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Rangeland Technology Equipment Council

1992 Annual Report

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Spokane, Washington
Sunday, February 9, 1992

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Drawings

Single copies of drawings are available from the Technology and Development Centers without charge.

Write to:

USDA Forest Service
Technology and Development Center
Building 1, Fort Missoula
Missoula, MT 59801

USDA Forest Service
Technology and Development Center
444 E Bonita Ave
San Dimas, CA 91773

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Reports

Range Handbooks

Richard G. Hallman, Program Leader, USDA Forest Service, Missoula Technology and Development Center, Missoula, Montana

Three range handbooks have been published by the Missoula Technology and Development Center and are now available from the Society of Range Management in Denver. These structural improvement handbooks consolidate numerous handbooks now scattered through many federal agencies into three volumes: *Fences; Facilities for Handling, Sheltering, and Trailing Livestock, and Facilities for Watering Livestock and Wildlife*. Each volume describes components, uses, advantages and disadvantages, safety and concerns, suggestions for redesign or new concepts for future development. Costs are included where possible. Pertinent books and articles are included in a bibliography in each volume.

***Facilities for Handling, Sheltering, and Trailing Livestock*, 8724-2809, September 1987.** This publication discusses facilities for wildland horse, sheep, and cattle management. The book describes corral systems (pens, alleyways, fences, and gates); restraining devices (loading, working, and squeeze chutes, cradles, and tables); and miscellaneous facilities such as dipping vats, spray pens, dusting alleys, back rubbers, and scales. Sheltering facilities include sheds, shade shelters, windbrakes, and feeding and watering devices. The section on trailing livestock describes driveways and driftways, low-water crossings, culverts, corduroy log crossings, and bridges. Facilities discussed may apply to wildlife as well as domestic animals, but specific information on wildlife management is not included.

***Fences* (8824-2803, July 1988).** This handbook consolidates information on planning, building, and maintaining fences. Information is included on: gathering site information; locating the fence; choosing a fence design; clearing the right-of-way; laying out the fence; and safety concerns. It describes components including braces and posts, brace designs, gates and materials and tools necessary to build a fence. Detailed descriptions of electric, wire, and wood fences are discussed.

***Facilities for Watering Livestock and Wildlife*, MTDC 89-1, January 1989.** This volume gives an overview of basic concepts, techniques, and equipment used to provide water for livestock and wildlife. These facilities are improvements that collect, transport, store, or provide access to water. Collecting water discusses wells, pump, windmills, dams, and reservoirs. Transporting water includes information on pumps and piping. Water storage describes reservoirs and storage tanks. The section dealing with access to water facilities describes methods of allowing wildlife and livestock to water without damaging the storage facility.

These volumes can be ordered from:

Society of Range Management
1839 York Street
Denver, CO 80206

There is a charge for each volume:

***Fences*, $10**

***Facilities for Watering Livestock and Wildlife*, $6**

***Facilities for Handling, Sheltering and Trailing Livestock*, $5**

Introduction

Dear RTEC Participants:

The RTEC session held in Spokane, Washington, February 8-10, was a milestone session. Each presentation had 100 to 110 people in attendance. Total attendance during the four hour program was estimated at 250. There were five presentations on Site Preparation and five presentations on Noxious Weed Management.

This is our third program under the acronym RTEC, which stands for Rangeland Technology and Equipment Council. In 1990 our informal Workshop (VREW), reorganized to reflect the diverse interests present in the he field of range management, and to incorporate all federal, state, and private land managers. We started in 1945 when there was a need to develop seeding equipment suitable for rangeland. Today the Council is focusing on high technology techniques as well as traditional equipment development for solving management problems.

Our recent programs have been featuring the various workgroups represented in the Council. These groups and chairs include:

Information and Publications
Dick Hallman, Chairman
USDA Forest Service
Missoula Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Plant Materials
Wendall Oaks, Chairman, SCS
Plant Materials Center
1036 Miller St.
Los Lunas, NM 87031

Fire
Phil Range, Chairman, BLM
Boise Interagency Fire Center
3905 Vista Ave.
Boise, ID 83705

Seeding & Planting
Harold Wiedemann, Chairman
Texas Agricultural Experiment Station
P.O. Box 2658
Vernon, TX 76384

Seedbed Ecology
Steve Monsen, Botanist
USDA Forest Service
Shrub Science Laboratory
725 N 500 E
Provo, UT 84664

Structure
Dan McKenzie, Range Specialist
USDA Forest Service
San Dimas Technology & Development Center
444 E Bonita Ave.
San Dimas, CA 91773

Weeds and Weed Management
Jim Oliverez, Noxious Weed Specialist
USDA Forest Service
Northern Region
Missoula, MT 59801

Our current project is the updating of the Revegetation Equipment Catalog. This is a two-year project and upon completion, it will be available through the Society for Range Management. If you know of equipment that should be listed, please contact us.

The 1993 Annual RTEC meeting will be held in Albuquerque, New Mexico. Our program will feature Decision Aids and Pinion/Juniper Management Strategies. We hope to see you there.

Sincerely,

Harold T. Wiedemann
Chair, Rangeland Technology and Equipment Council

Seed Propagation of Sedges and Rushes

Nancy L. Shaw and Emerenciana G. Hurd, Botanists, Intermountain Research Station, Forest Service, USDA, Boise, Idaho

Efforts to rehabilitate riparian and wetland disturbances in the Intermountain West have generated a demand for nursery stock of common sedges (*Carex spp.*) and rushes (*Juncus spp.*). Easily propagated vegetatively, "sprigs" or rhizome sections of species in both genera are commonly dug from sites near disturbances for immediate planting or production of container stock. However, adequate quantities of vegetative material are not always available, and in some cases field collection may cause environmental damage. Scheduling and logistics of harvesting, storing and propagating vegetative material and its possible contamination with weedy species present additional problems for growers. For these reasons we began investigating seed propagation of nursery stock or direct seeding as additional approaches for accomplishing revegetation objectives.

Inflorescences, Fruits, and Seeds

Sedge inflorescences consist of single or multiple spikes produced on reproductive culms. Fruits are small, leathery achenes, each enclosed in a persistent saclike perigynium. For species included in our studies (table 1), weight of achenes plus perigynia ranges from 0.5 to 2 million/lb, with an average of 1 million/lb.

Rush inflorescences range from panicles to open headlike structures. Fruits are capsules, each containing numerous tiny seeds. Seed weight for species under study (table 1) averages 39 million/lb and ranges from 14 to 69 million/lb.

Harvesting

Harvest dates for sedges and rushes vary with species, location, and site conditions. Ease of harvesting varies considerably with site conditions, plant density, and morphological characteristics of the species. It is likely that equipment and technology designed for hand harvesting native grass seeds may be used or modified to simplify collection of sedges and rushes. Collections adequate for research or production of nursery stock can be obtained by hand clipping inflorescences and dropping them into containers carried on a shoulder harness or belt. Readily disarticulating achenes of species such as C. microptera may be stripped from the inflorescences. Rush inflorescences with closed capsules are clipped; seeds can be shaken into a container if capsules have opened.

Greater quantities of seed would be required for direct seeding projects. Mechanical harvesters could be adapted for collecting from large monotypic stands on sites dry enough to permit their operation. Establishment of seed production plots on agricultural land would also increase seed availability. Problems such as wildlife or livestock use, insect and fungal infestations, and fluctuating soil moisture and water tables, could also be avoided or controlled by this approach.

Conditioning

Harvested material of both genera is sometimes quite wet and may require field drying to prevent molding. Sedge inflorescences or achenes can be spread over fine screens for drying. Screens must also be placed over material dried outdoors as achenes are easily scattered by breezes. Rush inflorescences are dried upright in large buckets.

Small collections of sedge inflorescences are conditioned by removing achenes from inflorescences using the palms of the hand or a rubbing board. The perigynium is not separated from the achene. Removal of coarse debris is adequate for direct seeding. High purities required for production of container stock are obtained using sieves (nos. 12 to 18), air screen cleaners, and seed blowers. Techniques and equipment for drying and cleaning small grass seeds could be adapted for use with larger lots of many sedge collections.

Rush capsules open during drying. Seed can then be shaken into a container and separated from chaff using a fine screen (0.3 to 0.6 mm openings). Capsules should not be crushed if high purity is required since it is difficult to separate fragments from the seed. Purities exceeding 90 percent are obtained by careful hand winnowing or by removing chaff with a fine stream of air.

Testing and Storage

Standard germination tests for sedge and rush species have not been developed. Viability determined by tetrazolium chloride staining is used to estimate seed quality. Viability of collections included in our studies ranges from 28 to 96 percent and has not declined after 14 to 17 months storage in closed glass containers at room temperature. Moisture content of these collections ranged from 6 to 8%.

Germination

Treatment to reduce fungal problems is often necessary when germinating sedge achenes. Work with tiny rush seeds is complicated by static electricity problems. These are alleviated by placing the seeds on a glass plate and manipulating them with a bamboo probe, both sprayed with an antistatic product. A hand lens or microscope is essential for examining rush seeds or germinants.

The limited literature on germination of Intermountain sedge and rush species suggests that alternating temperatures, light, and a moist to wet environment are common requirements for germination, favoring seedling emergence on moist, open substrates free of competing vegetation (Hurd and Shaw 1992, Johnson et al. 1965). Nature and degree of dormancy as well as specific incubation requirements vary among species and likely among populations. Based on our experience, seed propagation is possible for nondormant lots of species such as *Carex lenticularis*, *C. subfusca*, or *Juncus articulatus* and those that respond positively to cold stratification (30 days at 3 to 5 degrees C, such as *C. amplifolia*, *C. nebrascensis*, *J. effusus*, and *J. ensifolius*. We are presently developing pretreatments to relieve dormancy of species not responding to stratification.

Applications and Challenges

Use of seed for propagation of sedges and rushes would permit collection and storage of achenes and seeds of many species from a range of collection zones for later use. Availability of seed, container stock, and "sprigs" would add considerable flexibility to revegetation efforts.

Further work is required before the feasibility of propagating sedge and rush species from seed can be evaluated: (1) Equipment and technology developed for producing, harvesting, conditioning, propagating, and planting small-seeded grass and forb species should be evaluated for use with sedges and rushes. (2) Additional studies must be conducted to provide guidelines for relieving dormancy and maximizing germination of individual species. (3) Propagation practices for producing container stock of individual species from seed or vegetative material must be developed. (4) Techniques and equipment for preparing seedbeds and planting sites and planting seedlings on highly varied riparian and wetland sites are needed. (5) Direct seeding will require techniques for evenly distributing the small achenes and seeds. Pretreatments preparing the achenes and seeds for rapid germination on mist surfaces would permit spring seeding when danger of flooding is past.

For further information contact the authors at 208-334-1457 or Intermountain Research Station, Forest Service, U.S. Department of Agriculture, 316 E. Myrtle, Boise, Idaho 83702.

Hurd, E.M., and N.L. Shaw. 1992. Development of seed technology for Carex and Juncus species of the Intermountain Region. In: T.D. Landis (compiler). Proc. Intermountain Forest Nursery Association 1991 Annual Meeting; 12-16 Aug. 1991; Park City, Utah; USDA Forest Serv. Gen. Tech. Rep. RM-. {In Press}.

Johnson, W.M., J.O Blankenship, and G.R. Bram. 1965. Exploration in the germination of sedges. USDA Forest Serv. Res. Note RM-51.

Table 1.–Species included in seed propagation studies.

Sedges	
Species	***Common Name***
Carex amplifolia	Big-leaf sedge
Carex aquatilis	Water sedge
Carex douglasii	Douglas sedge
Carex Lanuginosa	Woolly sedge
Carex lenticularis	Lens sedge
Carex microptera	Small-winged sedge
Carex nebrascensis	Nebraska sedge
Carex pachystachya	Chamisso sedge
Carex praegracilis	Silver sedge
Carex rostrata	Beaked sedge
Carex sheldonii	Sheldon's sedge
Carex simulata	Shortbeaked sedge
Carex stipata	Prickly sedge
Carex subfusca	Rusty sedge
Carex vesicaria	Blister sedge
Carex vulpinoidea	Fox sedge

Rushes	
Species	***Common Name***
Juncus articulatus	Jointed rush
Juncus balticus	Baltic rush
Juncus bufonius	Toad rush
Juncus effusus	Soft rush
Juncus ensifolius'	Dagger rush
Juncus howellii	Howell's rush
Juncus tenuis	Slender rushes
Juncus torreyi	Torrey's rush

Roadbed Stabilization

Douglas D. Basford, Forester, USDA Forest Service, Salmon National Forest, Salmon Ranger District, Salmon, Idaho

Past grass seeding practices on the Salmon Ranger District in the early 1970's were generally inconsistent and ineffective on revegetating newly constructed roads. Seeding usually occurred in October or November on frozen and snow covered roads. This method usually resulted in low survival rates except on the moist sites.

Steve Monson was contacted at the Intermountain Research Station at Boise, Idaho in the early 1970's for advice and consultation. The Salmon Ranger District then modified their seeding practices to incorporate the following:

(1) Apply seed and cover and/or mix with the soil by harrowing or covering with a chain drag system. This allowed germination and root growth to occur under the snow before it melted in the spring of the year. Adequate root growth and hardening off of the plant species would then occur before the drought period during July and August. This was a key element in increasing our survival rates to the 80 or 90 percent level.

(2) Seeding and harrowing needs to occur in late September or early October before the ground freezes. Harrowing or chaining to cover the seed has been ineffective when applied on frozen surfaces.

(3) Avoid seeding in the late spring or during the summer. Success rates are usually low due to inadequate root development and drought conditions that occur during the summer.

By following these criteria the success rate of our seedlings increased to approximately 90 percent on the road surfaces and road fillls. Equipment was tested on the cut slopes in the fall of 1991 and will be evaluated in 1992 as to its success rates.

Equipment presently being used consists of an electric seeder mounted in the back of a pickup. Seeding is done ahead of the chaining or harrowing operations. A chain system attached to an extention off the blade of a road grader is used for the cut slopes. Part of the same basic chain system is also used for the fill slopes except it is attached to an extention mounted to the bumper of the pickup doing the seeding. This pickup is also used to pull the English Harrow to cover the seed on the road surface.

The cost of the equipment for this type of seeding operation is approximately $1000 to $1200. Estimated production rates are four to six miles per day.

Approximately 24 pounds of seed per acre were applied to the road surface. The seed mix used during the seeding operations consisted of the following species: (1) Timothy, (2) Intermediate Wheatgrass (3) Slender Wheatgrass (4) Southern Smooth Brome (5) Smooth Brome (Manchar) (6) Potomac Orchard Grass and (7) Mountain Brome (Bromar).

Field testing over the last 10 to 15 years indicates that this method has a high success rate if the above guidelines are followed. It is a cheap and economical method of revegetating disturbed areas and is easily adapted to the equipment found on any road construction project.

Seedbed Preparation In Cheatgrass Infested Rangelands

Milke Pellant and Mike Boltz, Range Conservationists, USDI Bureau of Land Management, Idaho State Office and Boise District, respectively, Boise, Idaho

Cheatgrass (*Bromus tectorum*), an introduced annual grass, dominates over 2 million acres of rangelands administered by the Bureau of Land Management (BLM) in southern Idaho. The BLM has initiated a greenstripping program using fire resistant vegetation to reduce the spread of wildfires on cheatgrass infested rangelands. Rehabilitation efforts on burned rangelands are also hindered where cheatgrass was common prior to the wildfire. Mechanical treatments are commonly used to reduce cheatgrass competition prior to the seeding process.

Disk Chain

The disk chain, and its modifications, used by Idaho BLM have been previously described (Pellant 1988 and Pellant 1990). The disk chain is a "one-pass" piece of equipment that prepares the seedbed and distributes seed over a 35 foot area. Monitoring studies have been established to document cheatgrass control on projects treated with the disk chain. The following recommendations are based on these studies:

1. Burning the surface litter and standing dead prior to operation of the disk chain improves cheatgrass control and seeding success.

2. Operation of the disk chain in the fall, the recommended time to plant, is ineffective if cheatgrass germination has not occurred. Cheatgrass density is often greater in the treated than in the untreated area if the disk chain is used in dry fall months.

3. Operation of the disk chain on moist, loam and silt loam soils enhances surface crusting, reducing establishment of seeded species. Use of the disk chain should be carefully monitored on moist soils.

4. Small seeds may be buried too deeply if dropped in front of the disk chain. Better establishment was observed when small seeds were placed behind the disk chain and covered with a light chain.

The disk chain is a cost effective and sound technique to reduce cheatgrass prior to seeding perennial vegetation. However, soil moisture, surface litter, cheatgrass phenology and seed size, all must be considered prior to making a decision to use the disk chain.

Plow and Seed

The Boise District has used Towner and wheatland plows to create greenstrips in areas still dominated by big sagebrush where firebreaks would enhance fire suppression capabilities. Removal of big sagebrush from the greenstrips is necessary to keep flame lengths short and close to the ground.

The greenstrips have of necessity traversed sites with differing levels of potential annual competition to seeded species, and have afforded an opportunity to evaluate the interaction of plowing treatments with site, pre-treatment vegetation, and season. Monitoring studies on these projects have revealed that:

1. Cheatgrass control in the seedling year is correlated with pre-treatment levels. Old, unrehabilitated burns which are dominated by annuals have high cheatgrass competition to seeded species; sagebrush communities with primarily bare ground or perennials in the understory have low levels of cheatgrass competition for a given season of plowing.

2. The season of plowing has a strong influence upon cheatgrass control. Summer plowing and fall plowing where no germination has occurred is ineffective for cheatgrass control because it relies too heavily on near-complete seed burial. Stones and surface litter tend to interfere with complete burial. Spring plowing is more effective because it generally kills the living plants. The more thorough the germination, the more effective the control.

3. Effective control of annual and perennial grass competition appears to be more important than sagebrush control to initial seeding establishment.

4. Sagebrush control with once-over plowing appears to be most effective in summer when soils are dry, sagebrush stems are brittle, and before sagebrush seed becomes viable. Early fall plowing may be equally effective if these conditions are met. Late fall or early spring plowing, particularly if the soils are moist, wet, or frozen appears less effective. In addition, late fall plowing plants viable sagebrush seed in a favorable seedbed.

5. Fire suppresses big sagebrush to a much greater degree than once-over plowing. Effective protection from fire is a necessary precondition for maintenance of big sagebrush in the successional patterns in the 8 to 12 inch precipitation zone in southwest Idaho.

6. Crested wheatgrass seedling density is influenced by:

- Pretreatment cheatgrass levels
- Season of planting
- Reseeding equipment

a. Ineffective fallow on sites with high pretreatment cheatgrass levels results in seeding failure. Sites with low pretreatment cheatgrass levels allow more latitude in timing and equipment used for treatment.

b. Fall planting has more consistent success and is less vulnerable to spring drought than spring planting.

c. Broadcasting with adequate seed coverage yields far higher seedling densities than drilling with depth bands for a given application rate. Tire drags and a vine roller cultipacker were used to cover the broadcast seed. Cultipacking action varied from nil in powder dry soils to high in moist to wet soils.

7. Alfalfa seedling density appears very sensitive to annual grass competition. Densities tended to be higher with broadcast planting than with rangeland drills if seed coverage was provided. Aerial broadcast of alfalfa without seed coverage has generally yielded disappointing results compared to rangeland drills. There was some tendency to have higher alfalfa densities for spring plantings.

Literature Cited

Pellant, Mike. 1988. Use of disk chain on southern Idaho's annual rangeland. In: Vegetation Rehabilitation and Equipment Workshop: 42nd Annual Report, Corpus Christi, TX,

Pellant, Mike. 1991. Rehabilitation equipment development in southern Idaho. Rangeland Technology Equipment Council: 1991 Report, Reno, NV.

Soil Bacteria For Weed Control

A.C. Kennedy, USDA Agricultural Research Service, Pullman, Washington

Annual weeds are a problem in range establishment. Downy brome (*Bromus tectorum L.*), commonly called cheatgrass, infests 5.7 million hectares in the western United States. Downy brome, an invader species from Eurasia, will germinate in fall or spring over wide ranges of temperature and moisture. It often is considered an important forage species providing early spring grazing; however, its short growth period, fluctuating forage production and high fire hazard make it less desirable than other species. Downy brome is an effective competitor for space, water, and nutrients because its roots continue to grow at low temperatures. The accumulation of downy brome root mass in the late fall through early spring allows it to be more competitive than other plant species. Perennial grass seedlings often fail because downy brome is so competitive.

Rhizosphere microorganisms often negatively influence plant growth. Manipulation of the plant root microflora to enhance selective plant antagonists may alter competition among range plants. Phytotoxic effects of microorganisms can be plant species and cultivar specific. Plant-suppressive bacteria potentially may be used to regulate the growth of unwanted plant species growing simultaneously with more desirable plants. This would be especially true if competitive weed growth coincided with environmental factors conducive to bacterial growth and production of weed-suppressive activity. Downy brome is an excellent weed species for this type of investigation.

Biological control offers a novel, alternative means of suppressing weed growth and establishment. We have isolated soil bacteria that are selective in their root growth suppression of various grass weed species. These naturally-occurring soil bacteria suppress plant growth by the production of plant-suppressive compounds. These bacteria are excellent biological control agents because they are aggressive colonizers of the roots and residue. The bacteria can function as a direct delivery system for the natural "herbicide" they produce. Most of the bacteria we studied inhibited root growth, although some bacteria inhibit seed germination. These inhibitory bacteria cause the greatest reduction in weed growth at low temperatures. They are most prevalent in the soil in late fall and early spring. Application of these bacteria during seed bed preparation and the resultant suppression of downy brome root growth may allow other plant species to out-compete the downy brome, thus leading to the establishment of more desirable range species.

Field studies were conducted in eastern Washington to evaluate the effect of the inhibitory bacteria on the growth of downy brome. In seeding field trials, in which downy brome was planted in rows, bacterial isolates reduced downy brome populations up to 30% and shoot dry weight up to 42%. In other studies, bacteria were applied to wheat fields infested with natural populations of downy brome. Downy brome and winter wheat growth and development were measured throughout the growing season. Reduction in downy brome growth varied and was dependent upon the specific bacterial strain. One strain of inhibitory bacteria reduced plant populations and above ground growth of downy brome 31 to 53%, respectively. In the same experiment, seed production of downy brome was reduced 64%. Winter wheat yields were increased by 35% with the application of the bacteria and subsequent suppression of downy brome growth. This increase in yield is similar to the yield increase expected from the elimination of a moderate infestation of downy brome.

Thus far, field studies along with laboratory and greenhouse studies have illustrated the ability of inhibitory bacteria to suppress the growth of grass weeds. This research demonstrates the use of plant-suppressive bacteria as biological control agents for grass weeds. Research into methods of application, such as, surface application, applications with straw residue or clay particles, and seed bacterization is continuing.

For further information, contact Ann C. Kennedy, USDA-ARWS, 2154 Johnson Hall, Washington State University, Pullman, WA 99164-6421, (509) 335-1554.

Sagebrush Establishment Enhanced By Snowfencing

Stephen B. Monsen, Susan E. Meyer, and Stephanie L. Carlson, Botanists, USDA Forest Service Shrub Sciences Laboratory, Provo, Utah

Introduction

Mine reclamation plans often call for re-establishment of native shrub species as well as perennial grasses and forbs. Many factors contribute to poor seeding success with shrubs, including incorrect planting methods, use of poorly adapted ecotypes, and failure to control competition from weeds and other seeded species.

One factor in seeding success commonly considered beyond control is the weather. Especially on semiarid sites, a dry winter can result in failure of even the best-planned seeding. This problem is most acute for small-seeded surface-emerging species like sagebrush.

Natural recruitment in sagebrush stands often occurs even in marginal years. This indicates that adult plants act to ameliorate seedling microenvironment by trapping snow, thereby extending the period of favorable surface moisture later into the spring. Cooperative studies were established with mines in four western states to test the hypothesis that snow harvesting would enhance sagebrush emergence and establishment, especially in marginal years.

Objectives

1. To test the effectiveness of snow harvesting in enhancing sagebrush seedling emergence and establishment at four contrasting western mine sites.

2. To compare the effectiveness of snow fence and straw mulch, alone and in combination, as snow harvesting techniques.

3. To relate the effectiveness of snow harvesting treatments to weather conditions at each mine site.

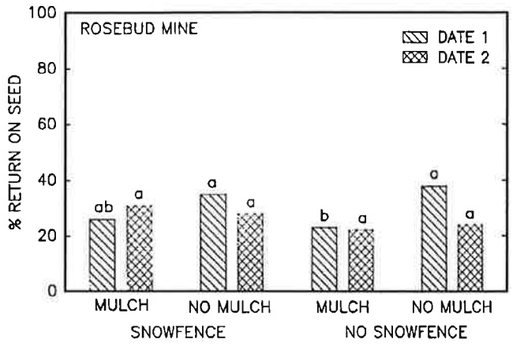
Methods

Experiments were established in autumn 1988, using similar plot layouts at all four sites. The sites were prepared by ripping, topsoiling, disking, and harrowing to provide a firm seedbed. Snowfence was then erected, and straw was crimped in for the mulch treatments. Plots were seeded by broadcasting with a uniform seeding rate of approximately 50 seeds (P.L.S.)/square foot. The seed source for each site was a locally adapted species and ecotype.

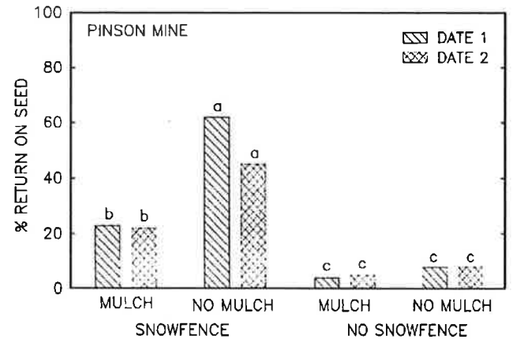
Plot evaluation took place approximately two weeds after spring snow melt-off at each site, and again in mid to late summer. For each 10 X 10 foot plot, all sagebrush seedlings within three 10 x 1 foot strips (30% of total area) were enumerated using a one foot square sampling frame.

Results were analyzed for each site using appropriate analysis of variance techniques. The least significant difference test was used for means separation ($P<0.05$). Seedling counts were converted to a return-on-seed basis (seedling/seeds sown) for graphic representation.

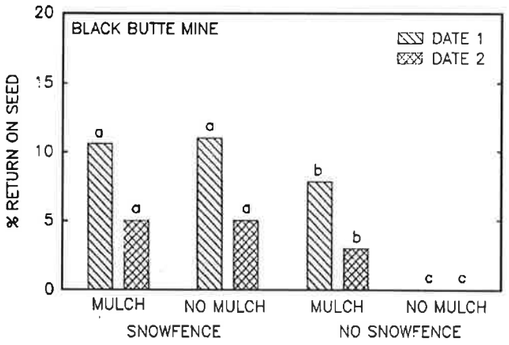
Results



At the Rosebud Mine, in northern Montana, above-average winter moisture resulted in excellent emergence and survival regardless of snow harvesting treatment. In this kind of year, snow harvesting produces no net increase in recruitment.



At the Pinson Mine, near Winnemucca, Nevada, an average moisture year provided enough winter snow cover in the snow fence treatment to produce six times as many established seedlings as the no snow fence treatment. Straw mulch had a negative effect. Even the control treatment gave adequate return on seed.



At the Black Butte Mine, near Rock Springs, Wyoming, a marginal moisture year gave lower return on seed than at Pinson or Colstrip, with no observed emergence in the eh control treatment. Both snow fence and straw mulch significantly improved sagebrush seedling establishment.

At the Stibnite Mine, at high elevation location near Stibnite, Idaho, observed emergence was minimal, possibly due to killing frost after snowmelt. A combination of snow fence and straw mulch resulted in significantly higher emergence. No living seedlings were noted on the second sampling date.

Conclusion

Results of this study indicate that snow harvesting techniques would be used effectively to enhance establishment of sagebrush species on mine disturbances in marginal moisture years. Small scale snow harvesting combined with intensive shrub seeding could be used to establish shrub patches that serve as centers for continued natural recruitment. These patches could be seeded without competition from aggressive perennial grasses.

Snow harvesting was effectively achieved using a four foot snow fence, which is costly and slow to establish. Modification of mechanical fencing equipment would likely increase the utility of existing machinery to construct small catchment fences. The system would be economically feasible on mine disturbance and other wildland sites. Other techniques may be used to harvest snow, including creation of deep furrows or soil mounds. Equipment is needed to construct and erect small snow catchment structures for treatment of barren surfaces.

Integrated Weed Management

Barbra Mullin, Weed Coordinator, Montana Department of Agriculture, Helena, Montana

Integrated Weed Management has been defined in a variety of ways. One definition is "a management system that uses all suitable methods in a compatible manner to reduce weed population to levels below those causing acceptable economic or ecological consequences." The key here is the use of all suitable methods. It is an ecological approach to managing unwanted plant species.

To correctly utilize an integrated approach it is important to assess all factors prior to making a decision: target weed, size of infestation, non-target vegetation, soil types, climatic conditions, important water resources. It is also important to understand the weed management objectives for the area: different land managers and agencies have different goals and restrictions on their activities, which will impact the final management decision.

There are many different techniques to be considered in developing an effective management plan. They include:

Prevention: The cheapest weed control is preventing establishment in the first place - quarantines, weed-free hay programs, and certification of agronomic crops are all examples.

Education: Field staff should be familiar with weeds found in the area as well as potential threats to the area. Staff training is critical. Educating the general public is also important — what weeds are of concern and why they are a threat.

Cultural: The use of plant competition and mulches to keep weed competition to a minimum can be used but generally works best with annuals.

Mechanical: The use of a physical method to eliminate the weed can be effective on small infestations. Handpulling, hoeing, and mowing are methods used. This is generally an expensive treatment.

Biological: When using a living organism to manage a specific weed we traditionally think of insects. Other tools include plant pathogens and grazing animals. Biocontrol methods generally will suppress host weed populations, but not contain or eradicate them.

Chemical: Herbicides can also be used to control unwanted vegetation. There are important licensing requirements and environmental concerns when using herbicides. It is critical to follow all label and site directions.

To make IWM work it is important to understand all of the methods available for use; evaluate the site and choices for restrictions and then take action. A systems approach to weed management, with increased emphasis on managing the land for beneficial species and specific controls targeting unwanted vegetation, is the ultimate goal of integrated weed management.

For further information, contact the author at: MDA, Capitol Station, Helena, Montana 59620, Telephone: (406) 444-2944.

Montana Noxious Weed Seed Free Hay

Larry Hoffman, Lewis and Clark County Extension Agent, Montana State University Extension Service, Helena, Montana

Purpose:

The purpose of the Montana Noxious Weed Seed Free Hay program is to provide forage free of designated noxious weed seeds for the feeding of livestock on private and/or publicly owned lands.

State of Montana Category I, Category II and Category III noxious weeds are a "must" in the certification of "Noxious Weed Seed Free Hay".

Category I	Category II	Category III
Canadian Thistle	Dyers Woad	Yellow Starthistle
Field Bindweed	Purple Loosestrife	Common Crupina
Whitetop	Sulphur Cinquefoil	Rush Skeleton Weed
Leafy Spurge		
Russian Knapweed		
Spotted Knapweed		
Diffuse Knapweed		
Dalmation Toadflax		
St. Johnswort		

Other noxious weeds listed below "must" be verified but may not disqualify the crop. Disqualification is a judgment made by the inspector following the County Weed Districts' policy for the county where the inspection is done.

Other:

- Baby Breath
- Burdock
- Caroway
- Downy Brome or Cheatgrass
- Common Tansy
- Common Mullein
- Cypress Spurge
- Halogeton
- Black Henbane or Henbane
- Houndstongue
- Lettuce - blue
  - prickly
- Musk Thistle
- Oxeye Daisy
- Perennial Sowthistle
- Poison Hemlock
- Purple Mustard
- Quackgrass
- Showy Milkweed
- Tansy Ragwort
- Tall Buttercup
- Tall Larkspur
- Toadfloax - common
  - yellow
- Wild Licorice

The Montana Noxious Weed Seed Free Hay program also provides an opportunity for the uninterrupted movement of forages into and through counties, states, or countries where regulations are placed on noxious weeds and/or where forages passing through or being brought in to an area require certification or other documentation certifying that the forage is free of noxious weed seeds.

Noxious Weed Seed Free Hay is a forage product that has been certified by an authorized inspector representing the County Extension Service or the Weed District.

Forage products that the MNWSFH program are working with at this time are: alfalfa hay, grass hay, alfalfa/grass hay, straw, grain hays and forage pellets/ cubes.

The program has not, at this point in the development, brought in hay quality. In the future, when general standards can be agreed on, the quality of hay will play a major part in marketing efforts.

Introduction:

Over the past 10 to 12 years, areas throughout Montana have been pushing for weed control management on a large scale basis. An area that has come up time and time again was for a statewide clean hay program to help manage and minimize the spread of noxious weeds. The Montana Noxious Weed Seed Free Hay program has met that challenge and has shown success and a need for noxious weed seed free forage.

The Montana Noxious Weed Seed Free Hay (MNWSFH) program has been functioning since 1989. The program has been administered by the Montana Extension Service, through the coordination and cooperation from Gene Surber, Gallatin County Extension Agent, and Larry Hoffman, Lewis and Clark County Extension Agent.

Figures showed an increasing interest for the programs in 1990 and then a leveling off in 1991 along with federal and state agency support and adjacent state and foreign inquiries to the MNWSFH program.

Hay Tonnage by Product:

Alfalfa - 3,118 tons
Alfalfa/grass - 7,185 tons
Other - 166 tons
Grass - 1,229 tons
Pellets - 64 tons
Straw - 225 tons

The Extension Service will continue to work with state and federal agencies, bordering states and provinces to promote MNWSFH education training of county representatives and administer the producer program until a financial base and authorized group can take on the responsibilities.

Statement Of Need:

MNWSFH is not based on a "problem" but as a solution to an ongoing problem - weed management.

Counties, states, provinces, and countries wishing to purchase Montana forage indicate a need for more "noxious weed seed free forage" to meet the intra- and interstate and international markets.

Private and public land (BLM, Forest Service, State Lands, FWP) managers are requesting higher standards of quality forage feed on their lands.

NWSFH needs time to organize sufficiently to promote and market noxious weed free seed forage effectively.

Specific Objectives: Standards of MNWSFH have been established as a support mechanism for weed management in forage production and for possible marketing

	1989	1990	1991
Counties in Program	13	23	35
Counties with Representatives	24	45	35
Number of Representatives	38	59	49
Producers	77	143	126
Acres - Inspected - Certified	3,386 2,536	12,953 11,156	6,321 5,935
Tonnage Certified For Sale	5,116	16,637	11,987

opportunities. Phase II of the MNWSFH program will continue efforts to broaden its scope and success by:

1) Developing a producer organization and board.
2) Coordinating a statewide forage organization.
3) Continuing to expand the MNWSFH program and strengthen policy acceptance with state and federal agencies for public lands.
4) Coordinating and promoting regional noxious weed seed free forage efforts.

The MNWSFH program will continue to:

1) Strengthen a uniform statewide project.
2) Continue to initiate policy.
3) Train county representatives.
4) Administer the program.
5) Educate producers and purchasers on the importance of MNWSFH.
6) Produce and distribute MNWSFH information, publications, etc.

A Weed Trust Grant, awarded in 1989, estimated that the MNWSFH program would take five years to become self supporting and sustaining. The program is now 3 years old.

The program is gaining merit, State and Regional recognition and is providing a weed free quality product for state, interstate and international markets.

The second phase of the MNWSFH program is to strengthen original objectives and promote a regional concept.

Regional Concept:

- 12 State Program
- Objectives:

Standardize

- *Inspection and Certification Policy*
- *Inspection procedures*
- *Form standardization*
- *Wildlife poster promotion*
- *Transfer standards*
- *Marketing the product*
- *Training standardization*
- *Quality Standards*

Biological Control of Spotted Knapweed and Leafy Spurge: Principles and Prospects

Jim M. Story, Montana State University, Western Agricultural Research Center, 580 Quast Ln., Corvallis, MT 59828

The existing methods of weed control, namely chemical, cultural and mechanical, are not providing adequate solutions to the control of many rangeland weeds in Montana and other areas of the Pacific Northwest as evidenced by the steady increase in weed-infested acreage on rangeland. In Montana alone, spotted knapweed, first reported in the state in 1927, now infests an estimated 4 million acres of rangeland, while leafy spurge, first reported in the state in 1923, now occupies an estimated 550,000 acres. Vast areas of the Pacific Northwest are threatened by these and other weed species.

A major reason for the rapid spread of these weeds is that the plants are introduced species and therefore lack the complex of natural enemies that effectively regulate their densities in their native area of eastern Europe. In view of this, Montana State University, in cooperation with USDA-APHIS, and USDA-ARS, has established a program which seeks to fill these natural enemy voids with Eurasian-collected organisms proven to be host-specific to the respective target weeds. This approach, known as biological control is rapidly gaining public support.

Biological control is particularly attractive because it is permanent, very selective, energy self-sufficient, comparatively economical, and environmentally safe since no toxic substances are introduced into the environment. However, biological control is not without its limitations:

1. It is a slow process and therefore not an immediate control.

2. It does not achieve eradication, but merely reduces densities to more tolerable levels.

3. It is often too selective; it will only attack one weed existing among a complex of other weeds.

4. It cannot be used against weeds which are valued under some situations since insects don't recognize boundaries.

5. It cannot be used against weeds that are closely related to beneficial plants as the insect may be unable to discriminate between the related plant species.

6. The use of insects against cropland weeds under intensive cropping practices is not feasible due to the elimination of the host weed.

To date, seven insect species (three flower head insects and four root insects) have been introduced against spotted knapweed in the U.S. Of these, five are established and increasing in numbers. The first U.S. releases of two new flower head insects will be made in the summer of 1992.

Eight insect species (six root insects, one stem insect, and one defoliator) have been introduced against leafy spurge. Seven of these insects are established. Additional insect species are currently being screened.

The obvious importance of biocontrol in the management of exotic weeds insures that biocontrol efforts will be expanding in the near future. However, as noted, biological control is not a "cure-all" and, therefore, cannot be looked upon as a replacement to herbicides. Successful management of our rangeland weeds will be a long-term effort involving the combined use of biocontrol and all other methods in an integrated approach.

For further information, contact the author at the above address or by phone: (406) 961-3025.

Noxious Weed Spraying Equipment (Abstract)

Fred Oligschlaeger, President, Spratronics, Inc., Bothell, Washington

1. *Operator Safety*
   - *Closed chemical loading*
   - *100% sprayer control from vehicle cab*
   - *Mid-ship mounted boomless spray head*
   - *Automatic Control of chemical application rates*
   - *Sprayer is flushed on site*

2. *Sprayer Features*
   - *Chemical injection control system*
   - *Water only in main tank, separate chemical tanks*
   - *Boomless spray head (single or dual)*
   - *9 foot wet boom (cover width of sprayer)*
   - *closed loading of chemicals*
   - *Printer & data logger (for record keeping)*
   - *Console displays*
     - . Acres sprayed
     - . Amount of chemical dispensed
     - . Application rate of each chemical
     - . Distance traveled
     - . Miles per hour
     - . Spray width

3. *Environmental Safety*
   - *Ultra low drift boomless spray head*
   - *Multi-channel chemical injection permits selective chemical spraying*
   - *Chemical application rates are constant regardless of ground speed or spray width sections.*
   - *Chemicals are contained in 15 or 30 gallon chemical tanks*
   - *7 section spray head*

4. *Sprayer Operator Productivity*
   - *Closed loading*
   - *Single pass spraying*
   - *Boomless spray head, 7 sections*
   - *Reduced spray clean-up time*
   - *Reduced spray calibration time*
   - *Chemical application rate change on the go*
   - *Printer Data logger for record keeping*

For further information, contact the author, Fred Oligschlaeger at (206) 338-0241, 15721 24th Drive SE, Bothell, WA 98012.

Simplex

Ken Glanz, Sales Representative, Simplex Manufacturing, Portland, Oregon

Simplex Manufacturing is a small, privately held corporation involved in the designing, fabrication and sales of aerial application equipment. The company dates back to the 1940's when the founder fabricated the first aluminum pumps for agricultural airplanes. From this beginning, Simplex has grown to be the largest supplier of equipment for helicopters and fixed wing aircraft in agriculture, forestry, firefighting and oil pollution control. Most of our early designs were for the Bell 47 and Hiller and were for wet application. During those years, Simplex developed the technology to build reliable equipment, spray booms for best pattern results, and how to vary flow rates for special projects. We have carried that technology into the 80's and 90's for larger aircraft, bigger systems and more technical controls.

Simplex systems provide a wide range of techniques from larviciding, low volume applications and ultra low volume applications with highly controlled droplet sizes. Our latest spray system is for spot spraying in forestry and for the drug enforcement agencies.

Today, with an increase in aerial application comes drift claims, higher insurance rates and environmental concerns, which require more and more applicators to look towards a dry, granular application. Simplex followed that lead by developing precision seeding system, ultra low weight system where just several pounds are applied per acre, and the DDA system where several ounces per acre can be applied. This has greatly reduced drift claim problems, but requires a whole different technology in equipment.

At the other end of the spectrum, Simplex manufactures spreaders that are capable of application rates up to 5000 pounds per minute, which represents 100 pounds per acre.

Simplex lead the way in aerial ignition by introducing a gelled fuel igniter system known as the Heli-Torch and marketed the industry standard Sure Fire gelling agent. This equipment has been used extensively in fire fighting with fire for wildlife habitats, slash burning and other fire applications including the burning of spilled oil. To complement our aerial ignition line, Simplex developed ground support equipment, including our mix-transfer system, ground firing and other equipment to make the burning operation more efficient.

The most recent addition to our product line is Fire Attack, designed for most popular working helicopters. Fire Attack utilizes micro-processor controlled loading, discharge, foam injection and record keeping functions all designed to be easily operated by the pilot. Additional products which Simplex represents includes water handling systems manufactured by Griffith Polymers and Fireflex Manufacturing, flow meter and load cell systems by Onboard Systems, and tee jet spray accessories by Spraying Systems.

For more information, contact Ken Glanz, Sales Representative, Simplex Manufacturing, 13340 NE Whitaker Way, Portland, OR 97230