

Observations On Operations of the Pettibone Hydro-Slasher PM 800



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***OBSERVATIONS ON OPERATIONS
OF THE
PETTIBONE HYDRO-SLASHER PM 800***

by

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ED&T 2272 TSI Slash Treatment

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INTRODUCTION AND SUMMARY

The Pettibone Hydro-Slasher PM 800 (fig. 1)—manufactured by Pettibone Corp., Baraga, Mich.—was observed during a demonstration in July 1979 in the Williams, Ariz. area. The demonstrations were conducted on the Williams Ranger District, Kaibab National Forest, Southwestern Region (R-3). Seven sites were selected by District personnel that represented a cross-section of problems the machine would encounter during forest operations on the Kaibab.

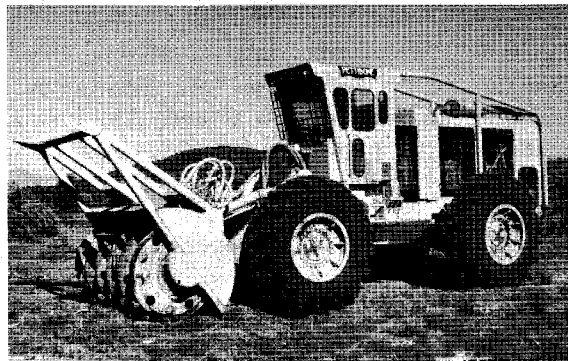


Figure 1. Pettibone Hydro-Slasher PM 800.

The machine was found to be effective in the treatment of Utah juniper (on a site with relatively few rocks and a site heavily infested with rocks), juniper and ponderosa slash, and thinning slash. However, the machine was not effective in an attempt to thin a ponderosa stand because of hydraulic problems.

Some data were collected during the operations in an attempt to estimate the machine's production capabilities. The data collected and the observations made are discussed relative to each of the sites and their respective differences.

The appendix is a description of the Hydro-Slasher.

OPERATIONS

Site 1—Juniper Treatment in Rock-Free Area

This site was a level Utah juniper area with very few rocks located approximately 10 miles west of Williams and slightly north of Interstate 40. The juniper clumps averaged 8-ft high with 6-in diameter stems

(fig. 2). The estimated stem count per acre ranged from 300 to 500. The site had been seeded with grass seed the previous day. The objective on the site was to eradicate the juniper to permit the production of grass. A 10-acre area adjacent to the access road to the site was selected and flagged for treatment.



Figure 2. Site 1 prior to treatment.

The machine made one pass around the perimeter (roughly 700 ft by 700 ft) of the flagged area and then was operated back and forth, treating the entire area in strips parallel to the access road. The machine's reduction head is 8-ft wide; however, because of clump spacing, the treated strips averaged 12-ft wide. Speed ranged from approximately $\frac{1}{2}$ mph in a heavy clump, up to about 2 mph in light and open areas. The machine had no difficulties with any of the material encountered that included heavy clumps of standing trees and some large downed and dead materials. Heavy loading caused a drop in the rotating speed of the reduction head rotor, but speed recovery appeared to be rapid when the head was unloaded at the end of a cut, or raised up from the work. The head was kept above the ground most of the time, with very little digging or mulching except when encountering an occasional high spot.

The head was rotated both clockwise and counter-clockwise to determine if any advantages could be identified for either direction of rotation. The original design direction and the direction considered normal is clockwise (i.e., the head is rotating in the same direction as the wheels of the machine during forward travel). Clockwise rotation causes the material to pass down under and behind the machine. Reverse rotation in juniper caused more stems to be uprooted and larger material to be pushed away from the head.

Reverse rotation is a safety hazard to nearby personnel because the material is thrown up to 100-ft high and 200 ft in front of the machine (fig. 3). For operation in juniper, this was not considered a problem. The direction of rotation did not appear to make a significant difference in end results. However, the operator preferred reverse rotation because visibility problems were less when debris and dust were thrown away from the machine.



Figure 3. Machine operation during Site 1 treatment using reverse rotation of the reduction head.

Treatment resulted in minimum surface disturbance and left a light litter cover plus stems and chunks (fig. 4). Observers generally commented that the amount and size of material left on the ground was good. Some indicated a preference for heavier treatment and the head was operated in contact with the ground for a short distance to check out this idea. The result was a scalping action that removed the top layer (2 in) of soil and was considered unacceptable (fig. 5). Measurement of the



Figure 4. Resulting litter from machine cutting a path through Site 1 juniper.

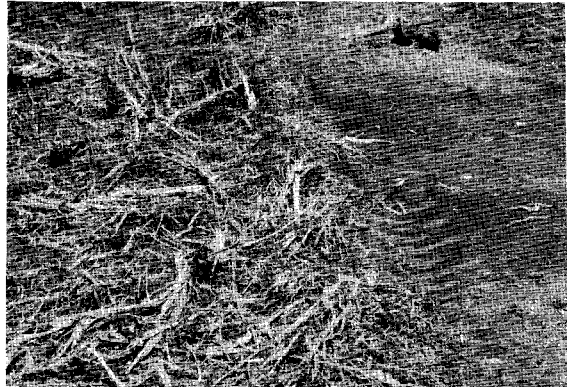


Figure 5. Comparative treatment strips on Site 1. The strip on the right shows the result of dipping the reduction head into the ground. The strip on the left resulted from operation approximately 2 to 4 inches above ground.

area treated during the first hour showed 1.6 acres. The production rate would probably exceed 2 acres per hour with more experience operating on this type site.

Site 2—Dozer-Piled Juniper

This site was adjacent to Site 1 in an area where juniper had been dozed and piled (fig. 6). The objective was to test the durability and design of the machine in this type of heavy work. The machine was used to eradicate one of the juniper piles that was nearly 15-ft high and 30-ft long (fig. 7). The machine had no trouble in masticating and spreading the material in the pile with the head operating in a reverse rotation. Operation was back and forth in the pile and a number of passes were required. Burning the piles would probably be a more cost-effective method of treatment.

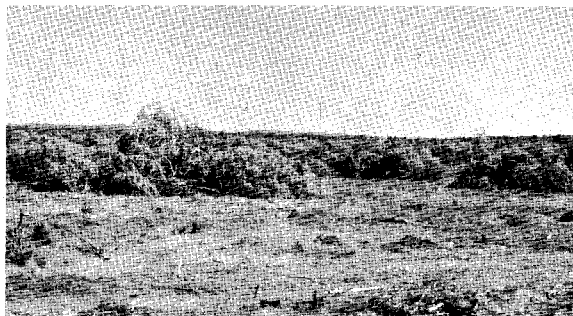


Figure 6. Hand-piled juniper on Site 2.



Figure 7. Machine treating a juniper pile on Site 2.

Site 3—Juniper Treatment in a Rocky Area

This site was approximately $\frac{1}{4}$ mile from, and very similar to, Site 1 with the exception of heavy outcroppings of rock making travel through the area and operation difficult (fig. 8). The machine operated over the rock and treated the juniper thoroughly and the results were considered excellent. Because of the rock, the machine required much backing and turning causing an estimated production rate of $\frac{1}{2}$ acre per hour. If management could accept less intense treatment, and if the operator had more experience in this type terrain, the production rate could possibly be brought up to an acre per hour. The area treated was too small to obtain an accurate production rate.



Figure 8. Site 3 after treatment.

Worthy of note is the fact that a track-type dozer had been pulled from operating on this site because production was too low and treatment was not satisfactory.

Site 4—Treatment of Thinning Slash Piles

This site was approximately 6 miles west of Williams and about $\frac{1}{2}$ mile south of Interstate 40. The objective was to reduce and scatter hand-piled ponderosa pine in an area that had been precommercially thinned within the last year (fig. 9). The desired treatment was to reduce the piles in and around the leave trees, such that the residues would rapidly decompose and not present a fuels or esthetic problem. The reason given by District personnel for this type treatment was that the piles would not readily burn and because of their position relative to the adjacent leave trees, burning could cause leave tree damage. The economics and rationale for this application may be questionable.



Figure 9. Hand-piled ponderosa on Site 4 prior to treatment. Note the close proximity of the pile to the surrounding trees.



Figure 10. Aftermath of pile treatment on Site 4 using reverse rotation of the reduction head. Note the larger materials are scattered but not broken up well.



Figure 11. Aftermath of pile treatment on Site 4 using forward rotation of the reduction head.

The machine averaged 3 minutes to reduce a pile estimated to be 6-ft high by 10-ft long and 6-ft wide. Material in the piles averaged 5-in in diameter by 5-ft long with an estimated 4 piles per acre. The machine had no problems treating the piles. However, the operator tended to favor using reverse rotation. This scattered the piles well, but did not break materials up as well as forward rotation because larger logs were not treated (figs. 10 and 11). Instead the logs were pushed away from the rotor rather than pulled into the rotor where they would be effectively broken up. Reverse rotation may also result in damage to leave trees due to the slinging of heavy materials into them; however, no damage was observed.

Operation on this site had to be terminated because of an oil seal failure on the rotor pump return line. Inspection revealed that the wrong seal had been installed. A new seal was installed and the machine was made ready for operation on Site 5.

Site 5—Treatment of Thinning Slash (3-yr old)

This ponderosa site was located approximately 20 miles south and 6 miles east of Williams. The objective was to reduce slash left from a precommercial thinning operation completed 3 to 4 years previous (fig. 12). Estimated loading was 10 tons per acre; however, materials 6 in and under represented a loading of less than 10 tons per acre. There was some large downed material (18- to 24-in diameter) left from a timber operation many years in the past that was beyond the capability of the machine. An unsuccessful attempt was made to treat some of this larger material.

A 1-acre plot was marked to facilitate time studies. Trees had been hand-thinned and slash was scattered in and around the leave trees that were spaced approximately 18 ft apart. Leave tree density was estimated at 300 per acre. The operation began with reverse rotor rotation causing good spreading of the material but not adequately treating the material which was very brittle with an average diameter of 4 in. Large stems (3- to 6-ft in length) were left instead of chunks. (The preferred result was for chunks 1- to 6-in long.) After a few minutes of operation, the rotor was reversed to normal rotation and the treatment was more successful. No problems were encountered in treating this site other than



Figure 12. Typical slash concentration on Site 5 prior to treatment.

maneuvering in and out of tight spots and avoiding large rocks (fig. 13). Half of the site was treated satisfactorily in approximately 30 minutes, giving a production rate estimate of 1 acre per hour (fig. 14).



Figure 13. Ponderosa stand on Site 5 prior to treatment. Note tree spacing.



Figure 14. Site 5 after treatment.

Oil seals on the machine's rear wheels were leaking excessively at the end of operations on this site.

Site 6—Treatment of Thinning Slash Piles

This was also a ponderosa site located approximately 7 miles south and 1½ miles east of Williams. The objective was similar to that on Site 5, primarily to reduce TSI slash. However, the slash on this site was fresh and green (fig. 15). An additional objective was to cut a 50-ft wide fuel break adjacent to the access road into the site. The loading of 4-in average diameter ponderosa pine slash was estimated at 10 tons per acre.



Figure 15. Site 6 prior to treatment.

The machine handled the greener slash without any problem and the results of the operation were generally the same as those discussed for Site 5. The tree spacing was approximately 18 ft. Larger materials left from previous logging operations along with large rocks made operating conditions very similar to Site 5 (fig. 16).



Figure 16. Site 6 after treatment.

There appeared to be a decrease in rotor rpm which seemed to be a progressive problem from Site 3 work through successive operations. This comment is based on visual observation only since there was no tachometer or other method to measure rotor rpm.

Site 7—Ponderosa Stand Thinning

This site was located across the road from Site 6. The objective was to thin thick doghair ponderosa pine stands that had approximately 2,000 stems per acre and to select dominant trees for leave trees (fig. 17).



Figure 17. Site 7 prior to treatment.

Tree height ranged from 15 to 30 ft and dbh of the stand ranged from 3 to 5 in. This site represented a typical ponderosa thinning problem for the machine and was to determine the machine's ability to maneuver while thinning and also to determine if the machine could selectively thin, or if it was restricted to strip thinning.

The machine was unable to maneuver after entering the stand so a decision was made to limit operation to strip thinning. Single pass treatment was not satisfactory (fig. 18).

All of the reasons for poor performance were not determined as a hydraulic hose failure stopped the operation after completion of three strips of less than 50-ft length. Operation of the push bar, drop in rotor rpm, apparent lack of power, and jamming of flails all contributed to failure to achieve the treatment objective. Other factors and the relative importance of these were not determined.

The rotor carriage assembly can be rotated by hydraulic cylinders to vary the distance by which the push bar leads the rotating flails (figs. 19 and 20). The machine was operated in the thick stand with the push bar leading the flails by the maximum amount. The result was bending the stems and actually dozing them over before the flails engaged them. ^{1/}

Rotor speed dropped when encountering multiple stems and the machine did not appear to have sufficient power for the rotor to recover speed while still engaging stems. This operation differed greatly from juniper stand treatment and pile reduction in that loading on the rotor was continuous while the machine moved forward. Clumps, single trees, and piles permit speed recovery because the load is not continuous.

^{1/} On the Tahoe National Forest, Calif., the San Dimas Forestland Residues Machine, prototype I, operated in a similar manner when the push bar extended too far ahead of the rotor. Stems were pushed over and the flails engaged the stems after they were bent nearly to a horizontal position. Satisfactory treatment was achieved on the Tahoe only by multiple passes with the machine.

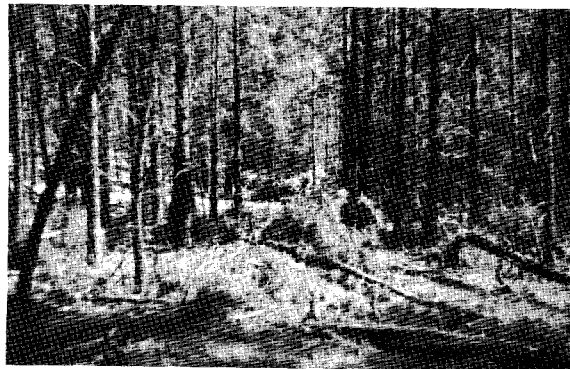


Figure 18. Aftermath of strip thinning attempt on Site 7.



Figure 19. Carriage assembly rotated to the normal operating position.



Figure 20. Rotation of the carriage assembly to move the push bar back to its minimum extension.

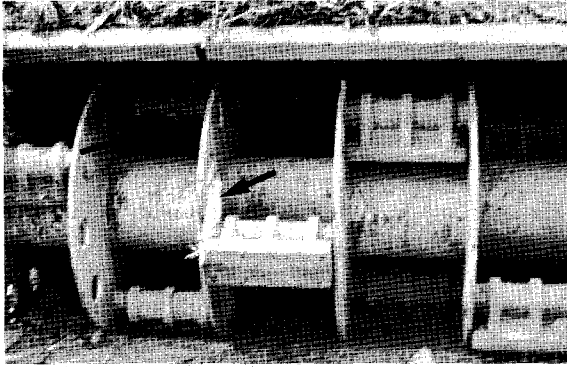


Figure 21. Flail jammed by a chunk of wood.

Observation of the rotor after the operation revealed that a number of flails were jammed with wood debris between the flail and the rotor disk (fig. 21). Inefficient treatment and a drop in rpm would result from this jamming. The debris might be thrown free if rpm were kept high, but this could not be determined.

ENGINEERING OBSERVATIONS

The following comments relate specifically to the design and performance of the machine on specific sites and in general.

Site 1

Design of the flails on the reduction head is such that debris builds up on flail surfaces and wedges between flail and rotor drum disks. This causes the rotor to become unbalanced and flails to occasionally jam. This problem did not appear to measurably affect machine production rate, but the rotor unbalance may cause machine maintenance problems and mechanical damage could result, if not corrected.

The radiator became clogged by dust and debris during operations and had to be frequently cleaned. The clogging caused engine heating problems and, of course, frequent stops to clean the radiator. This ultimately effected the machine's production rate.

The cab of the machine was not air conditioned. This required the operator to operate the machine with the door open because of the heat generated due to a greenhouse effect, body heat, and engine hydraulic systems. This made operations difficult in the dusty environment.

The machine hydraulics were overly sensitive to rapid speed changes in rotor rpm. When the rotor speed was rapidly decreased, the rotor motor began to pump to overcome the stored energy in the rotor, thus slowing the rotor down. The problem could cause large pressure spikes in the pump return line that could result in hose, seal, pump, and motor damage if the pressure spikes cannot be relieved at a rapid rate or dumped back to the reservoir.

The rotor motor and hoses seemed excessively hot to the touch indicating that there may be excessive oil temperature in the hydraulic systems. There is a need to monitor the hydraulic reservoirs with temperature gauges, so that the operator will be aware of high temperatures.

The oil seal on the right front wheel was leaking excessively and due to oil loss the gear train and axle could be damaged if not monitored closely and repaired.

The location of controls in the cab of the machine could be modified somewhat to simplify machine operation.

Rotor disks appeared to be bending slightly and a need to stiffen or reinforce them by increasing their thickness may be indicated.

Debris buildup between the rotor disks and carriage assembly was noted. This buildup, if excessive, will act like a brake between the rotor and the carriage assembly causing excessive stresses on the rotor drive belt (possibly overheating or slippage as a result). In addition, it does cause a drain of the energy required to keep the rotor running at an optimum rpm resulting in premature rotor spindown when working in heavy materials. The net result is a loss in machine effectiveness and production.

Site 5

At the conclusion of operations on this site, the two rear wheel seals were leaking excessively in a manner similar to that observed on the right front wheel during the operation on Site 1.

Site 7 and Other Sites

The debris buildup continued to become worse on

successive sites and whether the drop in rotor speed resulted from, or caused this, is undetermined.

CONCLUSIONS AND RECOMMENDATIONS

Operational Aspects Conclusions

The machine effectively treated Utah juniper at a production rate approaching 2 acres per hour on a site without rock and could probably exceed this rate as the operator gained experience.

The machine effectively treated Utah juniper on a rocky site so difficult that the prescribed tracked dozer piling operation had been stopped. Production rate was under ½ acre per hour and probably could not be increased beyond 1 acre per hour.

A reasonable cost estimate for operating a machine of this size and complexity is \$100 to \$150 per hour; at that rate the cost per acre would vary from as low as \$50 per acre on the good site up to \$300 per acre on the rocky site.

The machine effectively treated and reduced piles of juniper and ponderosa although the economics of such operations appear questionable.

The machine was not effective in thinning a ponderosa stand either selectively or in strips.

Recommendation

The machine should be used for TSI strip thinning in typical stands of various species of sufficient acreage to obtain data to verify machine performance, reliability, and production rates and costs.

Machine Aspects Conclusions

The operator's efficiency appeared to be affected due to the heat in the cab of the machine because there was no air conditioning provided.

The machine appeared to have problems of overheating hydraulics.

The radiator became clogged with dust and dirt.

Flails became clogged with debris and did not swing free.

Rotor rpm dropped and speed recovery capability seemed to deteriorate as operations moved from site to site.

Rotor speed drop could indicate a need for additional horsepower.

Recommendations

1. Add air conditioning in the cab.
2. Reconsider the design of machine hydraulic systems to determine cause of excessive pressures in rotor drive components.
3. Redesign radiator to prevent dust accumulation and clogging.
4. Redesign of flails to prevent debris buildup and jamming.
5. Add gauges in the cab to monitor rotor speed and hydraulic oil temperature.
6. Evaluate total horsepower requirement.

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APPENDIX

EQUIPMENT DESCRIPTION

Designation	Hydro-Slasher PM 800
Status	Production prototype
Cost (estimated)	\$80,000
Manufacturer	Pettibone Michigan Corp. P. O. Box 368 Baraga, MI 49908 (906) 353-6611

REDUCTION-HEAD MECHANISM

Type	Horizontal shaft
Cutters	10 free-swinging
Width of cut (ft-in)	8-4
Max. dia.working material size (in)	6
Type of drive	Hydrostatic and belt
Rotational speed (rpm)	975

PRIME MOVER

Type	Wheeled-rubber tired
Diesel engine net power (hp)	262
Transmission	Hydrostatic

MACHINE DATA

Width (ft-in)	9-0
Length (ft-in)	28-0
Height (ft-in)	10-4
Weight (lb)	35, 410
Ground pressure (psi)	10.0 front; 6.4 rear at 6-in penetration
