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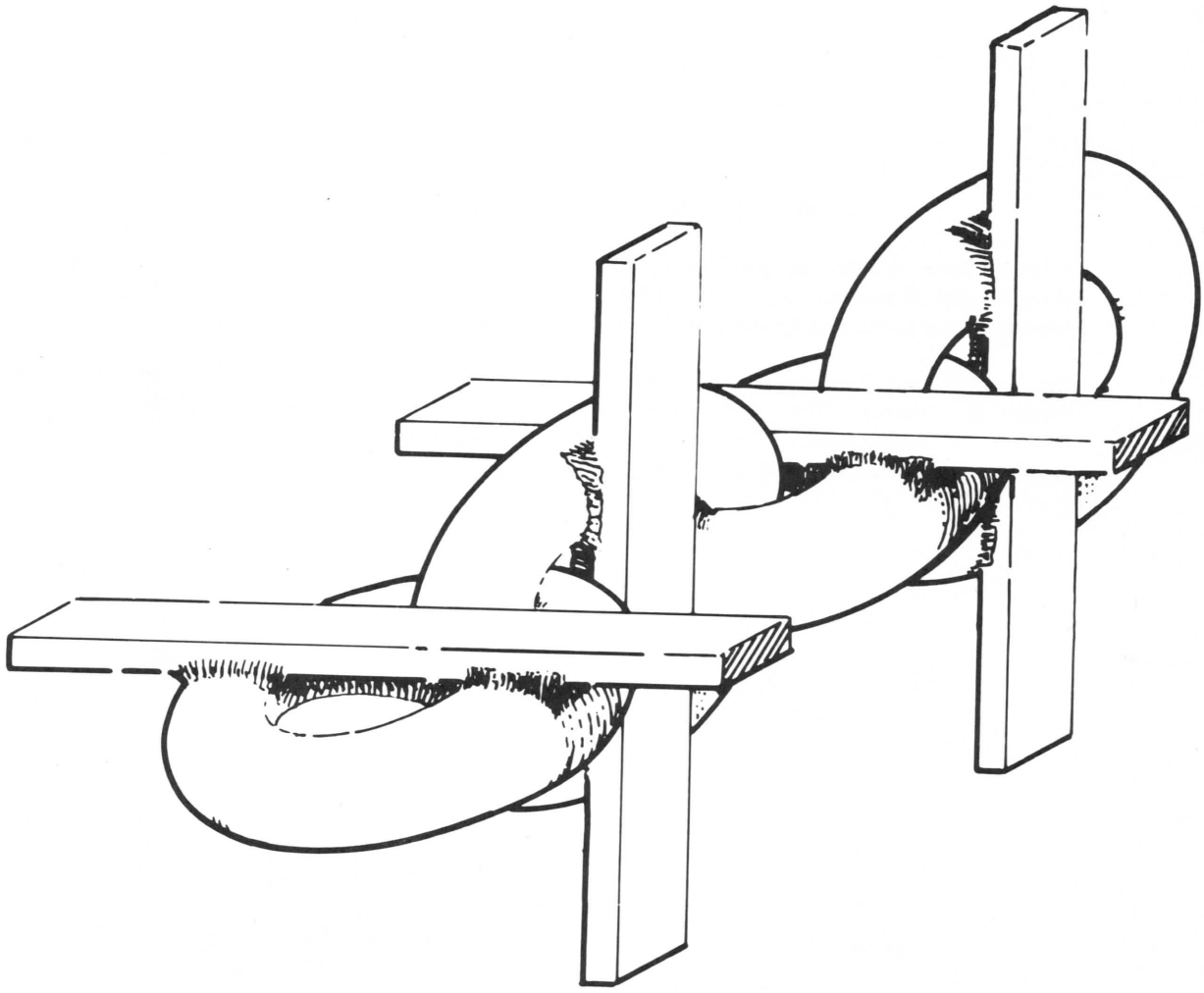
# Brush Management-

# Modified and Smooth Chains



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## INTRODUCTION

*Brush management through brush clearing or removal, usually in conjunction with a brush burning program, may involve several types of operations, each of which is best done by particular types of tools. Heavy, brushland disks may be used to knock down or incorporate low stands of material; dozing with the straight blade and brush rake in limited situations may be used to crush, clear, and pile brush; the chain or ball and chain equipment may be used to tear out and crush brush stands. For information on your particular needs, see also:*

*Brush Management—The Ball and Chain*, leaflet 2920.
*Brush Management—The Brushland Disk*, leaflet 2921.
*Brush Management—Straight Dozer Blade and Brush Rake Clearing*, leaflet 2923.

Controlled burning or "prescribed" fire is the most frequently used method for brushland management. The effectiveness of burning is increased when brush is mechanically treated or crushed, then allowed to dry 12 to 18 months.

One effective method of mechanical treatment for tearing out and crushing brush is the modified chain. Ranchers and land managers in California who have used this method report:

- better burns
  . . . fuel is concentrated on the ground.

- safer burns
  . . . crushed brush is drier than untreated vegetation and can be burned when wildfire hazard is minimal. This increases the possibility for summer burns if favorable weather occurs; summer burns produce ash seed beds that are not disturbed by rain.

- cleaner burns
  . . . most of the fuel is consumed and no blackened stems remain.

### Modified Chain

Fifteen or more years ago brush operators started preparing for burning by dragging ship anchor chains across brush fields between two tractors, crushing and compacting the brush. Generally good results were obtained. The Bureau of Land Management modified the anchor chain and improved its effectiveness by welding steel crossbars across, and extending beyond the sides of, each link (see fig. 1). The Bureau's "Ely chain," used in Nevada and New Mexico, was the model for modified chains now used in California. (Although more efficient, the modified chain is not as widely used as smooth or unmodified chain.)

**Size of tractors.** Most federal projects employing the modified chain have used tractors in the D8-46A category with 270 net engine horsepower. (For those dealing with drawbar horsepower, the equivalent can be calculated on the basis that drawbar horsepower equals 75 to 81 percent of net engine horsepower.) A few smaller tractors in the 200 to 230 net engine horsepower category have been used, but most operators recommend more

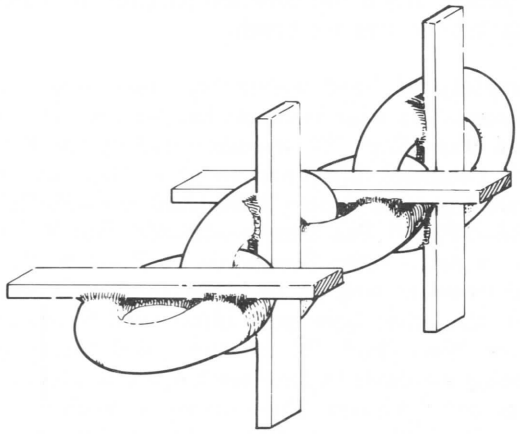

Fig. 1. Typical section of modified chain with welded steel crossbars.

power. Since traction is important when using the chain, a minimum track lug height of 2 inches is recommended.

**Size and length of chain.** The modified chain is made from heavy anchor chain, ranging from 40 to 90 pounds per linear foot. Chain usually is available only through Navy surplus in 90-foot lengths called "shots."

Modified chains vary from 90 feet (1 shot) to 270 feet (3 shots), depending on the size of tractors available, terrain, and the number of large trees and boulders. A 180-foot chain is a very practical length in mountainous terrain. The effective swath width averages about one-half the length of the chain, or about 90 feet for a 180-foot chain.

Cutting each shot of chain in half and inserting a Navy master connector link makes it possible to lengthen or shorten the chain by 45-foot increments, providing more flexibility in adjusting chain length and weight to terrain, obstacles, and tractor size. The chain also is easier to handle.

Heavier chains, from 60 to 90 pounds per foot before adding crossbars, are more effective. However, smaller chains have been used with generally satisfactory results. Furthermore, lighter chains are easier to handle and load onto trucks, and smaller trucks can be used for hauling.

**Modifying the chain.** The best results are obtained when the welded bars are perpendicular to each other from link to link. This means the bars should be welded onto every link or every third link. Bars will be parallel if welded onto alternate links. When the bars are at right angles to each other, the chain tends to "walk" and roll along, crushing, chopping, and sometimes pulling out brush. When the bars are parallel the chain tends to slide over the brush.

A variety of hard steels has been used for crossbars. The most resistant has been a material called Wearalloy® "B" manufactured by the Ford Steel Company, Maryland Heights, Missouri. Its physical properties are: BHN Hardness—350/380; Yield—170,000 Psi; Tensile—180,000 Psi; Reduction in Area—40%; Elongation in 2"—15%. This steel wears as well as, or better than, moldboard steel, the other type most often used to modify chains. Wearalloy® "B" has the added advantage of being available in long bar lengths of adequate width and thickness. This eliminates much of the expensive cutting necessary when moldboard or other steel plate is used.

®Registered trade name.

Recommended crossbar size is 1 inch thick, 3 to 4 inches wide, and up to 18 inches long — the length depending on the size of the chain. The bar should extend 4 to 5 inches on each side of the link.

When welding crossbars to the chain, first weld a small filler strip of strap iron to that side of the web of each link to which a crossbar will be attached. This raises the web almost flush with the outside level of the link and allows the crossbar to be arc-welded entirely across the link. Bars without this reinforcement have broken off in use.

**Brush removal techniques.** Most operators believe the best results are produced by pulling the chain in a broad J or U configuration with a swath width equal to about half the length of chain. Numerous variations have been used, depending on tractor size, terrain, and other factors.

Tractors should be of about equal horsepower so they can switch the lead position if a return swath is needed. They merely turn around in place and the tail tractor becomes lead tractor. To switch lead position, each tractor should be equipped with 20 to 25 feet of smooth lead chain with a swivel connecting the lead chain to the modified chain. The smooth chain allows the tractor to back up over it and turn around without running over the swivel and modified chain. A swivel at each end allows the modified chain to rotate and do a more effective job of crushing and tearing out brush.

A third swivel has been used by some in the center of the main chain; it allows each half of the chain to turn independently. The center swivel is not absolutely necessary, but it helps keep the chain from becoming twisted.

Many large swivels are available commercially. However, swivels made from D-9 track rollers and 1½-inch steel plate are used almost exclusively and serve the purpose quite well. The roller, with cover plates attached to keep out dirt, can be drilled and tapped to take a Zerk grease fitting, which should be protected by a raised welded ring. The swivels should be lubricated as often as the tractor. Swivels are usually attached to the modified chain with Navy master connector links and to the 20- to 25-foot smooth lead chain with a 2-inch diameter pin.

The smooth lead chain can be connected to the tractor on the rear drawbar or on the cable winch.

There is an advantage to using the cable winch connection. In heavy brush stands or in steep terrain where a tractor sometimes bogs down, the operator can winch out 50 to 100 feet, stop the tractor, and winch the chain up to it. Wherever tractors have difficulty getting traction, this proves very effective. Safety is another reason tractor operators like the winch attachment. Sometimes, in extremely high brush or in rough terrain, the operators lose sight of each other. One operator may be unaware when the other tractor stalls, and will continue to pull. This can result in pulling or twisting the stalled tractor. With the chain hooked to the cable, the operator of the stalled tractor can let out cable until he or the swamper gets the other operator's attention.

Because the modified chain is not very maneuverable it is hard to pioneer the perimeter of the area to be cleared. Often a tractor with a brush rake (usually one of the tractors used to pull the chain) can be used to cut the perimeter for the chain operation. This is very helpful, especially in difficult terrain. The brush rake also is helpful in defining buffer strips along stream bottoms.

**Capabilities of the modified chain**

*Vegetative types.* The modified chain is very effective in all types of chaparral (see table 1). Most operators suggest that two passes with the chain — in opposite directions — are needed to prepare brush for burning. However, one pass may be enough. In mature chaparral on the Cleveland and Los Padres National Forests, prescribed fire burned mature chaparral that had been crushed with one pass of the chain. Untreated brush outside project areas did not ignite during these burns.

In chaining operations, particularly during a second pass, there is a tendency for a windrow of brush to build up near the bottom of the chain loop. The chain eventually rolls over the windrow, but it again starts to accumulate brush. These windrows and the smaller scattered piles are easily burned.

Large trees, scattered or in groves, create problems because the modified chain is not very maneuverable. Depending on species and topogra-

TABLE 1. BRUSH CLASSIFICATION BY TYPE AND VOLUME.

| Vegetative Type[1] | Vegetation loading[2] | | |
|---|---|---|---|
| | Light | Moderate | Heavy |
| | tons/acre (estimated) | | |
| Light to medium chamise (2.5'-5' high) | — | 7-15 | 16-25 |
| Low brush mixtures including combinations of big sagebrush, California sagebrush, California buckwheat, white sage, black sage, coyote brush, chamise, and sumac (2'-5' high) | — | 7-15 | 16-25 |
| Mixed brush (5'-6' high) and scrub oak | 10 | 11-25 | — |
| Heavy pure chamise, manzanita or buckbush (4'-8' high) | — | 20-30 | 31-40 |
| Heavy mixed brush (6'-8' high) | — | 20-30 | 31-45 |
| Mixed brush with toyon, oaks, big manzanita and madrone on north slopes at higher elevations and latitudes (8'-12' high) | — | 30-45 | 46-60 |

1. Adapted by Clive Countryman and Lisle Green, U. S. Forest Service, and T. E. Adams, Cooperative Extension, from *Fireline Handbook*, U. S. Forest Service.

2. Prepared by Clive Countryman and Lisle Green, U.S. Forest Service.

phy, trees larger than 12 inches in trunk diameter (measured 4.5 feet from the ground) may be difficult to remove and will require extra maneuvering. This lowers the rate of production considerably. Low maneuverability also makes leaving islands for landscape and wildlife purposes difficult.

*Slope.* The modified chain is effective on uniform slopes up to 30 to 35 percent. Where winches pull the chain, slopes up to 45 percent have been treated successfully. The more rugged and broken the terrain the less effective the chain becomes.

*Rocks.* In most situations, rocks affect operations very little. Small rocks are moved or the chain tends to walk or roll over them. Very large boulders with perpendicular sides can catch the chain, requiring one of the tractors to back up and go around. Production is reduced considerably, but most users still are impressed with the capability of the modified chain in very rocky country.

*Roads.* When roads are crossed by the chain, the equipment can damage berms, fills, and overside drain structures.

When roadcuts are not too high it is possible to work above them by walking one tractor — usually the lead tractor — along the road. This technique has been used quite successfully on slopes that would otherwise be considered too steep.

*Production rate.* In light brush of less than 15 tons per acre, the rate of production has averaged 3.5 to 4.2 acres per hour on Forest Service projects in southern California. In heavier brush of 15 to 30 tons per acre, production rate dropped to 2 to 3 acres per hour. Where brush volume exceeded 30 tons per acre, production rate averaged 2.3 to 2.9 acres per hour. These rates include two passes, one in each direction. The lower rates in each case were on slopes of 25 to 35 percent. Higher figures reflect rates on slopes of less than 25 percent.

## Smooth Chain

Although modified chain is more efficient than smooth chain, smooth chain has proved to be an effective tool.

For example, in February 1960 on the cooperative Ranchita Range Study in San Luis Obispo County, heavy mixed brush 10 or more feet high was crushed by using smooth chain. Topography included broad, rolling ridges separated by narrow, steep-sided canyons. Slope near the top of each ridge averaged 30 to 35 percent.

The chain, 160 feet long, 75 pounds per foot, was pulled by two crawler tractors equivalent to the D7. On average slopes the tractors chained both up- and down-slope. On steeper slopes, contour or down-slope chaining was necessary because of the heavy chain weight.

To facilitate operation of the chain, a 30-foot length of 1¼-inch wire cable was used for attachment, by swivel, to each tractor. Cable attachment to the chain also was by swivel. A fifth swivel in the middle of the chain improved rolling and prevented twisting and knotting of the chain.

The equipment easily treated 8 acres per hour in one pass on broad ridges. On steeper side slopes production rate was halved.

Live oak trees up to 16 inches in trunk diameter were uprooted by the chain. Larger trees were pushed over with a straight dozer blade.

In October, eight months after crushing, the debris was burned completely; adjacent untreated brush could not be ignited.

## Costs

Costs of tractor operation can be calculated from data in "Farm Machinery Costs," L2263, Division of Agricultural Sciences, University of California. To these costs should be added cost of transportation, support equipment costs, and pay for tractor drivers and swamper(s).

On-site costs to the Forest Service in southern California, through 1973, have varied from $15 to $50 per acre in light brush and from $20 to $75 per acre in medium to heavy brush, for two passes. Computation of current costs requires adjustments for inflation.

## General Recommendations

*Safety.* On steep slopes, the lead tractor should be on the downhill side. This puts it ahead of rolling rocks knocked loose by the chain and the tail tractor.

Swampers should be behind or above the tractors and chain. They should not ride the tractors unless seats are provided.

*Communications.* Communications are very important for most operations where heavy equipment is being used. When two tractors are working as a team with one swamper, the usual hand signals are inadequate. Radio communications are strongly recommended when chaining, both for tractor operators and the swamper. In heavy brush it is easy for tractors to go off course. If the crew has radio communication the swamper can oversee and direct the operation from vantage points. Radio contact is very important when an operator and his tractor get in trouble.

Small citizens' band radios have been used to good advantage. The radios are mounted on the tractors and the operators are provided with headphones. Recent improvements such as the bone-conducting microphone and smaller earphones — both of which can be worn under a hard hat — have made this equipment comfortable to wear.

Another communications technique is dune-buggy whips with high visibility flags attached, fastened to the top of tractor canopies. Each operator and the swamper can keep sight of the tractors in high vegetation and in broken terrain. This inexpensive technique is recommended for all chaining operations.

*Use of contractors.* Contracts should be written so that both tractors are provided by the same contractor. Two separate contractors working with the same chain can generate problems: one contractor may think the other is not doing his share; if one contractor's tractor breaks down, the other contractor will still want to work, and if unable to do so, may bring a claim against the project or the other contractor.

Advantages and disadvantages of crushing brush with the chain:

**Advantages**

Costs per acre relatively low.

High rate of production.

Minimum soil disturbance.

Debris left on soil surface helps reduce erosion potential.

Works relatively well in rocky areas.

Crushed brush can be burned when surrounding untreated brush fields will not ignite readily.

**Disadvantages**

Not very maneuverable, difficult to leave specimen trees or clumps.

Needs radio communications.

Removes few roots and root crowns; resprouts are numerous.

Little or no debris incorporated into soil.

Application limited by slope and irregular terrain.

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