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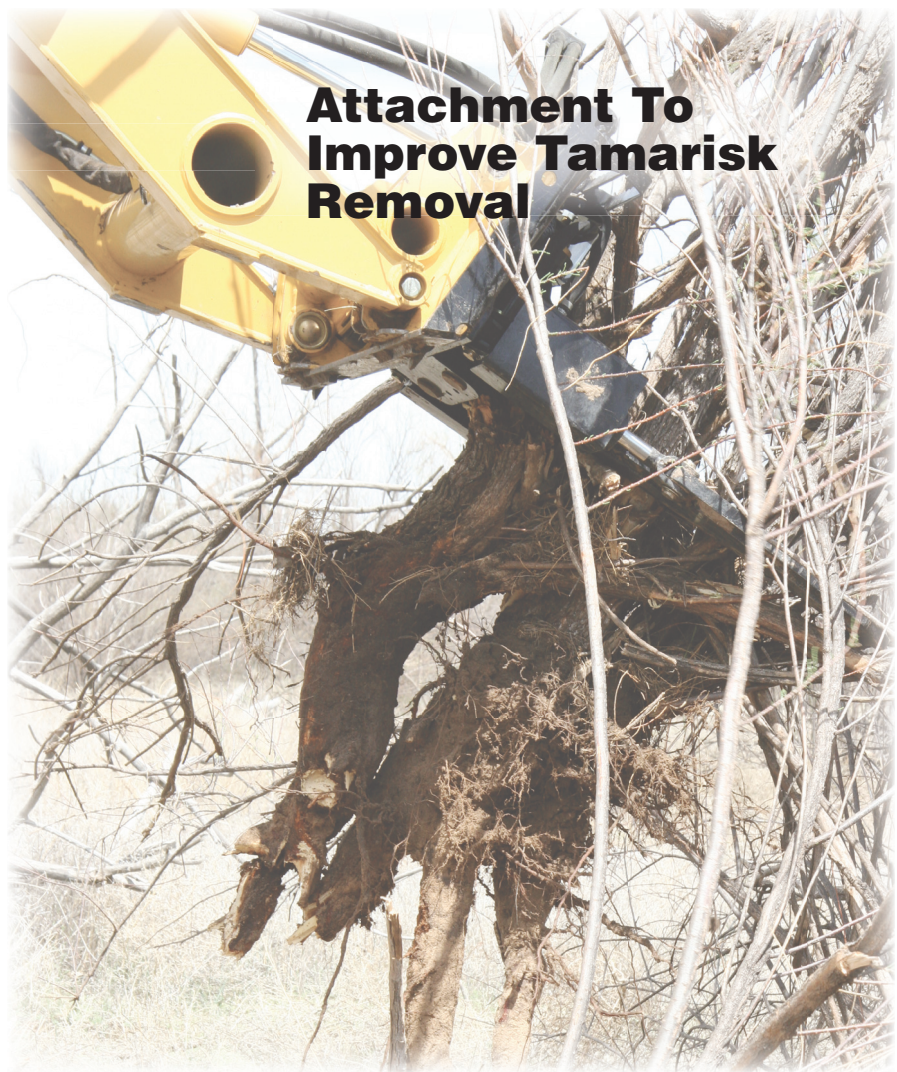
Attachment To Improve Tamarisk Removal

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Attachment To Improve Tamarisk Removal

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**USDA Forest Service
Technology and Development Program
Missoula, MT**

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Introduction

Tamarisk (*Tamarix* spp., salt-cedar) has become a serious threat to our Nation's riparian areas. Tamarisk outcompetes native vegetation and uses vast amounts of water. A large tamarisk can transpire 300 gallons of water a day.

White River National Forest employees mechanically remove tamarisk on the Comanche and Cimarron National Grasslands. Typically, a small dozer uproots the trees but may cause unacceptable soil disturbance. After the tamarisk and its root ball are "popped out" of the sandy soil, the trees are pushed into piles and burned. This simple, chemical-free method has been successful, but more tamarisks could be removed if a quicker or less expensive method was available.

John "Larry" Augustson, Randall Parker, and James McBreen, all from the White River National Forest, proposed an innovative approach to remove tamarisk that would also reduce the need for herbicides and prevent excessive soil disturbance. Augustson proposed using an attachment that mounts to the front bucket of either a backhoe or a front-end loader. The attachment would grasp the tamarisk close to

ground level with a pinching motion. Once the tree was secured, the tractor's hydraulic system would pull the tamarisk and root ball from the soil.

If tamarisk is cut, it vigorously resprouts, which can produce a more robust underground root system. Pulling might reduce the amount of resprouting because the sprouts have less energy reserves to draw from. Fewer sprouts would mean less herbicide would be needed to kill the sprouts. This report substantiates that resprouting is less of a problem if tamarisk is pulled.

Even though the technique was proposed by employees of the White River National Forest, MTDC tested the technique at the Cimarron National Grassland in Elkhart, KS. In the past, the Cimarron National Grassland has cut tamarisk off at the stump, piled and burned the plants, and killed the sprouts with herbicide.

After an extensive market and literature search, the best equipment match to meet the Cimarron National Grassland's operational criteria was a skid-steer attachment called the Star Hill JAWZ (invented and marketed by Starhill Solutions, Inc.). MTDC purchased the JAWZ attachment, which Cimarron National Grassland employees used to study both mechanical and chemical treatments. The cost of dozer piling and burning was not considered. The analysis of the estimated combined cost of mechanically treating the tamarisk and chemically treating sprouts provides a relative comparison, but does not report the total cost of treating each study plot.

When computing cost, MTDC assumed that specialized attachments were owned by the Forest Service, but that heavy equipment had to be rented. The assumption that all machines were rented (even though one was owned by the Forest Service) gives readers a better idea of the relative cost of pulling tamarisk. This report includes the Cimarron National Grassland's general assessment on the merits of pulling tamarisk and plans for such work in the future. Based on this small study, pulling tamarisk appears to be a reasonable alternative to cutting tamarisk if it is important to reduce the use of herbicides.

Highlights...

- Tamarisk is an invasive tree that consumes a great deal of water.
- Cutting tamarisk off at ground level removes the tree, but sprouts have to be treated with herbicide the following year.
- A compact, tracked loader equipped with a Jawz attachment can pull tamarisk from moist ground.
- Pulling tamarisk and treating the sprouts the following year cost 13 percent more than cutting tamarisk and treating the sprouts.
- When tamarisk is pulled, much less herbicide is needed the following year because sprouting is less of a problem.

Initial Equipment Demonstration

After conducting numerous phone interviews and an extensive literature and market search, MTDC arranged a field demonstration of the JAWZ attachment April 23 and 24, 2007, at the Cimarron National Grassland in Elkhart, KS. Cimarron National Grassland participants were Joe Hartman (district ranger), Andy Chappell (wildlife biologist), Nancy Brewer (rangeland management specialist), and Tim Higgins (heavy equipment operator). Dan Garcia de la Cadena, wildlife staff officer for the Kiowa and Rita Blanca National Grasslands, also attended the demonstration. Those participating from Starhill were John Lyddon (president) and Stuart Cave (employee). MTDC project leader Keith Windell was also present. The objectives of the equipment demonstration were to determine how much force is needed to pull clumps of tamarisk plants from the ground and to determine

whether the JAWZ (figure 1) attachment could perform the task.

To determine how much force was required to pull the tamarisk, a Dillon dynamometer (figure 2, serial No. AP505) was placed between a chain wrapped around the base of the tamarisk clump and a large, surplus military forklift designed for rough terrain (figures 3a and 3b).

The largest tamarisk clumps the forklift could drive to were chosen for the test. The results apply to tamarisk growing in sandy soils. Results will vary for other species of tamarisk or other soils. Other species of tamarisk found throughout the West are larger than the tamarisk pulled during this study. The sandy soil also made it easier to pull the tree clumps than if the soil was heavy clay or if the soil was frozen. Although the chain tended to slip, the forklift operator pulled 15 tamarisks (table 1).



Figure 1—The Star Hill JAWZ attachment was used to pull tamarisk plants from the ground.



Figure 2—A Dillon 20,000-pound dynamometer used to determine how much force was needed to pull tamarisk.



Figure 3a—A surplus military forklift designed for rough terrain was used to pull out tamarisk.



Figure 3b—Collecting pull data.

Table 1—The force needed to pull 15 tamarisk clumps from sandy soil during the spring.

Clump No.	Force (pounds)	Comments
1	8,500	
2	5,400	
3	5,400	
4	9,400	
5	8,400	
6	7,200	(The reset button on the dial's face may have been brushed)
7	3,000	
8	3,100	
9	4,800	
10	3,600	
11	5,300	(Extra large clump)
12	7,400	
13	3,800	
14	5,400	
15	10,000	

After the soil dried out later that summer, the forklift (which can pull with 12,000 pounds of force) could not pull out the tamarisk. Pull tamarisk in the spring when soils are moist!

Some of the clumps were larger around than the JAWZ could open (34 inches maximum). In these cases, the JAWZ grabbed a portion of the tamarisk stems at or slightly below the ground line.

The JAWZ attachment was tested on two different wheeled skid steer loaders: the Cimarron National Grassland's Bobcat S160 rubber-tired skid steer (figure 4) and a John Deere 260 skid steer (figure 5) borrowed from the Kiowa and Rita Blanca National Grasslands.



Figure 4—The Bobcat S160 skid steer loader.



Figure 5—Tamarisk pulled up by the John Deere 260 skid steer loader. Note the size of the tamarisk's root.

Tamarisk bundles were easier to pull out when they were rocked from side to side. The Bobcat S160 rubber-tired skid steer, which was lighter and had better flotation than the John Deere 260 skid steer, was less likely to get stuck in the sandy soils. The Bobcat S160 has an operating capacity of 1,600 pounds, a boom breakout force of 3,000 pounds, and a tipping load of 3,200 pounds. It has 56 net horsepower and an operating weight of 5,752 pounds. The Bobcat S160 had a more difficult time pulling tamarisk than the John Deere 260.

The John Deere 260 has an operating capacity of 2,400 pounds, a boom breakout force of 4,800 pounds, and a tipping load of 5,000 pounds. It has 69 net horsepower and an operating weight of 8,250 pounds.

After two afternoons of pulling trees, the general consensus among those participating in the demonstration was that the Bobcat S160 was too small. Although the John Deere S260 was more capable, its weight made it more susceptible to getting stuck in the sandy soils. Rubber-tracked loaders or skid steers with over-the-wheel rubber or steel tracks would have better flotation than wheeled vehicles.

Holes were left after the tamarisk was pulled (figure 6). The Cimarron National Grassland employees felt that these holes would probably fill in naturally.



Figure 6—The hole left after a tamarisk has been pulled from sandy soil at the Cimarron National Grassland.

The JAWZ arms were not always perfectly synchronized. Sometimes there was a delay when the arms opened. Starhill representatives said the arms become unsynchronized when one arm pushes against a firm object and the other closes. This causes the arms to be out of synch when they open. Starhill representatives said it is a simple matter for the operator to reset the JAWZ arms. Resetting the arms to the wide-open position before using the attachment to grab the next clump of tamarisk stems worked, but took time.

Sometimes the JAWZ arms slipped on the tamarisk stems, a problem that Starhill representatives attributed to operator error and inexperience. After the operator first closes the JAWZ around the tamarisk, the operator needs to hit the toggle to make sure the hydraulic grip remains tight while the tree is being pulled. This technique is not so important when the JAWZ attachment is used to pull metal stakes, but the technique is essential when the JAWZ attachment is used to pull a softer object, such as a clump of tamarisk.

Participants at the demonstration felt it might be worthwhile to try mounting the JAWZ attachment on a compact excavator. An excavator would be able to work farther away from the tamarisk stems, could reach over obstacles, would not have to drive to every single tamarisk clump, and would be able to pile the tamarisk more efficiently for burning. Cimarron National Grassland employees were

concerned that a larger excavator might cause resource damage, especially excessive soil disturbance.

After the demonstration, MTDC asked Starhill representatives to search for a commercial adapter plate so the JAWZ could be mounted on a compact excavator, investigate the hydraulic arm timing issue with the manufacturer (Paladin Brands) of the JAWZ attachment, and look into the possibility of developing an optional commercial brush bar for the JAWZ attachment. A brush bar would reduce the risk of damaging the skid steer. MTDC agreed to purchase the JAWZ attachment and compact excavator adapter plate for the Cimarron National Grassland in exchange for Cimarron National Grassland employees conducting a study comparing the use of the JAWZ attachment to pull tamarisk to the use of a brush saw to cut off the tamarisk.



Interim Equipment-Related Developments

Starhill discussed the timing issue with Paladin Brands, the attachment company that manufactures the JAWZ. Starhill said Paladin concluded there was no acceptable fix that would allow the price of the JAWZ attachment to remain competitive. One way to improve synchronization of the arms would be to replace the current spool-type hydraulic flow divider with a gear-type hydraulic flow divider. KLS Hydraulics, Inc., (Missoula, MT) suggested installing a specially paired set of cylinders and plumbing them in series. The outlet flow of the first cylinder in the series would become the inlet flow of the second. The cylinders would be sized so their rods travel at the same speed. KLS Hydraulics said this approach is used in farming equipment to raise loads equally and would be less expensive than a gear-type flow divider. Neither synchronization scheme was pursued. Cimarron National Grassland employees conducted the study using the JAWZ hydraulic system as originally designed.

Starhill determined that it did not have the resources to design or fabricate the brush bar for use only when the JAWZ attachment is mounted on a skid steer. The Cimarron National Grassland had a local fabricator make a custom brush bar for the JAWZ attachment.

Starhill located a manufacturer, Attach-All, that makes an adapter plate that will allow any skid-steer attachment to be mounted on a Komatsu PC50MR excavator (39.4 horsepower, operating weight 11,110 pounds).

The PC50MR compact excavator can apply force of 5,120 pounds at ground level (10 feet in front with standard arm length and blade down) or 2,740 pounds at ground level (10 feet to the side with standard arm length and blade down).

The PC50MR was the largest compact excavator within reasonable renting distance that was suited for the adapter. This compact excavator was thought to be an acceptable

compromise considering equipment size, pulling capability, and general rental availability (figure 7).

MTDC purchased one JAWZ unit for the Cimarron National Grassland and one adapter plate. The JAWZ cost \$3,895 with no shipping because it was already in Elkhart. The adapter plate cost \$2,100 (after a \$300 discount) plus \$100 shipping. The JAWZ attachment had never before been used on the PC50MR compact excavator, according to the attachment's manufacturer.



Figure 7—A Komatsu compact excavator. (Photo courtesy of Komatsu America).

Cimarron National Grassland Time and Motion Study

The time and motion study included two phases: the first considered mechanical treatments to remove tamarisk, and the second considered chemical treatments to kill the sprouts.

Phase 1—Mechanical Treatments

The overall goal of the study was to find the best way to remove tamarisk, while minimizing the use of chemical herbicides needed to kill sprouts. Phase 1 compared using the JAWZ attachment to pull out the tamarisk stems and root ball to using a brush saw mounted on a skid steer to cut the tamarisk stems at the ground line.

The original plan was to attach the JAWZ attachment to a PC50MR compact excavator and pull the plants. The compact excavator (with rubber tracks) could have piled the trees for burning and should have been able to maneuver easily in the sandy soils. Things did not work out as planned. Because the JAWZ attachment had to be mounted where it was working on the weak side of the excavator's hydraulic cylinder, the PC50MR compact excavator did not exert enough force to do the job.

A Bobcat T300 compact tracked loader (figure 8) was rented to replace the PC50MR compact excavator. The T300 has rubber tracks for improved maneuverability and flotation. The T300 compact tracked loader has 81 horsepower, a boom breakout force of 6,700 pounds, and a rated lifting capacity of 3,000 pounds.



Figure 8—T300 Bobcat Compact Track Loader (Photo courtesy of Bobcat Co.). No photos with the JAWZ mounted on the T300 were available.

One eradication method now used on the Cimarron National Grassland involves cutting tamarisk. Figures 9a through 9d show how the Cimarron National Grassland cuts tamarisk with a rigid Bobcat brush saw mounted flush with the ground on a skid steer.

The study site (divided into two study plots) was east of the Cimarron River crossing on Morton County Road 16 (figure 10). Both study plots ran north and south across the river. Cimarron National Grassland employees flagged the plots with surveyor's tape. The tamarisk infestation was heavier

on the north side of the river than on the south. The two 25-acre plots are adjacent to each other and have sandy soil.

The JAWZ attachment mounted on the rented Bobcat T300 compact tracked loader was used in one of the study plots. The rigid brush saw mounted on the Bobcat S160 skid steer loader was used in the other. The operators recorded time spent maintaining equipment, (fueling, greasing fittings, checking bolts, and so forth) and the time spent pulling trees or cutting them each day. Some very large clumps of tamarisk required more than one operation to remove the whole



Figure 9a—A Bobcat brush saw mounted on a skid steer loader.



Figure 9c—The Bobcat brush saw being used to cut tamarisk.



Figure 9b—The skid steer loader equipped with a Bobcat brush saw approaches a tamarisk plant.



Figure 9d—A tamarisk stump left after the plant was cut by a brush saw mounted on a skid steer loader.

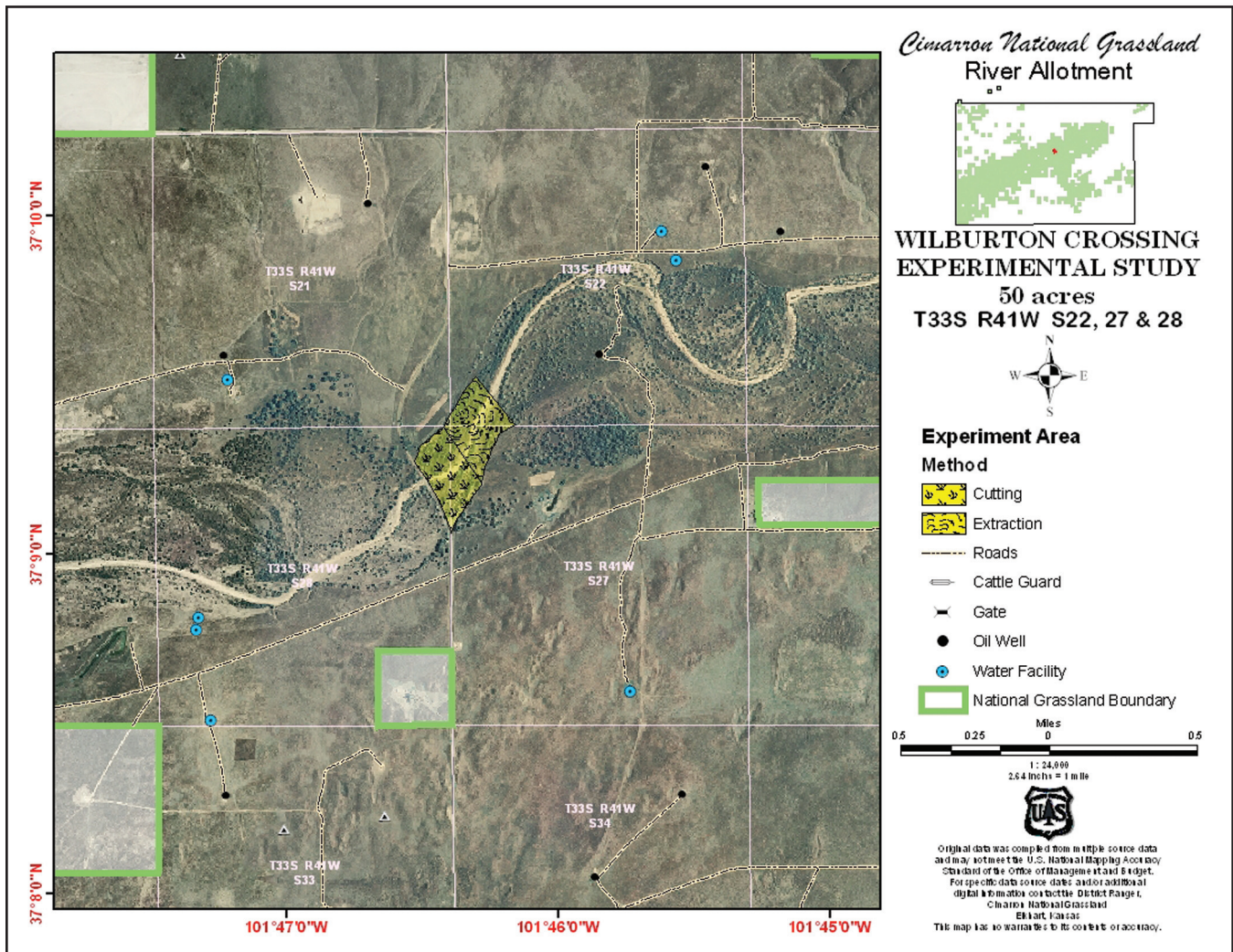


Figure 10—The study site at the Cimarron National Grassland was divided into a cutting plot and an extraction (or pulling) plot.

plant. The operator of the rubber-tired Bobcat S160 had to be careful when maneuvering to prevent the skid steer from getting stuck. The operator of the tracked T300 compact tracked loader did not have to worry about getting stuck.

Photopoints were set for monitoring. Cimarron National Grassland employees took before-and-after pictures (figures 11a through 13) of the overall study site.

Even though the study plots were the same size (25 acres), the pulling plot had slightly more tamarisk, which accounted for the extra time that was spent pulling tamarisk

rather than cutting it during the study. The fuel loading left after the tamarisk was pulled would have damaged the standing cottonwood trees if the dead trees were left in place and burned by prescribed fire. All heavier concentrations of cut or pulled tamarisks were piled by a bulldozer for burning the winter after the mechanical treatment. Table 2 compares the cost of pulling tamarisk to the cost of cutting it.

Although two different operators (earning different pay) conducted different parts of the study, the labor rate was figured at \$15.42 per hour rather than the operators' actual pay.



Figure 11a—The cutting plot before the tamarisk trees were removed (July 17, 2007).



Figure 12a—The pulling plot before the tamarisk trees were removed (August 16, 2007).



Figure 11b—The same plot after the tamarisk trees were cut (December 20, 2007).



Figure 12b—The same plot after tamarisk trees were pulled (December 20, 2007).

Table 2—The cost of cutting tamarisk compared to the cost of pulling tamarisk at the Cimarron National Grassland. Labor was valued at \$15.42 per hour. Pulling took longer because the plot where tamarisk was pulled had more tamarisk than the plot where tamarisk was cut. Each plot was 25 acres.

	Cutting	Pulling
Cutting or pulling time	76.25 h	91 h
Horsepower	Bobcat S160—56 hp	Bobcat T300—81 hp
Maintenance	15.25 h	18 h
Fuel used	92 gal	148 gal
Labor cost	\$1,410.93	\$1,680.78



Figure 13—Piles of plant material (December 17, 2007).

Maintenance and Repairs

Forest Service employees completed all repairs on the brush saw and JAWZ attachment using standard parts available locally. The Bobcat dealership in Garden City, KS, made all repairs to the Bobcats.

Brush Saw

Summary of maintenance included:

- Hydraulic hoses were replaced twice due to normal wear and tear (including some use before the test).
- The Bobcat S160 got stuck several times in the sandy soil. The time spent getting it out was considered maintenance.

JAWZ Attachment

Summary of maintenance included:

- The bolts that hold the JAWZ to the top plate were sheared off.
- The cover on the top plate was pushed in, breaking the coupler on the hydraulic hose.
- The cover on both hydraulic cylinders was pushed in.
- The step on the top/front corner of the mounting plate was pushed in.
- The O-ring on the top of the hydraulic block behind the cover on the top plate was replaced twice.

Bobcat Repairs

Summary of maintenance included:

- The T300 compact tracked loader was an older and well-used machine that required more general maintenance by Forest Service personnel.
- The windshield on the S160 skid steer loader broke while it was in transit and the windshield on the T300 compact tracked loader broke while it was being used in field.
- The T300 compact tracked loader had radiator and air conditioner leaks.

Equipment Operators' Comments

Equipment operators' comments included:

- The operator who was pulling the tamarisk felt that the JAWZ was more efficient than the cutting saw.
- Both operators said the T300 compact tracked skid steer loader had better mobility than the S160 rubber-tired skid steer loader.
- The JAWZ attachment was not closing completely during the final stages of the study. The gap between the blades allowed plants to slip.
- The JAWZ attachment would work better and faster if it was mounted lower on the mounting plate.
- The plants could be pulled more easily during the spring when the soils are damp.
- Although it took more time to pull tamarisk than to cut it off, there may be less regrowth, and less chemical may be needed to control regrowth.
- The pulling and cutting plots were evaluated for regrowth the following spring, before they were chemically treated.

Phase 2—Chemical Treatments

The study site (figure 14) and the rest of the Cimarron National Grassland experienced extreme drought from July

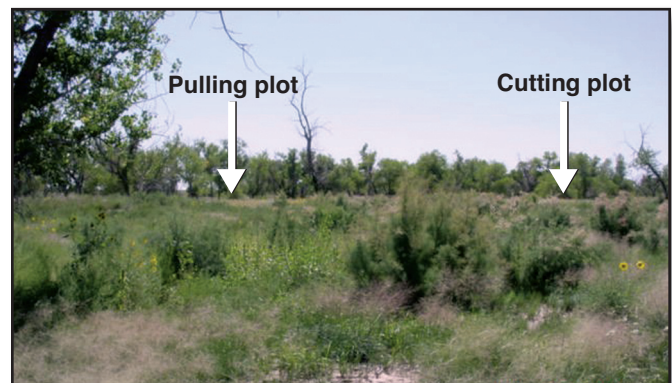


Figure 14—A portion of the tamarisk study site (September 4, 2008).

2007 to August 2008. During August 2008 about 4 to 6 inches of rain fell, causing much of the understory vegetation (grasses and forbs) to grow rapidly. The more drought-tolerant species responded more vigorously than others.

The tamarisk infestation was heavier on the north side of the river than on the south side. The infestation was heavier on the southwest side of the river than on the southeast side.

Tamarisk resprouted abundantly from stumps when it was cut with a brush saw. The height of the tamarisk sprouts ranged from 3 feet to about 6 feet (figure 15). There were few sprouts in the pulling plot where tamarisk was extracted with the JAWZ attachment. The height of the tamarisk sprouts there ranged from 1 foot to about 5 feet (figure 16).

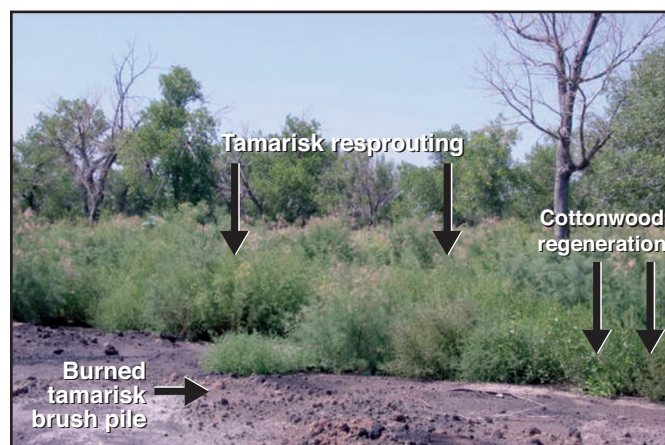


Figure 15—An overview of the study site where tamarisk trees were cut (September 4, 2008). The bare ground is where piled tamarisk was burned.

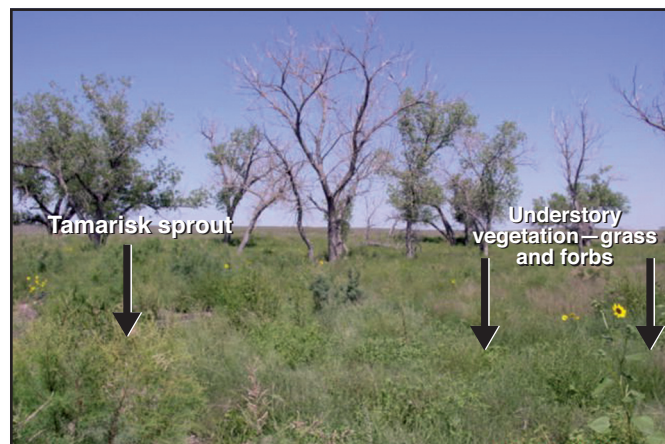


Figure 16—An overview of the study site where tamarisk trees were pulled (September 4, 2008).

Tamarisk was pulled during September 2007 when the soil was dry. Some tamarisk clumps had to be worked back and forth to pull them free. Plants that broke off at the top of the main root resprouted from root material left in the ground. These sprouts did not grow as tall as sprouts that grew from stumps because the stumps and their intact roots had more energy for resprouting.

Grasses at the study site include *Paspalum dilatatum* (dallisgrass), *Distichlis spicata* (saltgrass), *Eragrostis trichodes* (sand lovegrass), *Hordeum jubatum* (foxtail barley), and *Sporobolus cryptandrus* (sand dropseed). Forbs include *Croton texensis* (Texas croton), *Salsola kali* (Russian thistle), *Ambrosia artemisiifolia* (annual ragweed), *Amaranthus retroflexus* (redroot pigweed), and *Chenopodium album* (lambsquarters), with an occasional *Helianthus annuus* (common sunflower).

The tamarisk sprouts were treated with herbicide between August and October 16, 2008. The tamarisk south of the river was treated with Pathfinder II herbicide. Tamarisk north of the river was treated with the herbicide Triclopyr 4EC (generic equivalent Garlon 4) mixed with diesel.

South of the Cimarron River, 47.5 gallons of Pathfinder II were applied to tamarisk sprouts on about 26 acres. In the area where the tamarisk was cut, 85 percent more sprouts were treated than in the area where tamarisk was pulled. Thirty-three gallons of Pathfinder II were used in the area where tamarisk was cut compared to 15 gallons of Pathfinder II used in the area where tamarisk was pulled. Some of the sprouts were treated twice because they appeared to have been missed on the initial treatment or the chemical didn't appear to have an immediate effect on the plants. More Pathfinder II was used than had been expected.

North of the Cimarron River, about 7 gallons of Triclopyr 4EC was applied to about 24 acres. The area where tamarisk was cut had about 85 percent more sprouts to treat than the area where tamarisk was pulled. Four gallons of Triclopyr 4EC (with 16 gallons of diesel) were applied in the area where tamarisk was cut. Three gallons of Triclopyr 4EC (with 12 gallons of diesel) were applied in the area where tamarisk was pulled.

Treatment Cost Comparison

The costs of treatment include the cost of the mechanical treatment (cutting or pulling) and the cost of chemical treatment (herbicide to control the sprouts). This comparison did not include the cost of dozer piling and burning.

Estimated Mechanical Treatment Cost Per Acre

Table 3 shows that pulling tamarisk cost 46.9 percent more than cutting it.

Table 3—The estimated costs of pulling and of cutting tamarisk.

Cost	Cutting Tamarisk (dollars)	Pulling Tamarisk (dollars)
Equipment rental	1,700.00	2,850.00
Operator's salary	1,410.93	1,680.78
Diesel fuel	276.00	448.00
Total cost	3,386.93	4,974.78
Estimated cost per acre	135.48	198.99

Assumptions of the cost comparison:

- Even though the T300 compact tracked loader was used to cut tamarisk for 10 of the 76.25 cutting hours, we assumed that the S160 rubber-tired skid steer loader would have taken the same time to complete the task.
- Even though the Cimarron National Forest owned the S160 rubber-tired skid steer loader, we based the costs of using the S160 rubber-tired skid steer loader and the T300 compact tracked loader on authorized Bobcat dealer rental rates.
- Diesel fuel cost \$3 per gallon.

- Total rental time was based on combined operation and maintenance times. Time to transport equipment from the rental shop and back was not included.
- The Star Hill JAWZ attachment and Bobcat brush saw are owned by the unit doing the project. The cost of the attachments was not included in the analysis.

The cost of replacing parts broken during the study (hydraulic hoses, fittings, and so forth) is not included in the cost estimate. The cost of using a dozer to pile the tamarisk for burning is not considered. Table 4 shows the daily, weekly, and monthly costs of renting the two Bobcats.

Table 4—The rental cost of the S160 skid steer loader and T300 compact tracked loader.

Rental Cost	S160 Bobcat (cost in dollars)	T300 Bobcat (cost in dollars)
Daily	\$200	\$300
Weekly	\$650	\$1,100
Monthly	\$2,000	\$2,850

The weekly rates are based on five 8-hour days (40 hours) in a 7-day period. Monthly rates are based on 160 hours in a 4-week period. The Bobcat S160 used 92 gallons of diesel that cost \$276. The Bobcat T300 used 148 gallons of diesel that cost \$448.

The best rental arrangement for the 91.5 hours the Bobcat S160 was used would be to rent it for 2 weeks at the weekly rate and 2 days at the daily rate for a total rental cost of \$1,700. The best rental arrangement for the 109 hours the Bobcat T300 was used would be to rent it for 1 month at the monthly rate of \$2,850.

Estimated Chemical Treatment Cost Per Acre

The labor for treating tamarisk sprouts with herbicide cost \$597.62. Even though the study plot where tamarisk was cut had 85 percent more sprouts, the cost of labor for chemical treatment was split evenly between the two plots. The time needed to drive to areas that might need treatment within each plot was similar regardless of the number of sprouts that might need to be treated there. Table 5 shows the costs of labor and of herbicides used to chemically treat tamarisk sprouts.

Table 5—The cost of chemically treating tamarisk sprouts after tamarisk was removed by cutting or pulling.

Chemical Treatment Costs	Cutting Plot	Pulling Plot
Labor	\$298.81	\$289.81
Chemicals		
Pathfinder II	33 gal@\$39.70/gal = \$1,310.10	15 gal@\$39.70/gal = \$595.50
Triclopyr 4EC	4 gal@\$49.90/gal = \$199.60	3 gal@\$49.90/gal = \$149.70
Diesel	16 gal@\$3.00/gal = \$48.00	12 gal@\$3.00/gal = \$ 36.00
Total cost	\$1,856.51	\$1,080.01
Cost per acre	\$74.26	\$43.20

Only 56.6 percent as much chemical (including the diesel carrier) was used to treat sprouts in the plot where tamarisk was pulled (30 gallons) as was used in the plot where tamarisk was cut (53 gallons).

Table 6 shows the estimated total cost for mechanical and chemical treatments. The cost of piling and burning tamarisk that had been cut or pulled is not included in the total treatment cost.

Pulling tamarisk cost an estimated 13.4 percent more per acre than cutting it.

Table 6—Estimated total costs to treat the tamarisk removal study SITE at the Cimarron National Grassland. The costs do not include the cost of dozer piling and burning.

Total Treatment Costs	Cutting Plot (cost in dollars)	Pulling Plot (cost in dollars)
Mechanical treatment	3,386.93	4,974.78
Chemical treatment	1,856.51	1,080.10
Total treatment cost	5,243.44	6,054.79
Total treatment cost per acre	209.74	242.19

Discussion

The Star Hill JAWZ attachment can be mounted on a large compact tracked loader to pull clumps of tamarisk. Use of the JAWZ attachment is limited by the size of the tamarisk, the number of stems in the tamarisk clump, and the soil conditions. One growing season after a study comparing pulling tamarisk clumps to cutting them, the plot where tamarisk was cut had 85 percent more tamarisk sprouts than the plot where tamarisk was pulled. Only 56.6 percent as much herbicide (including diesel carrier) was needed to control tamarisk sprouts in the plot where tamarisk was pulled compared to the plot where tamarisk was cut. The pulling and chemical treatments cost 13.4 percent more than the cutting and chemical treatments. Although another year must pass to check for additional sprouting, the Cimarron National Grassland is very encouraged by the study's initial results. The Cimarron National Grassland plans to continue using the JAWZ attachment for tamarisk removal when the site conditions (tree size, tree density, and soil moisture) are suitable.

As the project progressed, Starhill Solutions, Inc., realized the benefits of mounting the JAWZ attachment on a larger machine that could apply more force. Starhill Solutions, Inc., has developed the Super JAWZ for an articulated rubber-tired front-end loader (figures 17a and 17b).

The Super JAWZ could pull large clumps of tamarisk from drier soils, but doing so would risk snapping the tamarisk off at the ground line. If that happens, additional sprouting is likely. Rubber-tired machines will not be able to maneuver in sandy river bottom soils as well as machines mounted on tracks.

The Cimarron National Grassland is interested in using a full-sized excavator to remove tamarisk. Boss Reclamation, LLC, based in Texas, has a proprietary excavator digging head (figures 18a and 18b) that has removed larger tamarisk and other invasive tree species. The Cimarron National Grassland would like companies with this type of equipment to bid on the Cimarron River vegetation treatment project, during which tamarisk would be removed on 196 acres.



Figure 17a—Star Hill Super JAWZ on a Caterpillar 924 removing a tree (Photo courtesy of Starhill Solutions, Inc.).



Figure 17b—Star Hill Super JAWZ with adapter for Caterpillar 924 (Photo courtesy of Starhill Solutions, Inc.).

Although larger equipment (such as a 140-horsepower excavator with 28-foot boom reach) will cost more to move in and move out than a compact tracked loader, larger equipment will have a higher production rate and will be able to remove larger tamarisk. Large excavators can use their arm to reach over river banks, another advantage. Because Boss Reclamation's digging head scoops under the root ball, it should leave far less root material behind than when tamarisk is pulled.



Figure 18a—Boss Reclamation equipment at work (Photo courtesy of Boss Reclamation, LLC).



Figure 18b—Boss Reclamation equipment at work (Photo courtesy of Boss Reclamation, LLC).



Conclusions

- Tamarisk roots become more difficult to pull from the ground as the soil becomes drier.
- When the soil becomes too dry or if the root system is too extensive, the JAWZ attachment tends to snap the tamarisk off at the ground line, allowing the roots to resprout.
- The JAWZ attachment mounted on a compact tracked loader has enough power to pull smaller tamarisk clumps.
- The JAWZ attachment mounted on a compact excavator does not have enough force to pull tamarisk clumps effectively.
- Machines with track systems are more maneuverable in sandy soils than machines with rubber tires.
- Less herbicide is needed to control resprouting after tamarisk has been pulled than when it has been cut.
- Pulling tamarisk costs more than cutting tamarisk, but because sprouting is less of a problem, chemical treatment of the sprouts costs less. The combined cost of pulling tamarisk and chemical treatments to control sprouts is 13.4 percent higher than the cost of cutting tamarisk and treating the sprouts. Some Forest Service units, including the Cimarron National Grassland, may decide that their management goals justify the extra expense of pulling tamarisk rather than cutting it.
- More studies are needed to better understand the actual difference between the costs of pulling tamarisk and treating the shoots and the costs of cutting tamarisk and treating the shoots.
- Future studies should include a breakdown of all costs, including piling and burning, so managers will have a better idea of the entire cost of eradicating tamarisk.
- The soil disturbance by the equipment used in the study and the holes created when tamarisk root balls were pulled out of the ground were acceptable to managers at the Cimarron National Grassland.
- Although monitoring will continue, the initial impression of managers at the Cimarron National Grassland and MTDC's project leader is that the concept of pulling tamarisk has merit.



Conclusions

About the Authors

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Keith Windell is a project leader for reforestation, fire, and residues projects. He has a bachelor's degree in mechanical engineering from Montana State University. He has worked for the California Department of Forestry; U.S. Department of the Interior, Bureau of Land Management; and the Forest Service.

Library Card

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Tamarisk (also known as saltcedar) is an invasive tree that consumes a great deal of water, transpiring up to 300 gallons of water a day from the soil to the atmosphere. Land managers throughout the Midwest and West are trying to remove tamarisk. The Forest Service's Cimarron National Grassland in Kansas removes tamarisk by cutting it at the ground level with a brush saw mounted on a skid steer loader. Herbicide was used to kill tamarisk that sprouts from the stump the next year. The Missoula Technology and Development Center helped employees at the grassland test a new alternative for removing tamarisk—the JAWZ attachment by Starhill Solutions, Inc.—that was used to pull clumps of tamarisk from moist ground. When tamarisk was pulled from the ground, less herbicide was needed the following year because sprouting was much less of a problem. Pulling tamarisk and treating the sprouts the following year cost 13 percent more than cutting tamarisk and treating the sprouts.

Keywords: herbicides, invasive plants, skid steers

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Electronic copies of MTDC's documents are available on the Internet at:

<http://www.fs.fed.us/eng/t-d.php>

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, CDs, DVDs, and videos on their internal computer networks at:

<http://fsweb.mtdc.wo.fs.fed.us/search/>