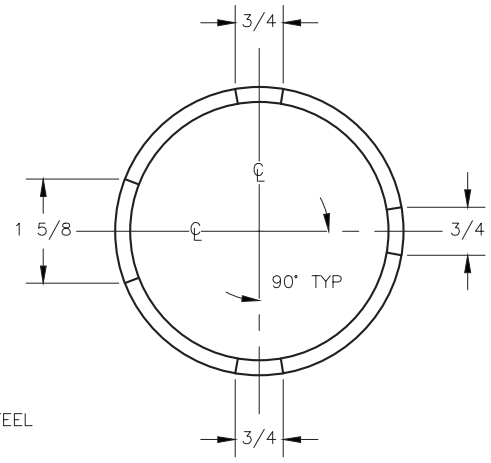
LEFT LEG SHOWN
MIRROR IMAGE FOR RIGHT

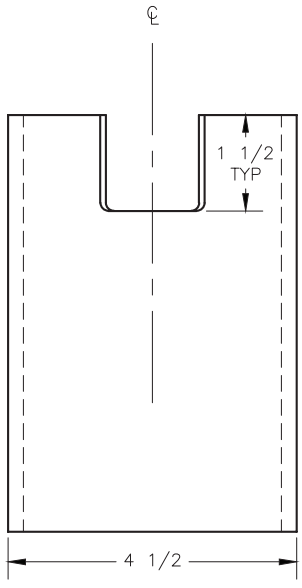
NOT TO SCALE

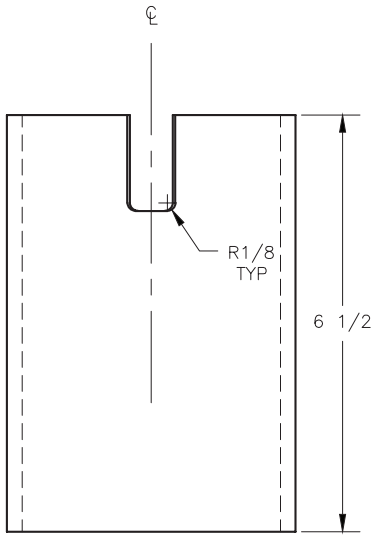
AXE HANDLE REMOVING JIG (STEEL)

CUT OFF HANDLE.
USE DRIFT PIN AND HAMMER TO DRIVE REMAINING HANDLE FROM BOTTOM OF EYE THROUGH TOP OF EYE.



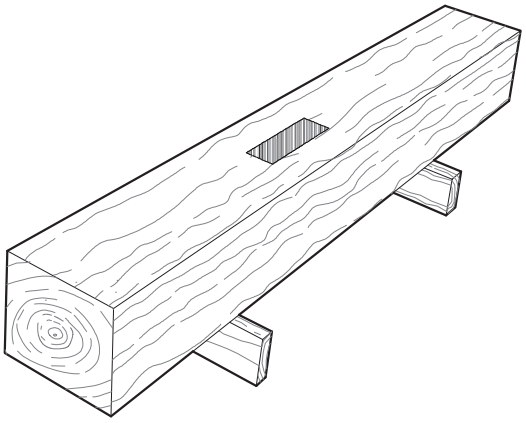




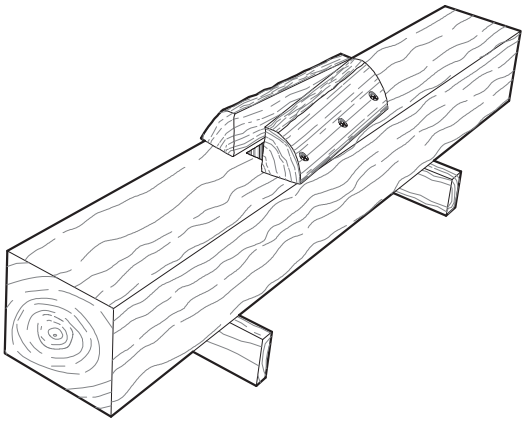


NOT TO SCALE

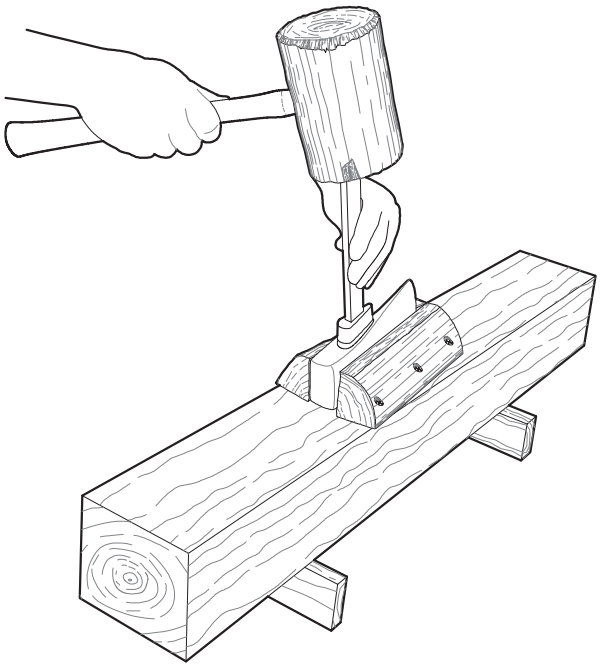
AXE HANDLE REMOVING JIG (PRIMATIVE)



DRILL 1–1/2 X 3 INCH HOLE THROUGH 8 X 8 POST.

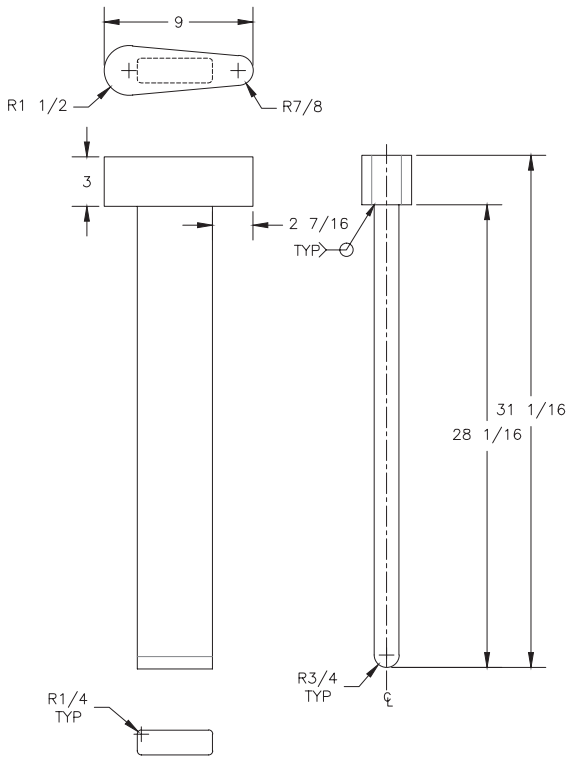


WOOD GUIDES CAN BE SCREWED INTO POST AT AN ANGLE TO HOLD AXE HEAD SECURE.

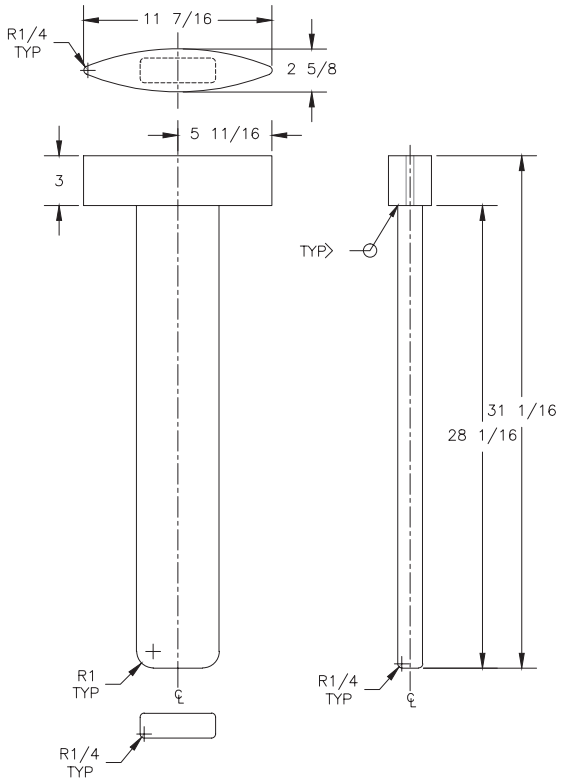


CUT OFF HANDLE.
USE DRIFT PIN AND HAMMER TO DRIVE REMAINING HANDLE FROM BOTTOM OF EYE THROUGH TOP OF EYE.

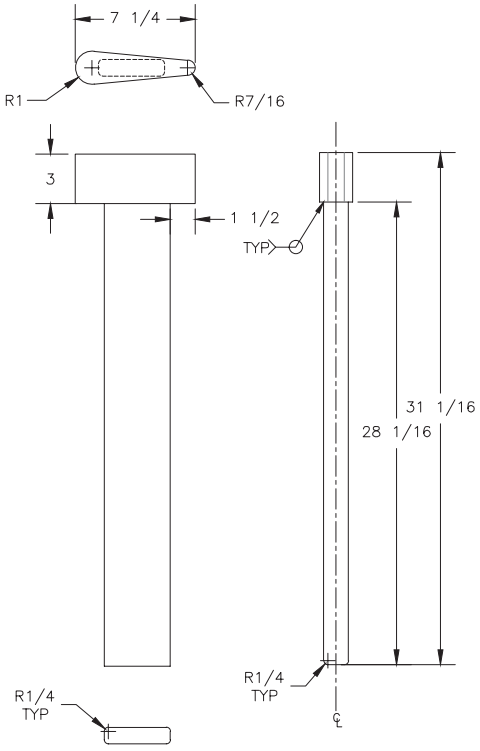
SINGLE & DOUBLE BIT AXE DRIFT PINS



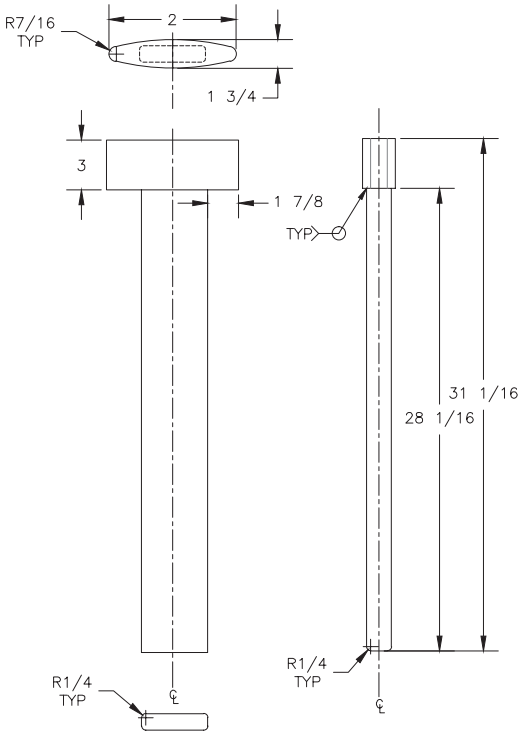
SINGLE BIT AXE
DRIFT PIN ASSEMBLY



DOUBLE BIT AXE
DRIFT PIN ASSEMBLY



SINGLE BIT BOY'S OR CAMP
AXE DRIFT PIN ASSEMBLY



DOUBLE BIT CRUISER AXE
DRIFT PIN ASSEMBLY

NOT TO SCALE

MATERIAL LIST

NO	PART NAME	REQD	MATERIAL–DESCRIPTION	SHEET
1	PLATE	1	.125 THICK 6061–T6 ALUM ALLOY SHEET	
2	LABEL	2	SEE NOTE 3	

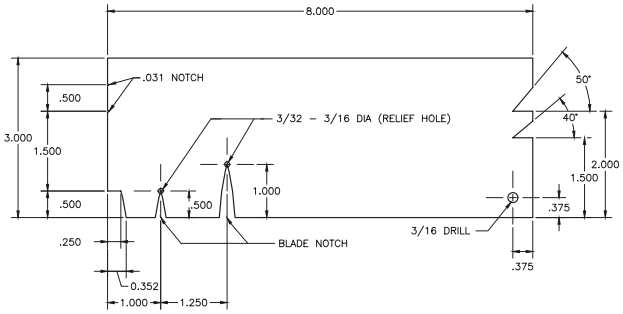
NOTES:

1. MAKE PLATE WITH NOTCHES SHOWN. USE BLADE NOTCH DWG TO MAKE DIE FOR THOSE NOTCHES. NOTE: THE DISTANCES FROM APEX OF BLADE NOTCH TO WHERE WIDTH MEASUREMENTS ARE TAKEN SHALL BE EXACT –– NO TOLERANCE ALLOWED. THE LARGER NOTCH OF THE GAUGE IS TO BE FITTED OVER BLADE MID–SECTION ONLY. THE SMALLER BLADE NOTCH IS FOR TOP OR FINAL 1/2–INCH OF ENTIRE BLADE EDGE. BOTH BLADE NOTCHES ARE USED TO ACHIEVE A SMOOTH, CONTOURED TAPER ALONG TOOL BLADE TO CUTTING EDGE.

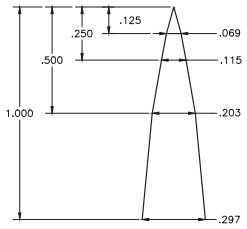
2. MAKE ANGLE NOTCHES AS SHOWN. EACH NOTCH ANGLE 50° AND 40° SHALL BE PERMANENTLY MARKED ON GAUGE IN CHARACTERS 3/16 TO 1/4 INCH HIGH AND PLACED SO THAT MAKINGS WILL BE VISIBLE WHEN LABEL IS AFFIXED. PAINTING SHALL NOT CONSTITUTE PERMANENT MARKING.

3. GOVERNMENT WILL SUPPLY CAMERA–READY COPY FOR LABEL. PRINT LABEL ON ADHESIVE BACKED MAT'L AS SHOWN. LOCATE LABELS ON FRONT AND BACK OF PLATES AS SHOWN IN THE ASSY.: ON FRONT SIDE OF GAUGE, LABEL SHALL BE FLUSH WITH TOP AND LEFT SIDE OF GAUGE; ON BACK SIDE OF GAUGE, POSITION LABEL FLUSH WITH TOP AND RIGHT SIDE OF GAUGE. TO PROTECT LABEL, TREAT WITH A WATER REPELLENT SPRAY (CLEAR ACRYLIC SPRAY COATING, PHOTO LACQUER SPRAY OR EQUAL). APPLY 2 OR 3 COATS. ALLOW THOROUGH DRYING TIME BETWEEN COATS. APPLY COATS AS NOT TO LIFT LABEL OFF PLATE.

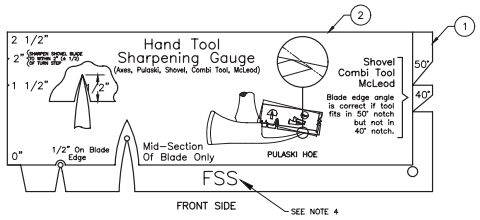
4. FSS MARK SHALL BE PERMANENTLY MARKED ON GAUGE IN CHARACTERS 1/4 TO 5/16 INCH HIGH. PAINTING SHALL NOT CONSTITUTE PERMANENT MARKING.



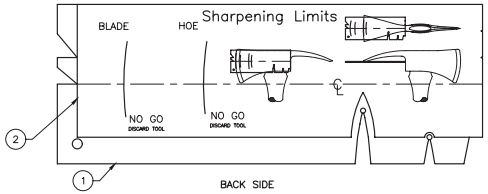
1 PLATE



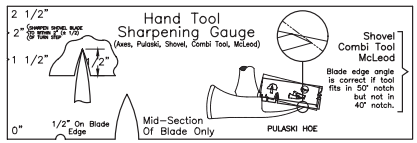
BLADE NOTCH
4X SIZE
SEE NOTE 1

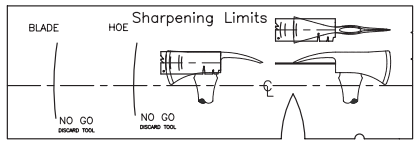


LOCATE LABELS AS SHOWN ON FRONT AND BACK OF PLATE



SHARPENING GAUGE ASSY





2 LABEL

THIS IS A REDUCED PRINT

	DATE	REVISION	BY
B	1/30/02	REMOVE GO LINES FROM LABLE	DWM
A	1/7/99	CONVERTED TO AUTOCAD	JHA

UNLESS OTHERWISE SPECIFIED
TOLERANCES:
FRACTIONS +/– ___
DECIMALS +/– .01
ANGLES +/– ___
DIMENSIONS ARE IN INCHES
BREAK SHARP EDGES

U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
TECHNOLOGY & DEVELOPMENT CENTER
MISSOULA, MONTANA

DRAWN	LASSILA
DESIGNED	
CHECKED	
APPROVED	
SCALE	FULL
DATE	MAY 1990

TITLE
SHARPENING GAUGE
HAND TOOLS

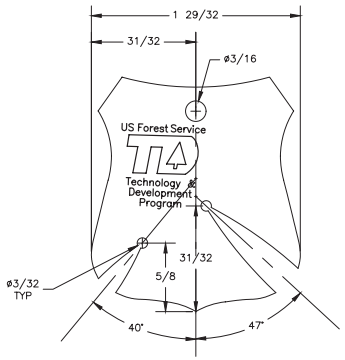
667–1

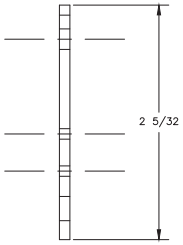
SHEET 1 OF 1

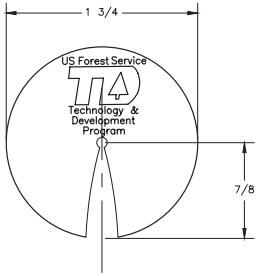
MTDC– 846 B

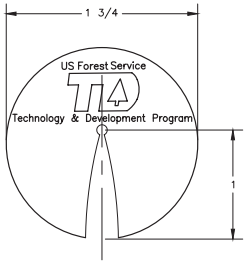
MATERIAL LIST

NO	PART NAME	REQD	MATERIAL – DESCRIPTION	SHEET
1	GAUGE	1	?????	

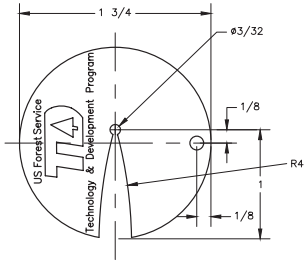








1 GAUGE
PATTERN PIECE



THIS IS A REDUCED PRINT

+

UNLESS OTHERWISE SPECIFIED
TOLERANCES:
FRACTIONS +/- ____
DECIMALS +/- ____
ANGLES +/- ____
DIMENSIONS ARE IN INCHES
BREAK SHARP EDGES

DATE	REVISION	BY

U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
TECHNOLOGY & DEVELOPMENT PROGRAM
MISSOULA, MONTANA

DRAWN D.MUCCI
DESIGNED .
CHECKED .
APPROVED .
SCALE FULL
DATE AUG 2017

TITLE
AXE SHARPENING GAUGE

1137-01.dwg

C SHEET 1 OF 1 NTDP– 1137

About the Author

Bob Beckley is a project leader and public affairs specialist for the Forest Service National Technology and Development Program (NTDP). He transferred to the Missoula Technology and Development Center from the Missoula Smokejumper Base in 1991. Along with his public affairs work, Beckley's primary project work for NTDP includes traditional skills, blasting and explosives, and safety. He is recognized by his peers both inside and outside the Forest Service as a traditional skills expert.

About NTDP

The U.S. Department of Agriculture, Forest Service, National Technology and Development Program, provides Forest Service employees and partners with practical, science-based solutions to resource management challenges. We evaluate, design, and develop new technologies, products, and systems to solve problems and deliver solutions.

The author with a mule from the Lolo National Forest Ninemile packstring.

Contact Information

Contact the National Technology & Development Program (NTDP) for additional technical information:
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National Technology & Development Program
Phone: 406–329–3978 or 909–599–1267
Email: wo_mtdc_pubs@usda.gov

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Search SDTDC <http://fsweb.sdtdc.wo.fs.fed.us/>

Library Card

Beckley, B. 2020. One moving part: the Forest Service ax manual. 1823–2812P –NTDP. Missoula, MT: U.S. Department of Agriculture, Forest Service, National Technology and Development Program. 234 p.

This manual provides information about different types of axes and their historic and current usage in the U.S. Department of Agriculture, Forest Service. Subjects covered include the anatomy of an ax, types of axes and related tools, selecting the right ax for you, the art of filing, sharpening an ax head, restoring or replacing an ax handle, using an ax, maintaining an ax, and purchasing an ax. The manual also includes a list of resources and information about ax manufacturers and suppliers.

Keywords: adzes, ax, axes, crosscut saws, double-bit axes, felling, handtools, hand tools, heritage, logging, lumberjacks, primitive skills, primitive tools, pulaskis, single-bit axes, survival skills, traditional skills, traditional tools, trails, two-man saw, wilderness


FOREST SERVICE
US

The author's collection of crosscut saws and axes. Some of them date back well into the 1800s.

Produced by
U.S. Department of Agriculture, Forest Service
National Technology and Development Program

1823–2812P–NTDP

One Moving Part: The Forest Service Ax Manual