Species for Seeding Mountain Rangelands in Southeastern Idaho, Northeastern Utah, and Western Wyoming

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Highlight: Tests of many species over several years on seven sites show that smooth brome and meadow and creeping foxtails are adapted for seeding most mountain rangelands. However, smooth brome did not maintain stands above 9,000-foot elevations. Intermediate and pubescent wheatgrasses are adapted to intermediate and lower mountain ranges. Other grasses that did well in one or more seedlings are: mountain, subalpine, and Regar bromes; timothy; orchardgrass; tall oatgrass; reed canarygrass; and hard fescue. Legumes and forbs that showed promise are: birdsfoot trefoil, crownvetch, birdvetch, alfalfa, and horsemint. Mixtures of adapted species gave better stands than single species. These tests reemphasize that we must prepare good seedbeds and control plant-competition to get good stands of seeded species. Pocket gophers killed many plants and caused seeded stands to deteriorate.

Mountain rangelands, with their relatively high precipitation, have a high forage potential. However, where vegetation and soil have been depleted, these lands are often difficult to revegetate, even by seeding. Seedling emergence of seeded species on depleted mountain ranges is slow and death loss is high (Hull, 1966). In some high places the snow does not melt until late May or June, and snowbanks may persist until July and August. Hence, the growing season is short and stands establish slowly. After seedlings emerge, they face daytime temperatures that frequently exceed 110°F at the 0.75-inch soil depth. Seedlings may also be damaged by rapid soil drying, frost heaving, smothering under ice, flooding, snow mold, pocket gophers, and competition with weedy vegetation.

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Species which have been recommended for one or more of these high elevation sites in the Intermountain Region are smooth brome, meadow foxtail, timothy, tall oatgrass, and intermediate wheatgrass (Plummer et al., 1955; Gomm, 1962; Hull et al., 1962; McGinnies et al., 1963; Hull, 1973).

This paper summarizes results of several studies that were initiated to determine species suitable for seeding mountain rangelands in southeastern Idaho, northern Utah, and western Wyoming.

Location and Procedures

Seedings were made in weedy openings

Table 1.	Characteristics of	the seven seeding	sites with number o	f species and	dates seeded.
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······································	Elevation	Precipitation	Number	
Location	(ft)	(inches)	of species	Date seeded
Franklin Basin ^a	8400	46	16	Spring 1960
20 miles ESE			30	Spring 1963
Preston, ID			40	Spring 1963
			6	Spring 1964
			52	Spring 1965
			12	Spring 1966
			47	Spring 1968
Monte Cristo	9000	40	25	Spring 1954
24 miles NE			25	Fall 1954
Ogden, Utah				
Blind Bull	9200	35	6	Fall 1953
22 miles NE			6	Spring 1954
Afton, Wyo.			4	Fall 1954
			6	Fall 1957
LaBarge	8700	31	19	Spring 1951
25 miles SE			16	Fall 1951
Afton, Wyo.			4	Fall 1953
			4	Spring 1954
Smiths Fork	7800	30	9	Fall 1955
17 miles SE				
Afton, Wyo.				
McCain	7000	30	6	Fall 1953
30 miles NNE			3	Spring 1954
Afton, Wyo.				1 0
Cabin Creek	6600	25	6	Fall 1953
16 miles NE			6	Spring 1954
Afton, Wyo.			4	Fall 1954
			6	Fall 1957

^aThree to ten additional species were seeded in several plots each spring and fall from 1957 to 1970 in method studies.

in the timber at seven locations on mountain rangelands in Idaho, Utah, and Wyoming (Table 1). Franklin Basin, Monte Cristo, Blind Bull, and LeBarge are in the spruce-fir zone. Smiths Fork and McCain are Douglas fir-aspen, and Cabin Creek is lodgepole pine-aspen. Most slopes are moderate, ranging from 1 to 15%.

Franklin Basin contained the most seedings. The dominant vegetation there is tarweed (Madia glomerata). There is some bushy knotweed (Polygonum ramosissimum), collomia (Collomia linearis), bicolor biscuitroot (Lomatium leptocarpum), and many spring-growing, fleshy-rooted plants. The soil is clay loam, low in organic matter and plant nutrients. The pH is 6.0. The soil compacts and hardens soon after snow melts. The six other sites are somewhat similar. except that some sites have more perennial vegetation. Blind Bull and LaBarge have considerable geranium (Geranium viscosissimum). McCain has scattered geranium, silver sagebrush (Artemisia cana), shrubby cinquefoil (Potentilla fruticosa), and many low-value forbs and grasses. Cabin Creek has scattered big sagebrush (Artemisia tridentata) and woody eriogonum (Eriogonum microthecum)

At all locations, the land was plowed or cultivated and harrowed to prepare a firm, weed-free seedbed. However, on the 1953 plots at Blind Bull and in all LaBarge seedings, some geranium survived seedbed preparation. At McCain only part of the native grasses and forbs were killed.

Species selected for seeding had grown well at other locations or had been recommended by plant introduction specialists. A total of 84 species and 35 strains were tested. The number of species in each seeding is listed in Table 1. Each species was duplicated at each seeding, except at Franklin Base where three or four replications were tested. From 2 to 4 mixtures of the major species were also seeded at each location.

Spring seedings were made as early as soil and road conditions permitted. This was early to late June at lower elevations and mid-June to early July at higher elevations. Fall seedings were made in late September or October. Success of spring and fall seedings varied among years and locations. Because seeding for neither season was consistently better, they are averaged for species success.

A hand seeder drilled seed in 12-inch rows at an average depth of $\frac{1}{2}$ inch. We planted 25 viable seeds/ft of row but increased the rate 50% for species having over 500,000 seeds/lb and doubled the rate for species having over 1 million seeds/lb. This gave 8 lb/acre of good seed for smooth brome and rates for other species according to their seed size. Legume seeds were inoculated with the proper nitrogen-fixing bacteria before seeding.

At Franklin Basin, seedlings were counted during spring and fall of the first growing season and the fall of the second season. In the second growing season, and each year thereafter to 1972, stands were rated for their success. At the other six locations, stands were rated each year from 1954 to 1961 and in 1965, 1967, 1970, and 1972. Success ratings were on a 0 to 10 basis: 1 to 2, very poor; 3 to 4, poor; 5 to 6, fair; 7 to 8, good; and 9 to 10, excellent.

Two gopher exclosures were constructed at Monte Cristo and Smiths Fork and one each at Blind Bull, McCain, and Cabin Creek to determine the effect of pocket gophers (*Thomomys talpoides*) upon the establishment and permanence of secded stands. At Franklin Basin, gophers were controlled by poison and traps.

Results and Discussion

Seedling emergence was generally good for all seedings, after which plant numbers usually decreased for 1 or 2 years. High seedling mortality usually resulted from summer drought, often from frost heaving in spring and fall, from plant competition with species not killed during seedbed preparation or with rapidly growing native species such as tarweed, and from pocket gophers that killed both seedlings and mature plants. After this initial decrease, some species then improved their stands, some maintained their stands, and some failed.

At Franklin Base seedling stands were good. The 1972 species ratings, averaged for all studies, are in Table 2. The following 25 grasses and 9 legumes either failed or nearly failed and are not included in Table 2:

Table 2. Average ratings of 25 grasses and 9 legumes seeded in 7 studies during 1960-68 at Franklin Basin, 1972.

	Number		Average
	of years	Number	stand
Species and strains ^a	seeded	of plots	rating
Grasses		···· · · · · · · · · · · · · ·	
Crested wheatgrass (Agropyron desertorum)	1	2	1.0
Crested wheatgrass x quackgrass (A. desertorum x repens)	$\overline{2}$	6	3.2
Thicksnike wheatgrass x hearded couch (A dasystachyum	-	Ũ	
x caninum)	1	3	63
Intermediate wheatgrass (A. intermedium) 6	7	44	5.2
Arctic Circle quackgrass (A. repens)	2	6	37
Slender wheatgrass (A. trachycaulum)	5	14	1.9
Pubescent wheatgrass (A. trichophorum) 3	4	16	53
Redtop (Agrostis alba)	1	2	3.5
Creeping foxtail (Alopecurus arundina ceus) 1	4	12	7.0
Meadow foxtail (A. pratensis) 1	5	17	7.0
Tualatin tall oatgrass (Arrhenatherum elatius)	2	6	2.5
Regar brome (Bromus biebersteinii)	2	6	5.8
Mountain brome (B carinatus)	4	12	4.5
Meadow brome (B. erectus)	3	9	3.8
Smooth brome (B. inermis) 5	7	36	7.9
Subalpine brome (B. tomentellus)	5	14	4.1
Brome (Bromus spp.)	4	10	2.9
Orchardgrass (Dact vlis glomerata) 6	6	32	4.1
Tall fescue (Festuca arundinacea)	2	5	2.8
Meadow fescue (F. elatior) 1	2	6	3.5
Hard fescue (F. oving var. duriuscula)	3	7	3.4
Red fescue (F, rubra) 3	4	13	3.3
Frontier reed canarygrass (Phalaris arundina cea)	3	8	8.7
Timothy (Phleum pratense)	3	10	4.0
Kentucky bluegrass (Poa pratensis)	2	5	3.9
Legumes			
Cicer milkvetch (Astragalus cicer)	4	10	37
Sicklepod milkvetch (A. falcatus)	4	10	21
Milkvetch (Astragalus spp.)	1	2	1.5
Crown vetch (Coronilla varia) 3	3	14	7.0
Birdsfoot trefoil (Lotus corniculatus) 2	3	11	7.0
Mountain lupine (Lupinus alpestris)	ž	10	33
Sickle alfalfa (Medicago falcata)	3	8	3.5
Alfalfa (M. sativa) 10	3	63	4 2
Birdvetch (Vicia cracca)	2	6	5.3

er ^aWhere numbers follow names, they indicate the number of additional strains tested.

Dearded couch	1 ano
Enimory wheeteres	Agropyron caninum
Thickenike	A. crisialum (2)
wheatgrass	A. ausystuchyum
Crested wheatgrass	A desertorium v A
v foirwow	a deseriorum x A. a
wheatarase	cristatum
Tall wheatgrass	A alongatum
Puchloof	A. elonguium
wheatarass	A. junceum
Wheatarass	4 obtusiusculum
Streambank	A ringrium ^a
wheatarass	21. ripurium
Rluehunch	A spicatum ^a
wheatorass	n. spicaram
Rearded wheatgrass	1 subsecundum (2)
Slender wheatgrass	A trachycaulum y
x squirreltail	Sitanion hystrix ^a
Annual falsebrome	Brachypodium
innuur russeerenne	distachyon
Falsebrome	R phoenicoides
Rumanian	B pinnatum
falsebrome	D. philatan
Woodland	R sylvaticum
falsebrome	2. 5)
Brome	Bromus brevis ^a
Pumpelly brome	B. numpellianus $(2)^a$
Fescue	Festuca altaica
Fescue	F ampla ^a
Sheep fescue	F. ovina $(2)^a$
Spike fescue	Hesperochloa kingii
Perennial ryegrass	Lolium perenne
Silkyspike melic	Melica ciliata
Melic	M. cupani
Big bluegrass	Poa ampla (also
0 0	Sherman)
Twogrooved	Astragalus bisulcatus
locoweed	5
Milkvetch	A. galegiformis
Milkvetch	Astragalus spp., ^a
Sweetvetch	Lathyrus tingitanus
Sweetvetch	L. tuberosus
Sanfoin	Onobrychis arenaria
Sanfoin	O. transcaucasica (2)
Sanfoin	O. viciifolia (2) (also
	Eski ^a and Onar [3] ^a)
Vetch	Vicia dasycarpa

¹ A number after the above species indicates the number of years seeded. An "a" indicates a trace; others failed completely.

Considering species seeded in 2 or more years, the best grasses at Franklin smooth and Regar bromes, reed canarygrass, and intermediate and pubescent grass, and intermediate and pubescent wheatgrasses. The best legumes are crownvetch, birdsfoot trefoil, and birdvetch. Alfalfa stands were good but have been reduced by livestock grazing and by gophers.

When strains were evaluated, Garrison creeping foxtail was slightly better than common foxtail. "Southland" smooth brome was poor but "Lincoln," "Manchar," "Sac," and "Saratoga" had good to excellent stands. "Chief" intermediate wheatgrass averaged better than "Amur," "Greenar," or "Oahe." "Luna," "Mandan," and "Topar" pubescent wheatgrasses were all good. "Chinook," "Latar," and "Wisconsin" orchardgrasses had excellent initial stands but all deteriorated to poor. "Emerald" and "Penngift" crownvetch were both good, as were "Cascade" and "Empire" birdsfoot trefoil. Alfalfa strains were only fair to poor. "Ladak," "Nomad," "Rambler," "Rhizoma," "Teton," and "A-169" were best, followed by "Beaver," "Ranger," "Travois," "P-550," and "KS-10."

At Monte Cristo, all stands deteriorated, with particularly rapid decreases from 1955 to 1960. Most decreases resulted from summer drought, frost heaving, and damage by gophers. Species that have fair to good stands after 18 years are: creeping and meadow foxtails, intermediate wheatgrass, and horsemint (Table 3). Mixtures of grasses and forbs in larger plots all have good stands. At LaBarge, many of the seeded plants died from drought, frost heaving, and competition from native species. Most stands became progressively poorer for several years. Some continued to deteriorate but creeping and meadow foxtails improved. Intermediate wheatgrass, smooth brome, and tall oatgrass maintained poor to fair stands (Table 3).

Eighteen species that either failed or had very poor stands at Monte Cristo and LaBarge and are not included in Table 3 are:

Fairway wheatgrass	Agropyron cristatum
Intermediate wheat	-A. intermedium
Western wheatgrass	A. smithii
Bearded wheatgrass	A. subsecundum
Meadow brome	Bromus erectus ⁰¹
Orchardgrass	Dactylis glomerata ^b
Great basin wildrye	Elymus cinereus
Creeping wildrye	E. triticoides
Bulbous barley	Hordeum hulhosum
Reed canarygrass	Phalaris arundinacea ^b
Subalpine	Stipa columbiana ^b
needlegrass Letterman	S. lettermanii ^b
Cicer milkvetch	Astragalus cicer
Cow parsnip	Heracelum lanatum
Porter ligusticum	Ligusticum porteri
Yellow sweetclover	Melilotus officinalis
Sweetanise	occidentalis ^a

¹An "a" indicates a trace at Monte Cristo and "b" a trace at LaBarge; the others failed at both locations.

At Blind Bull, McCain, and Cabin Creek, seedling stands were excellent but most became poorer, mainly because of competition with native vegetation. Meadow and creeping foxtails are the only species having good to excellent stands on all three sites and were the only successful species at Blind Bull, a highelevation site. Intermediate and pubescent wheatgrasses had excellent stands and hard fescue a fair stand at Cabin Creek, but all failed at Blind Bull. They were not seeded at McCain. Smooth brome had good stands and timothy fair stands at McCain and Cabin Creek, but both were very poor at Blind Bull. Slender wheatgrass, tall oatgrass, mountain brome, and orchardgrass, either failed or had very poor stands.

At Smiths Fork, the seedling year was hot and dry. By September, 1965, all seedlings of meadow foxtail and tall oatgrass were dead; a few seedlings of smooth and meadow bromes, alfalfa, and cicer milkvetch remained; and pubescent and intermediate (also Amur) wheatgrasses had poor stands. At present, meadow brome, alfalfa, and cicer milk-

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Table 3. Success ratings of 10 grasses, 4 forbs (including legumes) seeded in 1954 at Monte Cristo, Utah, and from 1951 to 1954 at LaBarge, Wyo., 1972.

	Location		
Species	Monte Cristo	LaBarge	
Grasses			
Intermediate wheatgrass (Agropyron intermedium)	5 ^a	5 ^a	
Slender wheatgrass (A. trachycaulum)	2 ^a	2 ^a	
Pubescent wheatgrass (A. trichophorum)	_b	3	
Creeping foxtail (Alopecurus arundina ceus)	4	6	
Meadow foxtail (A. pratensis)	5	4	
Tualatin tall oatgrass (Arrhenatherum elatius)	1	4 ^a	
Mountain brome (Bromus carinatus)	1	1	
Smooth brome (B. inermis (also Lincoln))	1	3 ^a	
Subalpine brome (B. tomentellus)	0	1	
Timothy (Phleum pratense)	_	2	
Forbs including legumes			
Horsemint (Agastache urticifolia)	5		
Mountain lupine (Lupinus alpestris)	1	1	
Bramble vetch (Vicia tenuifolia)	1	_	
Showy goldeneve (Viguiera multiflora)	1		

^aAlso seeded in adjacent large plots. ^bNot seeded. vetch have poor stands and smooth brome has increased to a good stand. Pubescent and intermediate wheatgrasses, including Amur, had excellent stands and have spread widely to vacant plots and outside the experimental area.

Mixtures were seeded each year for 13 years in large plots at Franklin Basin. The average air-dry yield from 1961 to 1972 was 4572 lb/acre, ranging from 2420 pounds in 1966 to 5755 in 1965. Mixtures at all seven areas normally yielded more, had better ground cover, and maintained better stands than single species. Seeding rates and larger plots may have accounted for the superiority of the mixtures. Increased seeding rates of mixtures and single species at Franklin Basin resulted in thick stands in which the plants were less damaged by frost than were widely spaced plants. Where seeding rates for adapted mixtures and single species were similar, the mixed stands were better.

Pocket gophers killed plants on all areas and caused many stands to deterioriate, especially at Monte Cristo. Because gopher exclosures were not maintained in later years of the study, little difference now exists between stands on protected and unprotected areas. The type of seeded stand influenced gopher activity. Gophers often clipped off short rows of single species in small plots but not rows of the same species in large plots or in mixtures. Where good seedbed preparation killed the fleshy-rooted plants readily eaten by gophers and where thick seeded stands resulted, gopher damaged was less than on areas with poor seedbed preparation and poorly seeded stands.

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