

power tracker are used to convert solar power into power to run the pump.

Pumping System

Water had to be pumped uphill with a 240-foot vertical head of pressure. A piston pump with approximately 0.55 hp was used. Water was pumped to the top of the rim through 1 1/2-inch galvanized pipe. From the rim to the catchment, 1 1/2-inch plastic pipe was used. The pumping rate was 4 gpm.

Water Storage

A Hypalon, rubber-lined dugout catchment was used to store the water once it was pumped uphill from the spring. The capacity of the catchment is 60,000 gallons. The inlet to the catchment is equipped with a float valve which activates a

pressure switch on the pump. When the catchment becomes full, the pressure switch turns the pump off.

At present, five troughs are filled with the catchment. These troughs are scattered along three and one-half miles of pipeline. In the future another three and one-half miles of pipeline will be laid in order to cover the whole chained area. The whole pipeline system will be served from the Gibbler Spring solar pump.

The solar system was chosen for this project and locality because of its dependability, low maintenance costs, and low initial costs. All other types of pumping systems were deemed more expensive due to the inaccessibility of the spring. Vandalism to the solar panels is the biggest concern at present, but so far they have withstood one season of hunting and firewood gathering.

Ranchers Control Leafy Spurge

C.A. Lacey, R.W. Kott, and P.K. Fay

HOW DO YOU STOP a weed that has a 15-foot deep root system and reproduces both by seeds and vegetative buds? These questions are being asked by many Montana ranchers in their battle against leafy spurge (*Euphorbia esula* L.).

Leafy spurge is a deep-rooted perennial that was introduced to North America from Russia about 1827 and has rapidly become a troublesome weed in the north central United States and southern Canada. It is estimated that the weed currently infests 2.4 million acres in North America, with severe infestations in Montana, North Dakota, Nebraska, South Dakota, and Wyoming.

Leafy spurge has invaded about 545,000 acres of range and pastureland in Montana and millions of additional acres of range are threatened. Once the weed is established, it competes with desirable vegetation and reduces grass production by as much as 50%. Since cattle generally avoid grazing in infested areas, carrying capacity can be reduced up to 75% by leafy spurge. This converts to an annual loss of about \$4 million dollars to Montana's cattle industry.

Biological Control

Researchers in Canada and the United States are studying the use of insects and pathogens for controlling leafy spurge. Three insects have been released in Montana. The spurge hawkmoth (*Hyles euphorbiae*) was released in 1978 and scientists are now trying to increase the population of this insect. A clear-winged moth, (*Chamaesphecia tenthriniformis*) was released in 1977, but was unable to become

established. A root-boring beetle, (*Oberea erythrocephala*) was released in 1982 and is considered another potential candidate for control of leafy spurge.

Plant pathogens, organisms which produce diseases in plants, also have potential as biological control agents. Research is being conducted to identify and screen pathogens which would help control leafy spurge.

Biological control methods have a long-range potential; however, there are problems. First, selecting, screening, and releasing an agent is slow and costly. It is estimated that control of leafy spurge will involve at least 20 scientist years at a cost of \$2 million dollars. Second, even if some agents are effective on leafy spurge, the level of control on the weed may not be adequate.

Chemical Control

Researchers are recommending the use of selected herbicides for leafy spurge control. Tordon is the most effective herbicide currently available. However, in most cases it must be reapplied after 3 years. Banvel and 2,4-D will provide control of the topgrowth, but must be applied annually. Cost of the herbicide and application for three years ranges from \$15 to \$120 per acre depending on the chemical and rate that is used. Although these herbicides can provide control of leafy spurge, in most cases, complete eradication of the plant is not possible.

Ranchers' Opinions

Many Montana ranchers have been using herbicides for leafy spurge control. However, according to Wilbur Holmes, a retired rancher in Absarokee, there are some problems. "We didn't have Tordon back in 1940, so we used 2,4-D. The problem with leafy spurge is that it will grow right in rocky ground or down along a stream bank. That makes controlling the weed with herbicides very difficult. Even where we could spray spurge, it always came back and we seemed to miss patches when we were spraying. Leo Lesnick, a neighboring rancher, agrees with Wilbur. "I sprayed leafy spurge for over 20 years with 2,4-D and each year the spurge was back," said Leo.

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About the senior author: Celestine Lacey was born and raised on a farm in southern New Mexico and received a B.S. degree from New Mexico State University. She worked for 5 years for the Soil Conservation Service correlating soil survey information with range site data in New Mexico and Utah. Currently she's working on a M.S. degree in agronomy specializing in weed science with a minor in range management at Montana State University.

Goals: Several weed species are becoming a major threat to the productivity of range and pastureland in Montana. These weeds are highly competitive and can reduce desirable forage production and impair the quality of wildlife habitat. Lacey says, "Our goal should be to develop ecological and economical techniques for controlling weeds on rangelands."—D. Freeman



Wayne Pearson surveys the effectiveness of herbicide applied in 1979 on leafy spurge. Photo taken in 1983.

Wayne Pearson (a rancher, Stillwater County weed supervisor, and president of the Montana Weed Association) has been conducting herbicide trials on leafy spurge for the past 9 years. "On old established leafy spurge plants, we've found the roots killed only to a depth of 18 inches even with our most effective herbicides. Therefore, in two or three years, the plant comes back and retreatments are necessary." Wayne has found that young spurge plants can be eradicated by Tordon since the root system is not well established.

Grazing Use of Spurge by Sheep

Wilbur Holmes first began using sheep to control spurge on his ranch in 1946. "The sheep did not appear to utilize leafy spurge during the first few years; however, by the early 1950's we had the plant under control," said Holmes. "We also found that unlike herbicides, the sheep didn't miss a plant and we made money on our lambs." Wilbur disagrees with landowners who report that sheep will not consume leafy spurge unless forced to the plant by over-grazing. "We never had to crowd the sheep to the spurge. There was

always plenty of grass, and the sheep ate the spurge in a free-choice pasture situation."

Leo Lesnick had heard about the success Holmes was having with his sheep controlling spurge and decided to give them a try on his ranch. "I had 250 acres that were about 60% leafy spurge," said Leo. "Some of the spurge was so thick that grass wouldn't grow." He estimated the average density of leafy spurge in his pastures was about 100 stems per square yard. "Now after grazing with sheep for 13 years, we have about 5% spurge, and the weed is only 2 or 3 inches tall in August.

Leo pastures 80 ewes with his registered Angus cattle and his stocking rate is 20 acres per cow unit per year. This is slightly below the recommended stocking rate of 17 acres per cow unit per year for his area. The most common grasses on his ranch are Kentucky bluegrass (*Poa pratensis*), bluebunch wheatgrass (*Agropyron spicatum*), and timothy (*Phleum pratense*). Spurge is the major forb.



Ranchers observe the effects of cattle grazing (left) and sheep grazing (right) on leafy spurge.

Holmes and Lesnick disagree slightly on the value of herbicides for spurge control. Holmes believes that a herbicide program can be combined with sheep grazing for a total control effort on a ranch. Leo feels that his sheep program has been so successful that he no longer uses herbicides. Instead, his spurge-infested areas are fenced and he lets the sheep control the weed. Leo believes that fencing is the biggest expense when part of a livestock operation is converted to sheep. Although some sheep are lost to predators, he still feels this is the most cost effective control method for leafy spurge.

Erling Peterson of Judith Gap, Bob LaBrum of Absorakee, David Maclay of Missoula and other ranchers throughout Montana also agree that sheep are effective in controlling leafy spurge. None of the ranchers found any ill effects on the sheep grazing spurge. In fact, several ranchers reported that lamb gains were greater on spurge-infested pastures. All the ranchers were quick to agree, however, that once sheep were removed the spurge would return.

Recent research conducted at Montana State University supports the ranchers' observations. A field grazing study showed that after a one- to three-week adjustment period,



Pasture on Lesnick ranch after sheep grazing controlled spurge. Leo estimates that this pasture was about 60% composition of leafy spurge before he started his sheep program in 1970. Photograph was taken in August of 1983 after sheep were removed from the pasture.

sheep readily grazed leafy spurge. The percentage spurge intake increased during the summer. By mid-August, spurge made up 40 to 50% of each animal's diet. This study concluded that there were no harmful internal effects or loss of body weight in sheep grazing leafy spurge. In addition, sheep with no experience grazing spurge consumed as much spurge as those having previous experience. Therefore, leafy spurge could be classed as a forage species under summer use by sheep.



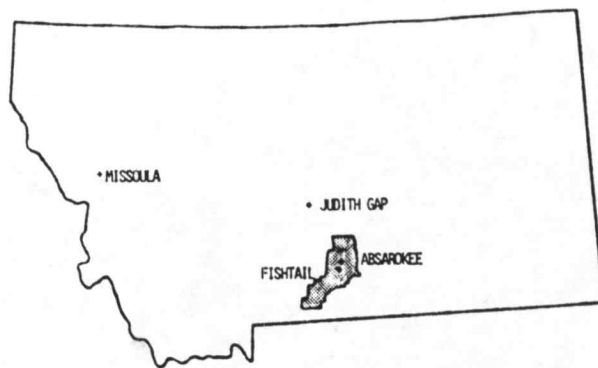
Celestine Lacey proudly observing a beautiful stand of bluebunch wheatgrass, the official State Grass of Montana.

Several Montana weed control specialists are now recommending the use of sheep for controlling large infestations of leafy spurge. For example, Wayne Pearson believes that sheep grazing is the best control method available for large acreages of spurge. To implement a sound management program, Wayne suggests fencing the spurge areas for sheep to stop the weed from going to seed. Sheep grazing should be combined with a herbicide program around the fringes of the infestations and on newly established spurge.

His advice to ranchers who have large infestations of leafy spurge is to view sheep as a weed control tool. Wayne believes there is no way to lose money with sheep since ranchers can sell the lambs at the same time they are controlling spurge.

Economical Spurge Control!

The addition of a sheep enterprise to the total ranch pro-



Map of Montana showing location of towns. Stillwater County (shaded area) is located in southcentral Montana.

gram has several advantages other than weed control. Lamb and wool are usually marketed at a different time of the year than calves. Therefore, sheep can improve the monthly cash flow of the total ranching operation. Also, an individual can schedule labor intensive activities within the sheep enterprise during slack periods and make more efficient use of ranch labor. A third benefit is that often, by grazing sheep and cattle together, the existing forage can be more efficiently utilized.

The amount of time and effort that a sheep enterprise will entail is entirely dependent on the type of production desired. If sheep are viewed just as a method of weed control and little production is expected, then they will probably require very little extra effort. On the other hand, if the sheep enterprise is viewed as a source of extra income, one must be prepared to make a commitment toward the sheep operation.

Conclusion

Sheep grazing is an excellent method for controlling large infestations of leafy spurge. Although the sheep will not eradicate the weed, with a good management system, they will keep it from spreading. Sheep grazing as a spurge control tool also has advantages over herbicides: ranchers receive a high return for their investment; environmental hazards are reduced; and spurge can be controlled in inaccessible areas.

By utilizing the experience of ranchers and research data, the following management guidelines were developed for using sheep to control leafy spurge:

- * Grazing should begin in the spring of the year when leafy spurge plants are several inches tall.
- * Pasture rotations should be scheduled so that the spurge does not go to seed.
- * If sheep are grazing spurge plants after seed set, the animals should be held for 5 days before moving to another pasture. This allows time for any viable seed to pass through the sheep.
- * Sheep grazing can be combined with a herbicide program for optimum control of leafy spurge.