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Chaining Trees after Wildfire

Tree encroachment within the Great Plains fire-dependent native prairies causes numerous deleterious impacts to rangeland livestock production and ecosystem functions. In 2016 and 2017, south-central Kansas experienced two of the largest recorded wildfires (Anderson Creek 313,000 acres and Starbuck 509,000 acres) in recorded history, resulting in millions of dead trees within native mixed-grass prairie. In addition to more immediate needs, part of the wildfire recovery was addressing dead-standing trees on 100s of thousands of acres (Figure 1). Dense stands of dead-standing trees (>200 trees per acre) are a resource concern due to being a vector for invasive tree seed dispersal, sheltering seed bank tree regeneration, providing raptor perches, grassland bird avoidance, preventing livestock utilization and range management practices. Standing dead trees are not readily consumed by prescribed burning and need to be incorporated into the herbaceous layer.

Figure 1. *Photo before 2016 Anderson Creek wildfire depicting closed canopy eastern redcedar within native prairie and steep drainages.*

Photo at same location after wildfire with dead-standing trees.

Traditional tree felling techniques in south-central Kansas include skid steer mounted saws and grapples; however, other techniques are needed for steep drainages, rough topography and dense stands that can be inaccessible or yield high costs for the landowner. Chaining (i.e. ship anchor chain pulled by 2 parallel tractors) has been reported to be cost efficient relative to other techniques for certain topography, tree heights, diameters and densities (Valentine 1961, McKenzie et al. 1984, Weidemann and Cross 1996, Bidwell personal communication 2013) (Figure 2).

Figure 2. *Elevated ship anchor chain, 6-foot tall roller ball in center, between 2 225 hp tractors, Barber County, Kansas 2019.*

OBJECTIVES of the chaining projects were:

1. Determine if dense dead trees in certain size drainages could be felled
2. Assess soil disturbance and percent tree breakover vs. uprooting (high soil disturbance) relative to time since fire
3. Calculate cost per acre
4. Examine equipment requirements and operations
5. Amount of tree residue after a prescribed burn

LOCATION Chaining was conducted in mixed-grass prairie, primarily Red Clay Prairie ecological site (PE 20-25), in south-central Kansas in February 2018, November 2019 and August 2020. Chaining sites had experienced a March 2016 wildfire; thus, dead trees had been present for 2 years, 3 years 8 months and 4 years 5 months since the wildfire. Also, an area of 8-year-old dead trees was present from a 2010 wildfire that was also chained. Drainages had 20 to 120 foot elevation changes with slopes around 12% at the base of drainages and 57% to 100% at the top of draws. Widths across drainages to level uplands were up to 290 feet. Tree composition was predominately eastern redcedar with smaller amounts of Siberian elm, cottonwood, walnut

and hedge. Prior to the wildfire, many areas were closed canopy cedar. Sites ranged from 100-200 trees per acre and had an average tree stem diameter of 10.5 inches (range 4 to 20-inch diameter).

METHODS The elevated chain consisted of a 6-foot diameter roller ball with an axle/bearing assembly through the middle and 90 feet of 3-inch, 27-pound link ship anchor chain on either side. In 2020, 100 additional feet of ship anchor chain ($40/ft) was purchased along with 2 swivel assemblies ($1,250 each) for a total chain length of 280 feet. Past research reported the 6-foot diameter roller ball would elevate the striking height on trees, requiring significantly less force (~84%) to fell compared to ground height (Weidemann 1996). The chain was attached to the bulldozers winch lines to allow additional length as needed for sloped draws and adjusting location of the roller ball. Local ranches engineered swivels that were attached between each dozer's winch line and chain (Figure 3) to prevent twisting (i.e. tightening and loosening) of winch lines. Two 225-horsepower dozers ran parallel along draws, pulling the chain in a horseshoe pattern to limit strike length and to windrow trees. Draws were chained downslope and upslope. One operator may travel in the bottom of a drainage as needed for wide draws.

Figure 3. *Rancher engineered swivel assemblies, 27-pound link and 6-foot roller ball assembly.*

RESULTS

A total of 52 acres and 63 acres of dead-standing trees were chained in 2018 and 2019, respectively. The percentage of dead trees breaking over at ground level increased with time since fire (Table 1) (Figure 4). A few live eastern redcedar trees were chained and all uprooted, causing significant soil disturbance. It was observed that 2019 uprooted trees were broken at the base of shallow lateral roots with lower depth of soil disturbance than 2018. When the chain was pulled in a horseshoe pattern, the downed trees were windrowed and limbs broken over (Figure 5)

Table 1. Percentage of dead-standing trees breaking over at ground level vs. uprooting after chaining at varying time since wildfire.

Time Since Wildfire	% Trees Breaking Over at Ground Level	% Trees Uprooting
2 years (n=513)	65%	34%
3 years 8 month (n=314)	77%	23%
8 years	100%	0%

Figure 4. *Uprooted tree (left picture) vs. tree broken at ground level (right picture).*

Including the cost of dozer operation ($165 per hour per dozer with mobilization) and any down time for equipment maintenance and repair, the cost was $141 per acre in 2018 ($70.81 without down time) and $126.38 per acre in 2019 ($86.02 without down time). Landowners / managers were on hand to assist with operations and repairs as needed. Down time in 2018 was primarily due to cable breakage from lack of

on day 1. Other delays consisted of operational experience, equipment being stuck and clasp
acement.

Figure 5. *Trees windrowed and limbs broken down after chaining in horseshoe pattern.*

The 2018 chaining site was prescribed burned in 2019 and the 2019 chaining site experienced a wildfire in 2020. Based upon on-site observations, approximately 65% of the downed tree residue was consumed, depending upon the location.

DISCUSSION Chaining was efficient and effective at felling dead trees, windrowing and incorporating dead-standing trees into the herbaceous fuel layer for follow-up prescribed burns. Standing dead trees are not consumed as readily by prescribed fire as trees incorporated into the herbaceous layer. It is recommended to chain 4 to 5 years after fire to minimize the force required to break over trees and limit uprooting. Due to erosion concerns, chaining of live trees in south central Kansas is not recommended. Positioning the ball near larger trees to raise the striking height allowed felling when chaining at ground level would not. It is recommended to chain downslope to utilize gravity and prevent dozer tracking. Valentine (1971) reported slopes up to 50% could be chained; however, Payne and Bryant (1998) recommend chaining for slopes < 20%. Slopes on this project varied from 12% to 57% or more. Steeper slopes required more coordination of the operation, but were possible. Increased soil disturbance, such as the chain cutting through steep ridges may occur on rougher topography. Some soil disturbance occurs during dozer tracking; however, chaining trees in drainages required one pass compared to significantly more travel required by a tracked skid steer with a saw and grapple. Chaining sites should be evaluated and selected based upon good range condition (% ground cover and climax species), canyon widths, access and soil type. Locations need adequate fuel loads for follow-up burning. Planning the route improves efficiency and practice chaining benefits dozer operations. The chain length to swath ratio should be 2:1 to 3:1 to reduce force required and promote windrowing. Upland trees should be cut before chaining drainages. The $133.69 average cost of chaining was significantly less than the NRCS woody residue payment rate $465.26 (60% rate); however, the estimated cost only included bulldozer operation and mobilization. Costs for the chaining materials or renting the chain were not included. The chain links and drum have not required any repair. Wiedemann (1996) reported chaining an average of 12.1-12.4 acres / hour with a 6-foot elevated chain and live trees. In this project, chaining of moderate to steep drainages ranged from 2.3 – 4.66 acres per hour. Operators proposed adding more chain and an additional roller drum nearer the dozers.

LITERATURE CITED

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Photos before (above) and after (below) chaining dead-standing trees

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