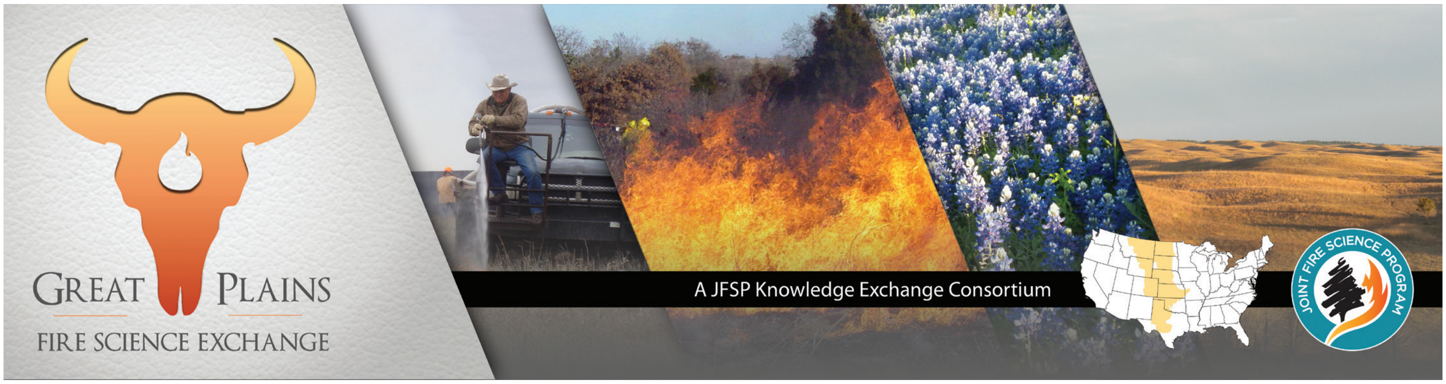

Use of elevated chaining for cedar skeleton removal following fire

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INTRODUCTION

Tree encroachment in Great Plains grasslands negatively impacts prairie plants and wildlife, along with decreasing forage production for livestock. Two large wildfires occurred in southern Kansas in 2016 and 2017. These wildfires burned with great intensity, killing many of the undesirable trees but leaving the dead tree skeletons on hundreds of thousands of acres. The standing dead trees within the mixed-grass prairie still provide perches for birds that spread invasive tree seeds, alter wildlife behavior, provide protection for unwanted tree seedlings, as well as interfere with livestock handling and other range management practices (Figure 1).

Figure 1. Tree skeletons, primary eastern redcedar, interefere with livestock handling and provide perches for birds who reseed trees.

Standing dead trees (also called skeletons) on accessible upland sites are frequently removed with skid-steer mounted saws and grapples, while areas within steep drainages, rough topography, and dense stands require other techniques. Chaining offers one effective solution.

METHODS

Chaining consists of a large anchor chain (typically 25-90 pounds per link, 100-500 feet long) attached at each end to a heavy-duty tracked vehicle, such as a bulldozer.

The dozers work in tandem, moving parallel to each other, dragging the chain between them. When the chain encounters a tree, it snaps it off near ground level and the tree and broken-off branches fall to the ground.

In wide draws, one side may be chained at a time, with one dozer on the upland and the other in the bottom of the draw. Otherwise, the dozers are generally positioned on the upland on either side of the ravine, with the chain dragging down the sides and across the bottom.

A six foot diameter hollow steel roller positioned mid-way along the chain reduces dragging friction and slightly elevates the height at which the chain contacts trees. The elevated chain was found to reduce the amount of chain force needed by 67% to knock trees over, thus reducing fuel costs and the size of the dozers needed to effectively pull the chain.

Dragging the chain in a curve results in tree skeletons being windrowed and positioned on the ground, thus

Figure 2 a-b. Chaining ravines leaves tree skeletons on the ground for rapid consumption in the next prescribed burn.

allowing them to be burned up in the next prescribed burn. Consumption of downed tree carcasses in a first post-chaining prescribed burn was observed to be about 65%. Consumption is dependent on the 100-hour and 1000-hour fuel moisture content at the time of the burn.

Postponing a prescribed burn after a wildfire may allow more grasses (fine fuels) to accumulate, resulting in increased fire intensity, thus greater consumption of downed tree skeletons.

Chaining is most successful if trees are allowed to fully dry out at least 3 years post-fire. This allows the roots to rot, requiring less force to break trees off at the ground level. It has been found that tree skeletons chained immediately after a fire are more likely to be uprooted rather than snapped off, resulting in large root balls on the surface and more soil disturbance (Figures 2 and 5).

Years since fire	% of trees snapped off	% of trees uprooted
2.0	66	34
3.6	77	23
8.0	100	0

Figure 2. Tree skeletons are more likely to be snapped off rather than uprooted if chaining operations are postponed for several years after trees die.

Figure 3. Trees of substantial size can be snapped off with chaining.

Chaining has successfully been used to knock over dead mature elm, cottonwood, redcedar, walnut, and hedge (bois d'arc) trees, as well as cedars at densities up to 200 trees per treated acre (closed canopy when alive) in prairie drainages with greater than 80 feet elevation changes and slopes greater than 30%. (Figure 3).

CONSIDERATIONS AND MANAGEMENT TECHNIQUES

- The chain-length-to-swath ratio (i.e. chain length-length of chain striking trees) should be between 2:1 to 3:1 so dozers work together and not against each other, and to promote windrow formation.
- When large trees are encountered, positioning the chain so the roller is near the tree aids in snapping off the tree as the chain is pulled. Chaining operations

generally move from upslope to downslope to minimize dozer tracking and maximize the impact of the chain on trees.

- Sites should be evaluated for compatibility with chaining, including range condition, canyon widths, access, and soil type. Determine a route for dozers that maximizes their efficiency. Remove trees on the upland prior to chaining to increase accessibility and maneuverability. On upland areas not used for driving access within the pasture, it may be efficient to chain (12 acres/hour) tree skeletons if stands are over 100 trees/acre.
- Dozer operator experience influences chaining time and cost.
- When chaining live trees the chain must be attached directly to the dozers. When chaining tree skeletons in the draws and canyons it is best to attach the chain to the winch on the dozers, allowing dozer operators to quickly adjust the length of the chain, making it easier to maneuver around impassable areas without impacting the other dozer or slowing down the operation. Using the winch cable to adjust the chain length also allows operators to keep the chain down on the ground and not ride up over trees at lower elevations in draws or canyons.
- Steeper slopes (>50%) require more coordination between operators than shallower slopes. On steep ridges and highly uneven terrain, the chain may cause some soil disturbance, but normally not enough to cause erosion problems. Dry soil conditions results in more snapped trees and less soil disturbance during chaining operations.
- Single pass chaining with tracked dozers can leave a smaller footprint than many passes made with a skid steer loader to cut trees.
- Calls should be made prior to chaining to locate pipelines and other infrastructure that may be damaged if snagged.

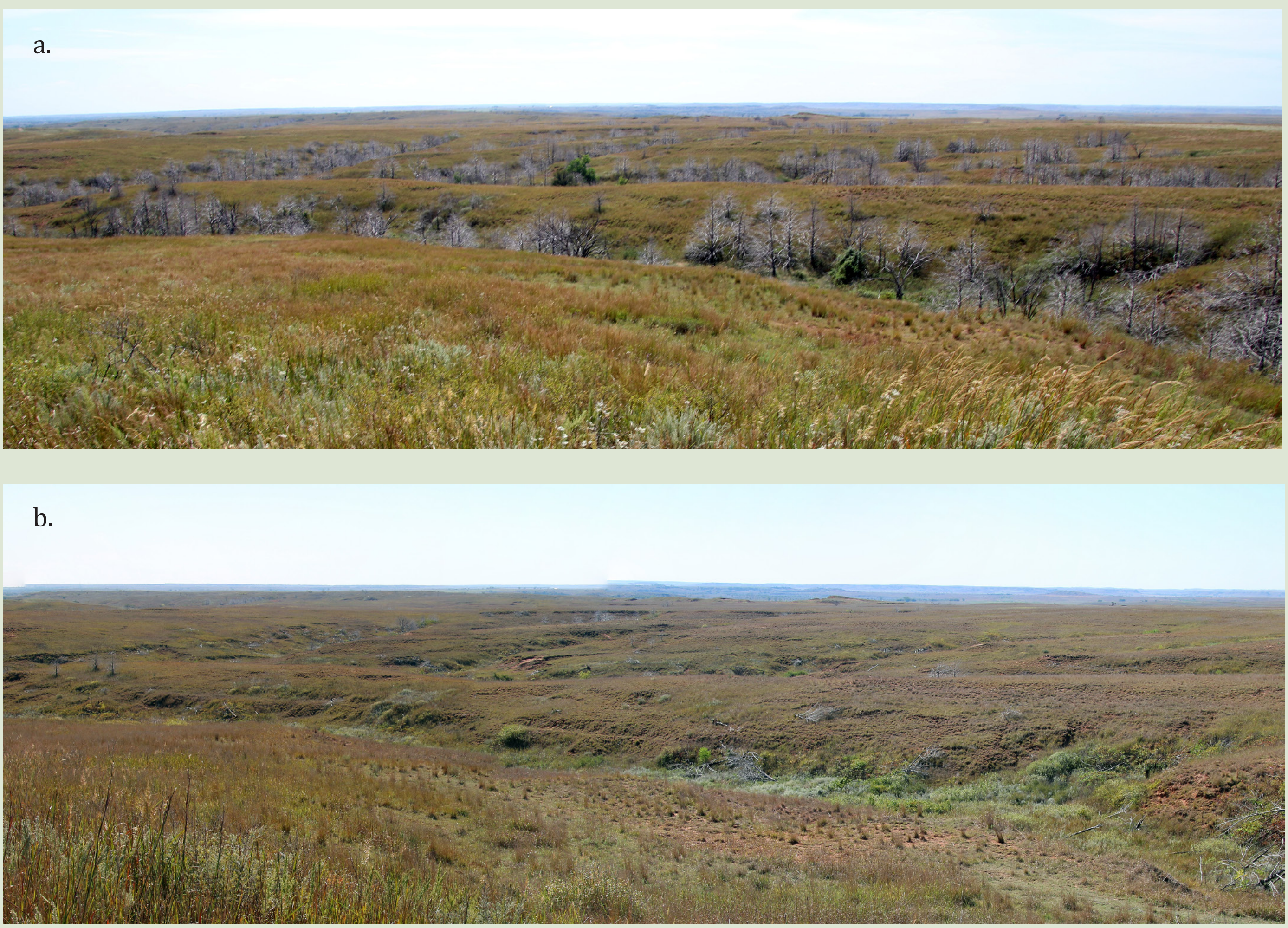

Figure 4 a-b. Before (a) and after (b) photos reveal the effectiveness of chaining through ravines. Tree skeletons left by a wildfire have been laid on the ground where they can be readily consumed by fire.

Figure 5 a-b. Postponing chaining for several years after tree death can result in more trees breaking off (snapped) (a) rather than being uprooted (b). Uprooting trees causes greater soil disturbance.

Figure 6 a-b. A hollow steel ball (a) is attached to an axle and connected to a marine anchor chain pulled by two dozers (b). Steel roller ball illustrated is 54" in diameter with 4" solid steel axle through the body.

Figure 7 a-e. A swivel assembly keeps the chain from kinking: a. cable; b. chain and clevis hook; c. swivel; d. clasp; e. anchor chain.

Figure 8. Chaining operation in progress showing arrangement of dozers pulling the chain across a ravine. Chain outlines a "horseshoe " shape (curve) that leaves broken off trees and branches in a loose windrow. The chain curve between dozers results in a swath width considerably less than the overall length of the chain.

COSTS

Estimated costs (2021) for chaining drainages are summarized in Figure 9. Maintenance and repair time are influenced by operators' experience with chaining, equipment becoming stuck, and clasp replacement. Costs were 3-10 times less than other traditional techniques such as using a skid steer or feller buncher.

Item	Cost	Notes
Dozer operation	$165/hour	With maintenance and repair time included, costs range from $70.81/acre to $141/acre; 2.3-4.6 hours/acre; 225 hp dozers with winches; winch cable should be at least 1 1/8 inch in diameter.
Roller (steel buoy)	varies	4-6' diameter with center axle/bearing assembly; at least one roller should be installed near the middle of the chain; 6' diameter hollow steel mooring buoy can be used: shop-built axle assemble will an additional cost.
Chain	$40/foot	3-inch diameter, 27^{+}-pound link ship anchor chain; average chain length is 200'-500'; chain will roll when pulled.
Swivel assembly	$1,250	Can be shop-built for less; attach between dozer winch cable and chain end to reduce untwisting and breaking of the cable while in operation.
Clasp	$450	Attaches chain to the dozer cable; swivel is placed between clasp and dozer.

Figure 9. Estimated costs for chaining equipment may include shop-built items. Used marine supply companies are a good source of chaining equipment.

SUMMARY

Chaining promotes removal of tree skeletons by laying them on the ground surface where they can be consumed with a prescribed burn, rather than remaining standing for perhaps decades. Rangeland management activities can be planned and accomplished without the interference of tree skeletons. Chaining can rapidly remove hundreds of tree skeletons in a relatively short time without damaging desirable plants or causing erosion.

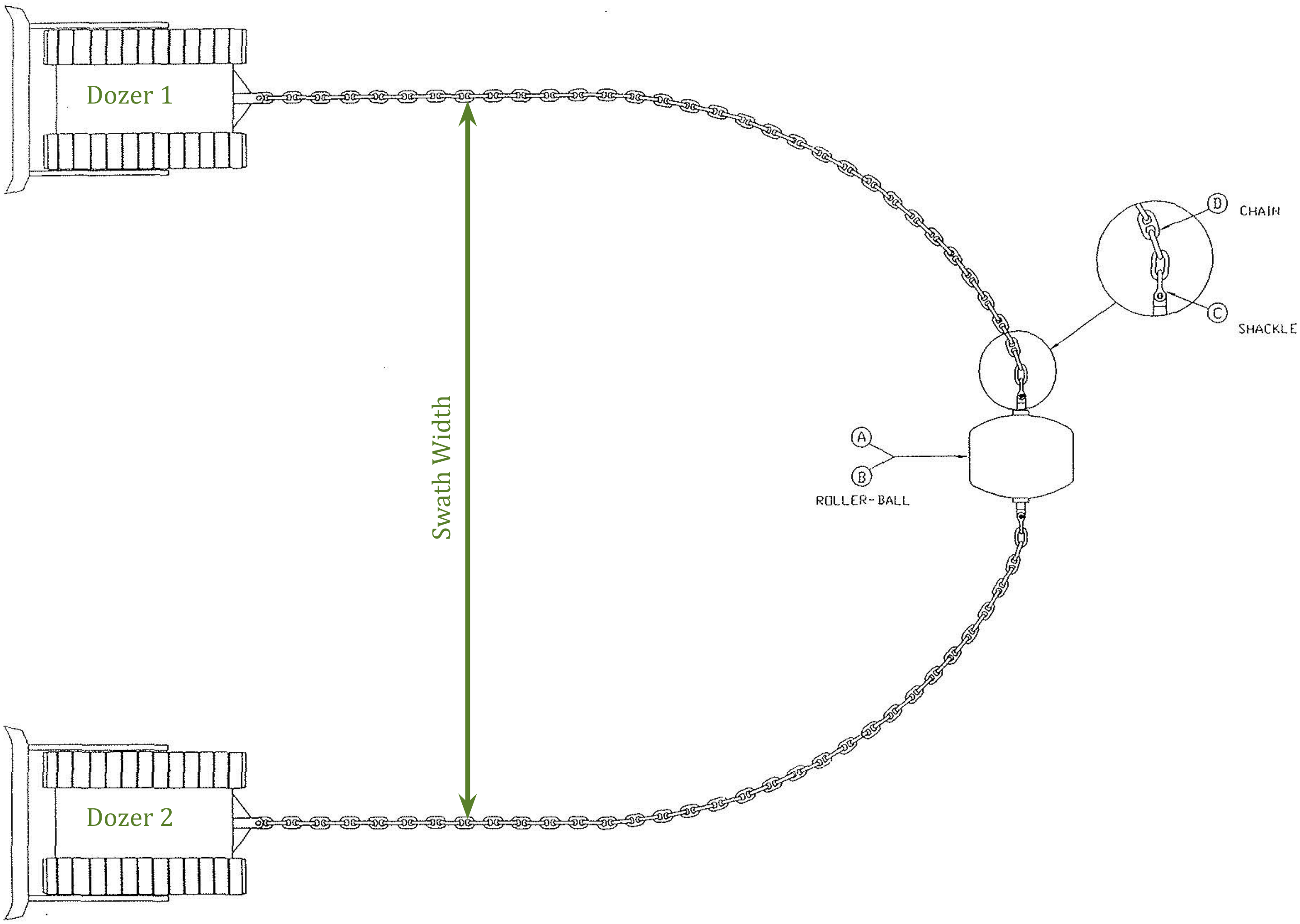

Figure 10. Top view of dozer and chaining assembly.

Materials List for Figures 10, 11, and 12			
	Part Name	#	Description
A,B	Roller Ball	1	
C	Shackle	2	2 ft. screw pin anchor shackle
D	Chain	2	20623 (27 lbs/ft.) x 90 anchor chain
1	Roller	1	Parts 2-5
2	Eliptical tank head	2	48” OD x 0.5” wall
3	Spacer	1	12’’6.8125” x 0.5 steel plate rolled to 48” OD
4	Shaft	1	4” cold rolled steel; length varies with head dimensions
5	Hub Shield	2	11” x 0.375 wall tubing
6	Roller Assembly	1	
11	Bearing Assembly	2	
18	Hub Assembly	2	

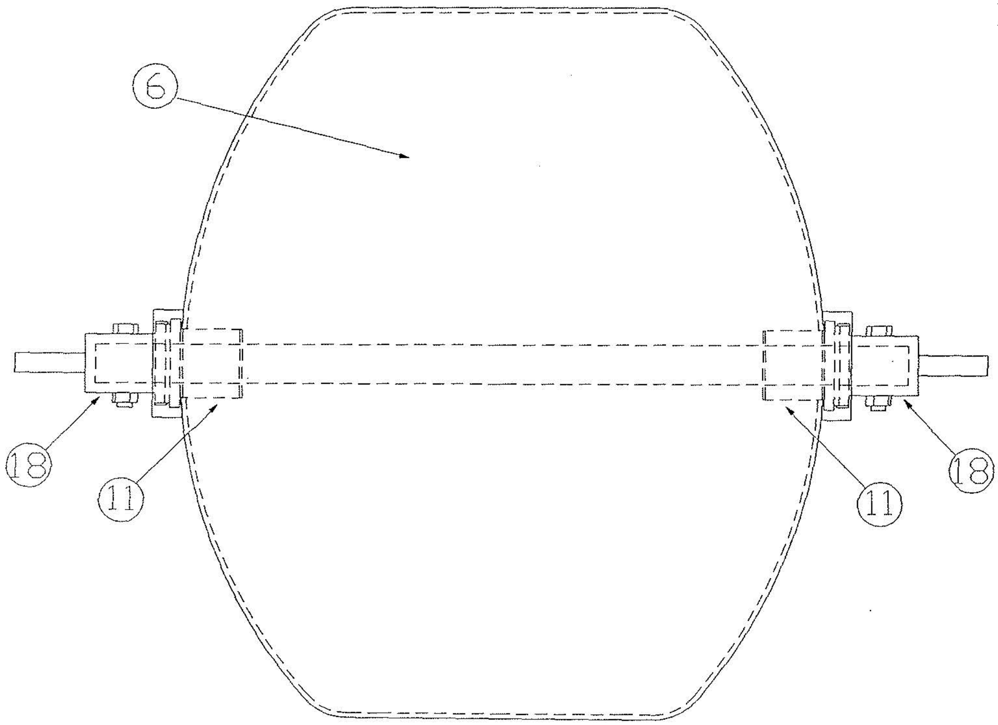

Figure 11. Side view of roller ball chaining assembly.

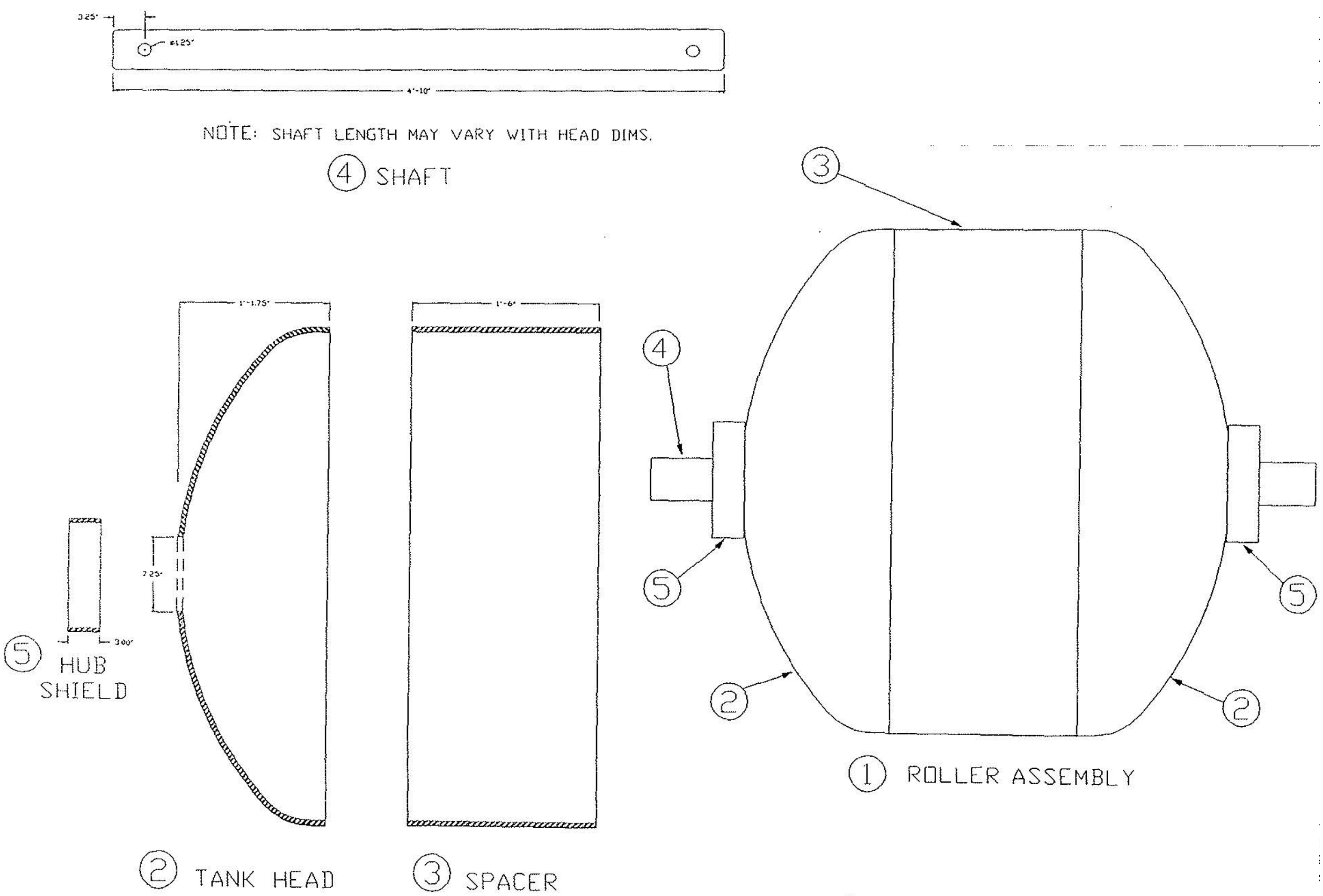

Figure 12. Detail of roller ball chaining assembly.

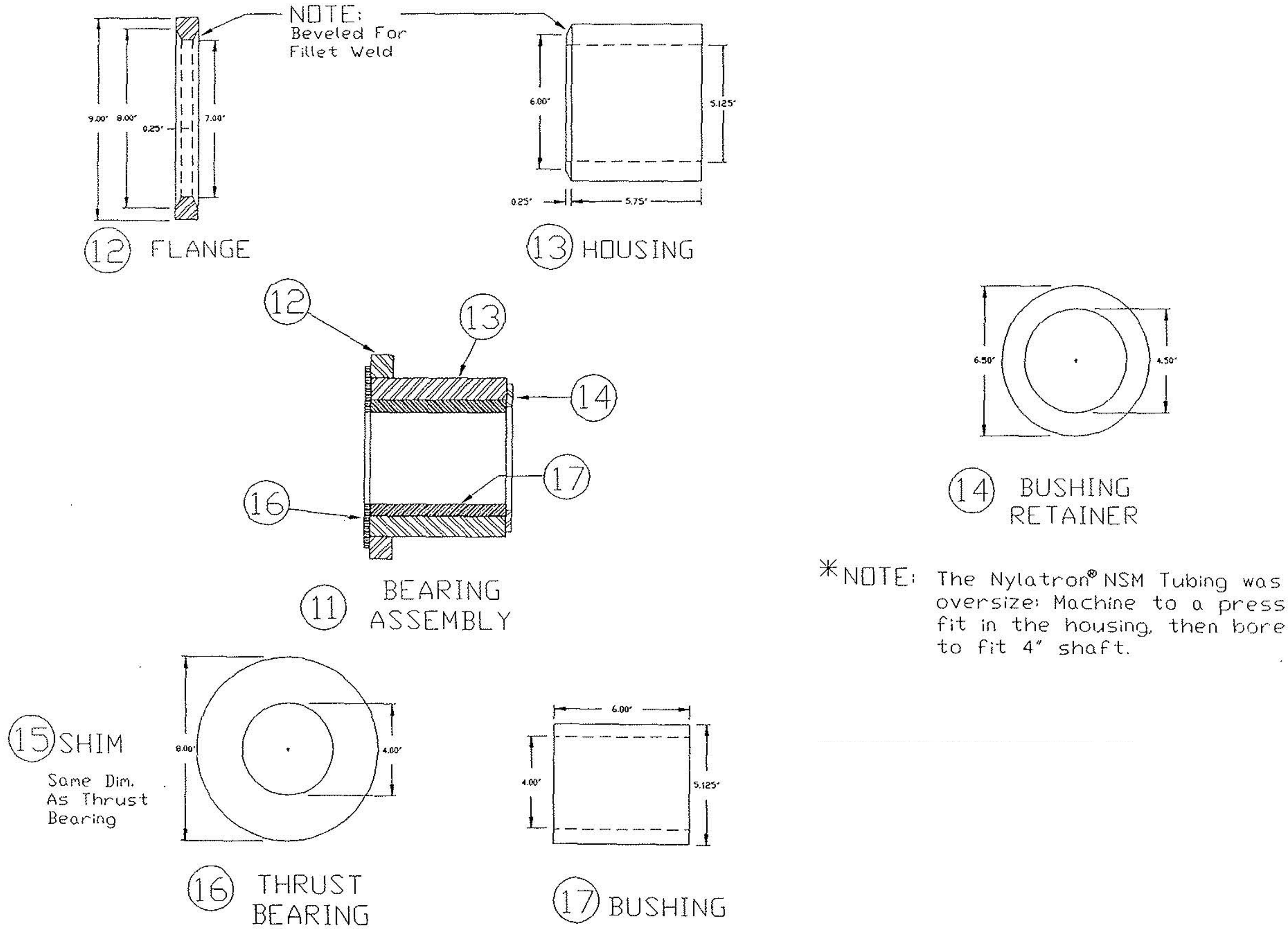

Figure 13. Detail of bearing assembly.

Materials List for Figure 13			
	Part Name	#	Description
11	Bearing Assembly	4	Parts 12-17
12	Flange	1	1" plate steel
13	Housing	1	7" x 1" steel wall tubing
14	Retainer	1	0.25" plate steel
15	Shim		14 gauge hot rolled steel
16	Thrust bearing	1	0.25" Nylatron® NSM
17	Bushing	1	5" OD x 4" ID Tube Nylatron® NSM

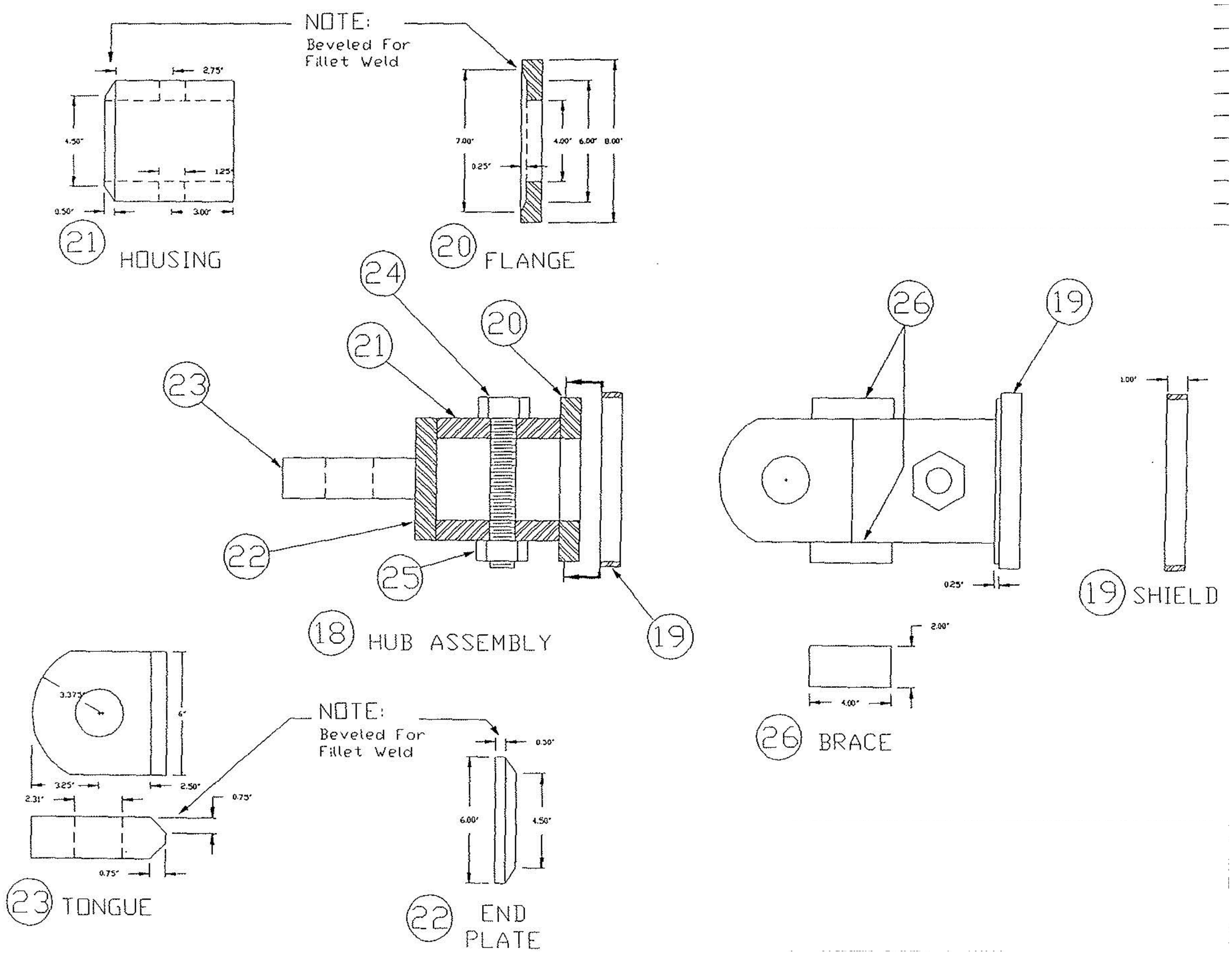

Figure 14. Detail of tongue assembly.

Materials List for Figure 14			
	Part Name	#	Description
18	Hub Assembly	4	Parts 19-26
19	Shield	1	8.5” x 0.25” wall tubing
20	Flange	1	1’ plate steel
21	Housing	1	6” x 1” wall tubing steel
22	End plate	1	1” plate steel
23	Tongue	1	2” plate steel
24	Cap screw	1	8” x 1.25” x 12 NF Grade 8
25	Locking nut	1	1.25” x 12 NF Grade 8
26	Brace	2	1” plate steel

PHOTO GALLLERY

Figure 15 a-b. Additional types of swivels.

ADDITIONAL RESOURCES

Video links: https://youtu.be/TWMIMehyEoQ https://www.facebook.com/ksgrazinglandscoalition/videos/423675742610103

The chain and ball assembly illustrated in this publication is owned by the Oklahoma State University Department of Natural Resource Ecology and Management and may be available to be borrowed or rented. For information, call 405.744.5437. Inventory reference #405-744-5000.

For more information about chaining, contact your local NRCS office, conservation district, or state wildlife biologist.

The following companies sell equipment useful for chaining. No endorsement is intended, nor is criticism implied of similar suppliers not mentioned.

Buoy ball (**steel roller ball**). Blue Ocean Marine Equipment <http://blueoceanmarineequipment.com/marine-supply-equipment/surplus-equipment/>

Chain, swivels, and couplers. Anchor Marine and Industrial Supply, 6545 Lindbergh, Houston, TX 77087. 713.644.1183.

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Adapted from:

Flanders, A. 2021. Chaining trees after wildfire. Kansas Grazing Lands Coalition Field Day, October 21, 2021, Hardtner, KS. Handout.

Bidwell, T., M. Wiederman, G. Schultz. 1993. Roller-ball chain specifications. Texas A&M University, Chillicothe-Vernon.

Photo credits:

Figure 1: Carol Baldwin

Figures 2, 3, 4, 5, 7, 9: Aron Flanders, USFWS KSPFW

Figure 8: Z Bar Ranch, Luke Yearout

Related Publications:

Bidwell, T. G., J. R. Weir, D. M. Engle. 2002. Eastern Redcedar Control and Management – Best Management Practices to Restore Oklahoma's Ecosystems. Oklahoma Cooperative Extension Service, Oklahoma State University

McKenzie, D., F. R. Jensen, T. N. Johnson, and J. A. Young. 1984. Chains for Mechanical Brush Control. Rangelands (6) 3: 122-127.

Payne, N. F. and F. C. Bryant. 1998. Wildlife Habitat Management of Forestlands, Rangelands, and Farmlands. Krieger Publishing Company, Malabar, Florida.

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Wiedemann, H. T. and B. T. Cross. 1996b. Draft requirements to fell junipers. Journal of Range Management. 49(2): 174-178.

For more information, visit www.gpfirescience.org.