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Brush-Clearing Head Evaluation

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The natural regeneration of some pine species after large wildland fires can produce extremely thick stands. These stands of lodgepole pine—and in some cases, ponderosa pine—can have more than 15,000 seedlings per acre. As the stands grow, they become extremely dense. Individual trees grow very slowly. The stands provide poor habitat for some wildlife, including large mammals such as elk, deer, and bears. In addition, the stands are susceptible to disease and insects. The stands will thin themselves naturally over time, but that process takes many years.

Thinning these stands is an important step in producing and maintaining sustainable ecosystems. Precommercial thinning (thinning before the trees are large enough to sell) can be accomplished during various stages of a stand's life. Precommercial thinning is often conducted when trees are large enough for a chain saw to fell them easily. However, in thick, natural regeneration stands, it may be many years before the trees are that large. Meanwhile, these stands will be stagnant and the habitat will be poor for some species of wildlife. Thinning also can be done when the seedlings are very small, for example, a 1-inch stem diameter or smaller. Thinning at this stage eliminates competition between trees, allowing the remaining trees to grow faster and produce a stand that is more suitable for wildlife.

Thinning young stands has problems that must be addressed. Many trees will have lower limbs that are on or near the ground. The trees must be severed below these limbs to kill the tree. Chain saws are unsuitable, because the saw may strike rocks or the ground. Hand pruners can be used, but using them is very labor intensive and usually cost prohibitive. Brush-clearing saws (figure 1) with circular saw blades are usually the most efficient method, but the blade must be resharpened repeatedly or replaced if it strikes a rock or the ground. Table 1 describes the advantages and disadvantages of three methods for thinning small-diameter stands.

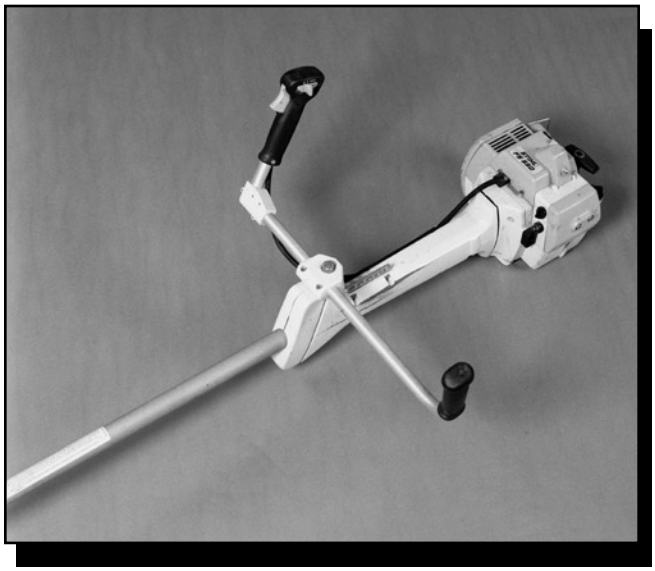

Figure 1—Stihl brush-clearing saw.

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Table 1—Advantages and disadvantages of different methods to precommercially thin small-diameter stands.

Cutting tool	Site conditions	Advantages	Disadvantages
Chain saw	Larger diameter trees (over 2 inches)	Relatively fast; more equipment and contractors are available.	Dangerous when cutting close to the ground; frequent sharpening is needed when striking the ground or rocks; must wait until a stand has thinned itself, resulting in poor habitat and tree growth; hard on the operator.
Brush-clearing saw	Smaller diameter trees (under 2 inches)	Relatively fast; easier on the operator; less fatiguing than using a chain saw.	Frequent resharpening if the blade strikes the ground; many more trees have to be cut than when stands have larger diameter trees.
Hand pruners	Small-diameter trees (under 1 inch)	Pruners can cut into the ground below the lowest whorl; less fatiguing.	Very slow; stooping can be hard on an operator's back; many trees have to be cut; high cost.

New Brush-Clearing Head

The Missoula Technology and Development Center (MTDC) was asked to investigate tools to precommercially thin stands that regenerate naturally after a fire. A market search uncovered a new brush-clearing saw attachment that claimed to eliminate many of the problems associated with circular saw blades. The commercial tool is called the TUFF KUTT (figure 2). The TUFF KUTT is an attachment made of an aluminum-alloy housing with three replaceable steel blades that form a flail-type cutting mechanism.

A TUFF KUTT head was purchased and tested at the Island Park Ranger District of the Targhee National Forest in Idaho. One TUFF KUTT head that was mounted on a Stihl FS 550 brush cutter failed during testing. The aluminum-alloy housing cracked (figure 3) and testing was stopped. Repeated attempts to contact the manufacturer were unsuccessful. Fortunately, we were able to contact the original inventor. He said that the manufacturer had focused on downsizing the original design to enter the consumer market. The inventor (now the director of technology for Fire Prevention Services, Inc.) agreed to produce a test run of the original design and allow the Forest Service to field test that design for 2 years. The test period ended December 31, 2002. This report summarizes the findings.

Figure 2—TUFF KUTT brush-clearing saw head.

Figure 3—The alloy housing of this TUFF KUTT brush-clearing head fractured during testing at Island Park, ID.

Design and Concept

The clearing head (figure 4) was designed to cut small brush around rocks and to cut below the ground without the need to sharpen the blades. The head's cutting diameter with new blades is 11 inches. The head can cut up to 2-inch-diameter softwood trees, although test results show that the head should not be recommended for use on trees this large. The head works best on trees that are 1¼ inches in diameter and smaller, and for briars, grasses, and brush.

Figure 4—The original design of the brush-clearing head used in Forest Service evaluation.

The clearing head is constructed of two lightweight aluminum-alloy castings housing three rotating (replaceable) steel blades mounted on steel pins. The saw's mounting nut keeps the clearing head together. No other mechanical fasteners are needed. The clearing head weighs about 3 pounds with the blades. The head's steel blades swing out as the head rotates, producing a well-balanced, easy-to-use cutting tool that can "carve" trees to cut them. The clearing head does not require that the tool be held tightly. The head should be pressed against the material being cut rather than swung into the material.

The main benefit of this brush-clearing head is its ability to strike the ground, rocks, and other hard debris repeatedly without loss of performance. The blades are designed to get shorter through wear without requiring sharpening. Cutting in rocks actually produces a slight curl at the end of the blade, enhancing the cutting action. Blade life depends on site conditions and the material that is being cut.

Recommended Brush-Clearing Saws

The clearing head's manufacturer determined that brush-clearing saws manufactured by Stihl have the best power head and gearbox for use with the clearing head. No other manufacturer whose saws were tested could produce gearboxes that would hold up to the punishment of day-to-day use of the head.

Stihl models FS280K, FS350, and FS450 are recommended for use with the brush-clearing head (see table 2 for comparison). The FS 280K clearing saw is no longer manufactured, but this saw was able to stand up to all the testing to date. Such saws may still be available. The power output is satisfactory and the gearbox can withstand the punishment from the head. Other attributes that make the FS 280K a good choice include a long shaft length (35 inches), light weight (17 pounds), and adjustable handlebars. In addition, the saw rapidly recovers its cutting speed after it has slowed while cutting material.

Table 2—Comparison of different Stihl brush-clearing saws.

	Stihl brush-clearing saw models		
	FS 350	**FS 280K**	**FS 450**
Weight (pounds)	15.4	17	17.4
Displacement (cubic centimeters)	36.3	39	44.3
Fuel capacity (pints)	1.35	1	1.43
Maximum engine speed (revolutions per minute)	12,300	12,500	12,500
Tube wall thickness (inches)	0.0625	0.0625	Heavier than 0.0625
Shaft length (inches)	36⅞	35	31⅝

Because the FS 280K is no longer readily available, the Stihl FS 350 is a good substitute. It is similar to the FS 280K, but has a slightly smaller engine and is about 1½ pounds lighter. The FS 450 would also work with the brush-clearing head, but it is about ½ pound heavier than the FS 280K and has a much shorter shaft, which may make the saw harder to maneuver.

Stihl makes another brush-clearing saw, the FS 550. This saw was not tested because it was considered too large, had a shaft that was too short, was heavy, and was too expensive.

Several minor modifications to the saw's guard are needed before the brush-clearing head can be mounted on the Stihl saws. Two gussets or "ears" must be removed from the guard so it can be mounted farther back from the end of the shaft. Also, a small piece should be removed from the lower corner of the guard, tapering back about 1 inch. This allows the clearing head blades to rotate without hitting the extreme outer corner of the guard. The modifications will be detailed in the clearing head operator's manual supplied by the manufacturer.

Safety Equipment

The clearing head can throw debris in all directions, including toward the operator. Also, the brush-clearing saw and the noise associated with cutting trees or brush create a noisy working environment. Proper safety and hearing protection equipment are required (figures 5a and 5b). The safety equipment and specifications will be listed in the clearing-head operator's manual. The minimum recommended safety equipment includes:

- Wraparound chaps—Protect legs from flying debris.
- Heavy-duty shoulder harness—Reduces fatigue and allows the brush-clearing saw to be released quickly.
- Safety helmet—Provides head protection.
- Ear muff (28-decibel, noise reduction rating minimum)—Provides hearing protection.
- Steel face screen, (24 gauge, 8 by 15½ inches)—Provides face protection. Do not use a shorter shield or a shield with a plastic screen.
- Aluminum adapter for the face shield mount (mounting hardware for face shield).
- Safety glasses with side shields.
- Leather gloves.
- Leather boots.

Figure 5a—Safety equipment (lower body) required to protect operators using the brush-clearing head.

Figure 5b—Safety equipment (upper body) required to protect operators using the brush-clearing head.

The equipment above has been field tested to provide maximum operator protection while allowing the operator to be very aggressive with the brush-clearing system. The importance of using this safety equipment cannot be overemphasized.

Evaluation

The clearing-head system was tested by several districts in the Intermountain and Pacific Southwest Regions. The tests were intended to show how well the heads stood up to the rigors of various environments, to obtain workers' comments on the head's strengths and weaknesses, and to provide an overall impression of the usefulness of the system. The heads were loaned to the districts for about 2 years so they could use them on a variety of projects. After use, the heads were returned for examination so wear patterns could be examined. Details of the evaluation included:

- All clearing heads were numbered so that evaluations could be related to a specific casting.
- All clearing heads were at a known location.
- A data logbook was supplied with each clearing head to enter hours worked and other data.
- An operator's manual was supplied so all operators had the same information and specifications.
- A four-page evaluation form was included to be returned to MTDC.

Results—The brush-clearing head was tested in a variety of conditions and vegetation. These included thinning thick, young ponderosa and lodgepole pine stands (trees 3 to 6 feet tall with 5,000 stems per acre), medium-sized ceanothus, bitterbrush, Douglas-fir, tanoak, manzanita, poison oak, blackberry, madrone, and Oregon grape. Some of the work was for thinning, while other work was for clearing roadsides or firelines.

Blade replacement depended on the site conditions. Some operators working in very rocky conditions suggested that the blades be replaced at least daily, while others working in areas that were not as harsh suggested the blades could last weeks.

All but one of the heads held up well. The bottom housing of one head fractured when the head hit a rock abruptly (figure 6). A crack had developed from the small hole in the casting. This hole had been machined into the casting to help remove the pin used to hold the blades between the two housings. The hole is not required and will not be machined in any new heads.

Figure 6—A brush-clearing head that fractured during testing. The fracture was a result of a machined hole in the casting. The design flaw will be corrected.

Another problem discovered during the testing dealt with the head's mount on the Stihl saw. Stihl has modified the shoulder height of the gear-head thrust plate on their new brush-clearing saws. Only a small amount of the head's surface contacted the thrust plate. The head's mounting surface cracked. Stihl has developed shims to fill the gap at the shoulder, which will eliminate the problem.

Comments From Evaluators—As part of the evaluation, the workers operating the brush-clearing saw were asked to critique the system.

Positive comments included:

- The head minimized back strain when workers were cutting small material close to the ground. It excels in "doghair" stands of seedling-size vegetation that would be hazardous to both chain saw and operator if a chain saw was used. The longer the blades stay sharp, the faster they can cut smaller stems and chew through larger ones.
- We were able to bury the blades below the soil grade to cut small brush plants under the root crown fairly effectively. We also used the head on medium-size ceanothus and ribes plants to make subsurface grubbing with handtools easier. This method

improved overall clearing production significantly. The head was also used to cut and mulch a test area within a prescribed fire maintenance project. The intent was to observe the ease of lighting the prescribed fire and flame behavior compared to untreated ground.

- The system is efficient, cuts easily, is easy to use, is well balanced, is dependable, and the blades stay sharp a long time.

- The system is excellent for thin-and-release units or for brush clearing in large areas. It is also very effective when clearing brush ahead of sawyers who are cutting trees in thick berry stands or in poison oak.

- The system worked well to cut brush and trees down low when they were against rocks or other obstacles.

- The heads are good for people who can't maintain or sharpen blades. There is little downtime because there is no need to resharpen the blades.

Other comments include:

- More personal protective equipment is needed for the chest and groin. The brush-clearing head threw rocks and debris toward the chest and groin, frequently causing minor injuries.

- The steel blade on the brush-clearing head is harder on the saw because it produces more vibration than other blades.

- The brush-clearing tool throws bigger chunks of material and requires a larger safe working area than other tools.

- Operators found that the expectation that the head could cut material up to 2 inches in diameter was a bit optimistic under most conditions. Cutting material up to 2 inches in diameter is realistic only with patience and sharp blades. Under actual conditions, cutting material up to 1 inch in diameter is a more realistic expectation.

- When the head encounters anything large on the front or right side, the recoil swings the brush-clearing head and the operator abruptly to the side, but experience using the tool will eliminate this problem.

Conclusions

The new brush-clearing head with steel blades is effective for thinning young stands where workers must cut close to the ground (even in the ground) or around rocks. After some practice, the operator can become extremely efficient in clearing brush, trees, and other material with little or no downtime. The efficiency may make it practical to thin large areas of thick natural regeneration at an early stage rather than waiting for the stand to mature enough for chain saws to be useful. Clearing regeneration early may produce a stand that is more hospitable for wildlife and may promote tree growth. The clearing head has other uses, such as clearing trails or clearing undergrowth ahead of sawyers when constructing fireline.

The use of personal protective equipment cannot be overemphasized. In fact, from the test subjects' comments, more equipment to protect the chest and groin should be specified and required to be worn. Additionally, the design of a larger or improved brush-clearing saw guard on the head may help prevent some of the debris from hitting the operator.

Two design flaws noted in field tests led to the fracture of one head. These flaws were determined by the manufacturer to be a direct result of the machining of the castings. The design flaws will be eliminated in the final design of future manufactured units.

Contact Pete Tagget at Fire Prevention Services (phone: 619–562–1058) for more information and availability of the brush-clearing head. At this printing, the head's price had not been set.

About the Author

Andy Trent is a project engineer at MTDC. He received his bachelor's degree in mechanical engineering from Montana State University in 1989. Before coming to the center in 1996, he worked as a civilian engineer for the U.S. Department of the Navy. Andy works on projects in the reforestation and nurseries, forest health protection, and watershed, soil, and air programs.

Library Card

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Describes the evaluation of a new steel-bladed head for brush-clearing saws that can be used to cut small-diameter trees (less than 2 inches in diameter) efficiently. The brush-clearing head has an aluminum alloy housing with three replaceable steel blades that do not have to be sharpened. The head eliminates many of the problems encountered when using circular saw blades to cut brush. The new tool may make it possible to thin stands of lodgepole pine or ponderosa pine while the trees are still young and small. Trees in these stands have usually been allowed to grow large enough so that they could be safely cut with chain saws. The crowded stands were growing slowly during this period. If the stands were thinned earlier, the remaining trees would grow more quickly, and wildlife species that prefer open stands would benefit. However, when trees are small, they must be cut off near the ground during thinning to keep their lowest limbs from regrowing. Making cuts close to the ground with chain saws can be dangerous and is tiring. In addition, chain saw blades must be resharpened when they strike rocks or dirt. So must the blades of circular saws. The steel blades of the head do not require sharpening, but they must be replaced when the blades have become too badly worn. In rocky areas, blades might have to be replaced daily. The head throws debris that can cause injuries. Operators must wear protective equipment. Even though operators wore protective equipment during the evaluations, they suffered minor injuries in the chest and groin.

Keywords: brush-clearing head, precommercial thinning, safety at work, saws, tools

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