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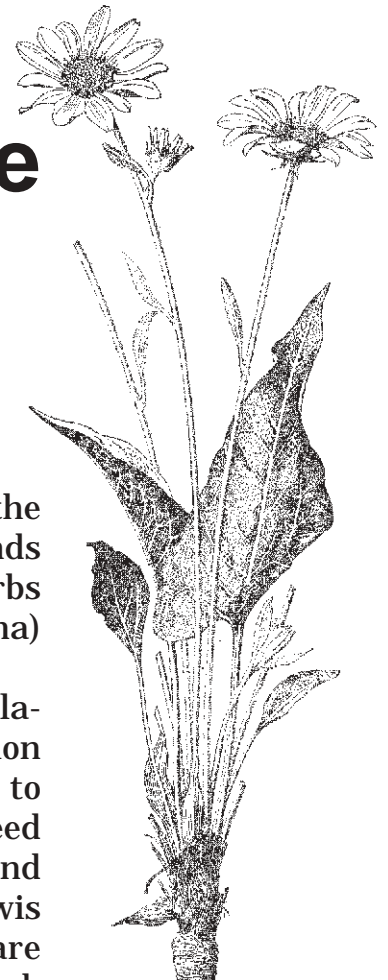
Chapter

19

Forbs for Seeding Range and Wildlife Habitats

Forbs are abundant in all vegetative types throughout the Intermountain West. Most are found intermixed in grasslands and as understory plants in shrub and forest types. Forbs provide ground cover, soil stability, community (flora and fauna) diversity, nutritious forage, and are of aesthetic value.

Forbs should be seeded in most range, watershed, mine reclamation, highway, recreational site, restoration and revegetation projects. Many commonly used forbs have been introduced to the Intermountain West and are now under cultivation for seed production. The principal introduced forbs planted on range and wildlands are alfalfa, small burnet, and cicer milkvetch. Lewis flax, Rocky Mountain penstemon, and Palmer penstemon are the major native forbs being commercially grown and planted. Additional species are being commercially grown in seed fields as demand increases. Seeds of many native species are collected from wildland stands but generally are in short supply.



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Important characteristics of a number of forbs are listed in table 1. Seeding recommendations for principal vegetative types and conditions are discussed in chapter 17. Seed characteristics and information about collection, cleaning, and storage are provided in chapter 24. Forbs adapted to different vegetative types and conditions are included in the seeding recommendations.

The following forb species have the potential for improving range and wildlife habitats in the Intermountain West. A brief description along with information regarding ecological relationships and distribution, cultural requirements, use, and management of each species are included.

Table 1—Characteristics of Selected Forbs.

Species	Ratings ^b													Vegetative type to which the species is adapted							
	Ease of handling seed	Ease of seeding	Ease of transplanting	Germi-nation	Initial estab-lishment	Seedling growth rate	Final estab-lishment	Persis-tence	Natural spread	Forage yield	Early spring palata-bility	Summer palata-bility	Toler-ance to grazing		Evergreen-ness	Compati-bility with other species	Seed produc-tion	Soil stability	Flood toler-ance	Shade toler-ance	Range of adapt-ability
Alfalfa, range type	5	5	4	4	5	5	4	5	4	5	5	4	4	3	5	5	4	2	4	5	SAA,PP,MB,JP,MS,BS,WS
Allieria	2	4	2	4	4	5	5	2	5	3	5	3	4	1	3	4	3	1	3	3	JP,MS,BS,WS,BS
Angelica, small leaf	2	5	1	4	5	5	3	3	3	4	5	4	3	1	3	5	3	3	3	2	SAA,MB
Aster, blueleaf	2	2	5	4	4	4	5	5	5	4	4	4	5	2	2	3	5	4	3	4	A,WM,PP,MB,JP,BS
Aster, Englemann	2	2	4	3	3	3	4	4	5	4	4	5	4	2	4	2	4	4	4	2	A,WM,PP,MB
Aster, Pacific	2	2	5	4	3	3	4	5	5	3	5	5	5	2	3	3	5	4	3	4	A,WM,PP,MB,JP,MS,BS
Balsamroot, arrowleaf	4	4	1	3	1	1	4	5	2	5	5	1	4	1	4	4	3	1	2	3	PP,MB,JP,MS,BS
Balsamroot, cutleaf	4	4	1	3	1	1	4	4	2	3	4	1	4	1	4	3	3	1	2	2	PP,MB,MS
Balsamroot, hairy	4	4	1	3	1	1	4	5	2	4	5	1	4	1	4	4	3	1	3	2	PP,MB,MS
Bluebell, tall	3	4	4	3	2	4	3	4	3	5	5	5	4	1	2	3	4	4	3	2	SAA,WM
Bouncing-bet	5	5	5	4	4	4	5	5	5	4	3	3	4	2	3	4	5	4	3	3	PP,MB,MS
Burnet, small	5	5	4	5	5	5	4	3	4	3	5	5	3	5	4	5	3	2	2	3	PP,MB,JP,MS,BS,WS
Cinquefoil, gland	4	4	5	4	5	4	5	5	5	5	3	3	5	1	5	4	5	4	1	3	A,WM,PP,MB
Clover, alsike	5	5	5	4	4	3	4	4	4	4	4	4	4	2	3	3	4	5	3	1	WM
Clover, strawberry	5	5	5	5	5	4	5	5	5	2	4	4	4	2	4	3	4	5	3	2	WM,IS
Columbine, Colorado	2	4	4	3	3	3	4	3	2	2	4	4	2	1	4	2	3	5	5	2	SAA,WM
Cow parsnip, common	3	3	2	3	3	3	4	3	2	5	4	4	2	1	4	4	3	4	4	2	SAA,WM
Crownvetch	5	5	5	4	4	4	5	5	5	4	4	4	4	2	2	4	5	3	4	3	A,PP,MB,MS
Daisy, common oxeye	3	3	4	2	2	3	5	5	5	2	4	5	4	2	3	3	4	2	3	3	A,PP,MB,JP
Deervetch, birdfoot	3	4	5	4	4	4	4	3	4	5	5	5	5	2	3	3	5	3	3	3	A,PP
Eriogonum, cushion	4	4	2	4	4	3	4	4	3	2	3	5	4	4	3	4	3	2	3	4	PP,MB,JP,MS,BS
Fireweed	1	2	4	5	5	5	5	2	5	4	4	3	5	1	4	4	4	3	4	3	SAA,WM,PP,MB,JP,MS,BS
Flax, Lewis	5	5	4	4	5	4	5	3	5	3	5	3	4	4	4	4	3	2	3	4	PP,MB,JP,MS,BS,WS
Geranium, Richardson	2	3	4	3	2	4	4	4	3	3	4	4	4	2	4	2	3	4	4	2	SAA,WM
Geranium, sticky	2	3	4	3	2	4	4	4	3	3	4	4	4	2	4	2	3	4	4	2	SAA,WM
Giant hyssop, nettleleaf	2	4	3	3	2	3	3	3	3	4	4	4	4	2	4	4	3	3	3	2	SAA,MB
Globe-mallow, gooseberryleaf	3	5	3	3	3	3	4	4	4	3	3	2	4	2	4	3	4	2	2	3	JP,MS,BS,WS,SS,BS
Globe-mallow, scarlet	4	4	4	2	3	4	4	5	3	3	3	3	4	2	4	3	4	3	3	3	MB,JP,MS,BS,WS,SS,BG,BB
Globe-mallow, stream	4	5	4	3	2	3	4	4	4	4	3	3	3	3	4	4	3	3	2	3	JP,MS,BS,WS,SS,BS
Goldeneye, Nevada	3	3	4	4	4	4	5	3	5	3	4	4	4	1	4	3	2	2	2	3	MS,BS,WS
Goldeneye, showy	3	3	4	4	4	4	5	3	5	3	4	4	4	1	4	4	4	3	3	3	SAA,PP,MB,JP,MS,BS
Goldenrod, Canada	2	2	4	3	3	3	4	4	4	4	4	4	4	2	4	4	4	4	3	3	A,PP,MB
Goldenrod, low	2	2	4	4	3	4	4	4	4	4	4	4	5	2	3	4	4	3	3	3	A,PP,MB
Goldenrod, Parry	2	2	4	4	3	4	4	4	4	4	4	4	5	2	3	4	5	3	3	4	A,PP,MB
Groundsel, butterweed	4	2	4	3	3	3	4	4	4	4	3	4	4	2	3	4	4	4	3	2	A,PP,MB
Helianthella, oneflower	4	3	3	5	4	3	4	4	4	3	4	3	3	1	5	3	2	3	3	3	A,PP,MB,MS
Iris, German (common iris)	1	4	5	2	1	4	5	5	4	2	5	4	4	5	3	1	4	4	4	4	SAA,PP,MB,JP,MS,BS,WS
Ligusticum, Porter	4	3	2	4	3	3	3	4	3	3	4	4	4	1	3	4	3	2	3	2	A,PP,MB

(con.)

Table 1 (Con.)

Species	Ratings ^b											Vegetative type ^c to which the species is adapted									
	Ease of handling seed	Ease of seeding	Ease of transplanting	Ease of germination	Initial establishment	Seeding growth rate	Final establishment	Persistence	Natural spread	Forage yield	Early spring palatability		Summer palatability	Tolerance to grazing	Evergreenness	Compatibility with other species	Seed production	Soil stability	Flood tolerance	Shade tolerance	Range of adaptability
Lomatium, nineleaf	3	3	4	3	3	4	4	4	3	3	4	3	4	1	4	3	4	3	3	3	PP,MB,MS
Lomatium, nuttall	3	3	3	3	3	3	4	3	3	2	5	2	4	1	3	4	3	2	3	3	A,PP,MB
Lupine, Nevada	5	5	2	3	3	4	4	4	3	4	4	4	4	1	4	3	3	2	3	4	JP,MS,BS,WS
Lupine, silky	5	5	2	3	3	3	4	4	3	4	4	4	4	1	4	3	3	3	3	4	A,PP,MB,MS
Lupine, silvery	5	5	2	3	4	3	4	4	3	4	4	4	4	1	4	3	3	3	3	4	A,PP,MB,MS
Medick, black	4	5	5	5	5	4	4	4	4	3	4	4	4	2	4	5	5	4	3	2	A,WM,PP,MB,JP,MS,BS
Milkvetch, cicer	4	5	5	3	3	3	4	5	5	5	4	4	4	3	4	5	5	3	4	4	SAA,WM,PP,MB,JP,MS,BS
Milkvetch, Snake River plains	4	5	2	3	3	3	4	5	4	4	4	4	4	3	4	3	4	3	4	3	PP,MB,JP,MS,BS,WS
Milkvetch, tall	4	5	2	3	4	4	4	4	4	2	3	4	4	3	3	3	4	4	4	2	PP,MB,JP,MS,BS
Painted-cup, northwestern	2	4	1	2	2	3	4	3	2	3	4	4	4	1	2	2	1	3	3	3	SAA,WM,PP,MB,JP,MS,BS,WS
Peavine, flat	4	5	4	3	3	3	3	4	3	4	4	4	4	3	5	2	5	4	4	3	SAA,PP,MB
Peavine, perennial	4	5	4	3	3	4	4	4	4	3	3	5	3	2	3	3	4	4	4	3	SAA,PP,MB
Peavine, thickleaf	4	5	4	3	2	3	4	5	3	4	4	4	4	2	4	2	5	4	4	4	SAA,PP,MB
Peavine, Utah	4	5	3	3	2	3	4	4	3	4	5	5	3	2	4	2	4	4	4	3	SAA,PP,MB
Penstemon, Eaton	5	5	5	3	5	4	4	3	5	3	4	4	3	3	3	3	3	3	3	4	PP,MB,JP,MS,BS,WS
Penstemon, littlecup	5	5	4	4	3	2	4	4	4	4	3	4	4	3	3	3	4	3	3	3	PP,MB,JP,MS,BS,WS
Penstemon, low	5	5	5	3	4	3	5	5	5	2	4	4	4	3	4	3	5	3	3	3	PP,MB,JP,MS,BS,WS
Penstemon, Palmer	5	5	4	5	4	4	3	3	5	4	4	4	4	5	3	4	3	2	3	4	PP,MB,JP,MS,BS,WS
Penstemon, Rocky Mountain	5	5	4	5	4	3	4	3	4	3	4	4	4	4	4	5	4	3	3	4	PP,MB,JP,MS,BS,WS,BS
Penstemon, Rydberg	5	5	4	3	2	3	3	4	4	3	4	4	4	3	3	3	4	3	3	3	A,PP,MB,JP,MS
Penstemon, sidehill	5	5	4	4	3	3	4	4	4	2	3	3	4	3	2	4	4	5	3	2	SAA,WM,PP,MB
Penstemon, thickleaf	5	5	4	3	3	3	4	4	4	2	3	3	4	3	4	3	4	3	3	3	PP,MB,JP,MS,BS,WS
Penstemon, toadflax	5	5	4	3	2	3	4	4	4	2	4	3	4	3	4	3	3	3	3	3	PP,MB,JP,MS,BS,WS
Penstemon, Wasatch	5	5	4	3	4	4	3	3	5	4	3	2	4	3	4	4	4	4	3	4	A,PP,MB,JP,MS,BS
Sage, Louisiana	2	3	5	4	2	4	4	4	5	3	2	3	5	3	4	4	5	4	3	4	SAA,WM,PP,MB,JP,MS,BS,WS
Sage, tarragon	2	2	4	3	1	4	4	4	3	3	2	2	4	4	3	3	4	3	3	3	SAA
Saintoin, common	5	5	5	5	4	4	4	3	4	5	5	4	4	3	3	4	3	3	4	3	PP,MB,JP,MS,BS
Salsify, vegetable-oyster	3	2	3	4	5	5	3	3	4	3	3	4	4	3	4	4	3	4	4	4	PP,MB,JP,MS,BS
Solomon-plume, fat	4	3	3	2	2	3	4	4	3	2	5	4	3	1	3	3	3	5	3	2	SAA,WM,PP,MB
Sweetanise	3	3	2	3	4	3	4	4	4	4	4	4	4	2	4	4	3	4	5	3	SAA,WM,PP,MB

(con.)

Table 1 (Con.)

Species	Ratings ^b													Vegetative type ^a to which the species is adapted								
	Ease of handling seed	Ease of seeding	Ease of trans-planting	Germi-nation	Initial estab-lishment	Seedling growth rate	Final estab-lishment	Persis-tence	Natural spread	Forage yield	Early spring palata-bility	Summer palata-bility	Toler-ance to grazing		Evergreen-ness	Compati-bility with other species	Seed produc-tion	Soil stability	Flood toler-ance	Shade toler-ance	Range of adapt-ability	
Sweetclover, white	5	5	3	5	5	5	2	3	3	3	3	4	3	3	4	5	2	4	3	4	4	SAA,WM, PP,MB
Sweetclover, yellow	5	5	3	5	5	5	2	3	4	4	3	4	3	3	4	5	2	4	3	4	4	SAA,WM, PP,MB
Sweetroot, spreading	3	4	3	2	3	3	4	3	2	2	4	4	3	2	4	4	3	4	4	2	2	JP,MS,BS,WS, SAA,WM, PP,MB
Sweetvetch, Utah	2	4	3	3	3	3	5	4	3	4	4	4	4	3	4	4	3	3	3	3	3	PP,MB,JP,MS, BS,WS
Valerian, edible	3	3	2	2	2	2	3	5	2	3	4	4	4	1	4	3	3	4	4	3	3	SAA,WM,PP, MB,JP,MS
Vetch, American	4	5	4	4	2	4	4	5	3	4	4	4	4	3	5	4	4	3	4	3	3	SAA,WM,PP, MB,JP,MS
Vetch, bramble	4	5	4	5	3	2	4	5	3	3	4	4	4	3	5	4	4	3	4	3	3	BS,WS,SS, BG,BB
Yarrow, western	4	4	5	4	4	4	5	5	5	3	4	4	5	4	4	5	5	5	4	5	5	SAA,WM,PP, MB,JP,MS,BS

^aKey to vegetative type: SA = Subalpine; A = Aspen-conifer; WM = Wet and semiwet meadows; PP = Ponderosa pine; MB = Mountain brush; JP = Juniper-pinyon; MS = Mountain big sagebrush; WS = Basin big sagebrush; SS = Shadscale saltbush; BG = Black greasewood; BB = Blackbrush; IS = Inland saltgrass.

^bKey to ratings: 1 = Poor; 2 = Fair; 3 = Medium; 4 = Good; 5 = Excellent.

Family Compositae

Achillea millefolium ssp. *lanulosa* _____

Western Yarrow

In the Intermountain West the majority of the yarrows fall into three taxonomic units: *Achillea millefolium* ssp. *millefolium*, which was introduced from Europe and is widely cultivated in North America, and *A. millefolium* ssp. *lanulosa*, a native to North America, which is divided into two varieties—var. *lanulosa* (western yarrow) that occurs from the valley floor to above timberline and var. *alpicola* that is generally found above timberline (Welsh and others 1987). All three taxonomic units intergrade. Western yarrow, a perennial member of the sunflower family, has flowers that are borne in flat-topped cymes (fig. 1) that are white, grayish, and barely pink, all with yellow centers (Hermann 1966). The leaves and flowers are aromatic.

Ecological Relationships and Distribution

Western yarrow is found in Southwestern Canada, in all States west of North Dakota, south to Northern Mexico, and from the low plains to subalpine communities. Greatest areas of occurrence are in mountain brush, ponderosa pine, aspen, and open timber



Figure 1—Western yarrow in a mixed grass forb community.

types (USDA Forest Service 1937). Western yarrow has good fire tolerance, some shade tolerance, and is fairly resistant to drought. It grows in sandy to loam soils that range from weakly basic to weakly acidic (USDA Forest Service 1937; Wasser 1982). Yarrow spreads by rhizomes and seed, and is especially useful on disturbed or misused sites. Tolerance to grazing is good.

Plant Culture

Western yarrow can be seeded successfully by drilling or broadcasting. Seeds are small (4.1 million per lb [9.0 million per kg] at 100 percent purity) and should not be planted more than 0.25 inch (6 mm) deep. Seeds germinate uniformly, and produce vigorous seedlings. Seed is usually marketed with about 50 percent purity and 80 percent germination. It is recommended that seed be stored no more than 2 years, due to loss of viability. The species is easily transplanted. Western yarrow can be seeded successfully in mixtures with other species (Stevens and others 1985c).

Uses and Management

Western yarrow has fair forage value for sheep, somewhat less for cattle, and is used by small and large game animals (Hermann 1966; Kufeld 1973; Kufeld and others 1973; USDA Forest Service 1937; Wasser 1982). It provides important habitat for upland game birds. This species has good potential for revegetation and for stabilization of disturbed sites from big sagebrush through the subalpine zones. Western yarrow establishes and spreads well in sites occupied by annual weeds. It persists with heavy grazing, and often recovers well by natural seeding. Areas seeded to western yarrow should not be grazed for at least 1 to 2 years following seeding.

Varieties and Ecotypes

There is considerable variation, and locally adapted ecotypes should be planted.

Family Compositae

Artemisia ludoviciana _____

Louisiana Sage (wormwood)

There are a number of subspecies and numerous varieties and ecotypes of Louisiana sage in the Intermountain West (Holmgren and Reveal 1966; Welsh and others 1987). Considerable differences occur among the various subspecies, varieties, and ecotypes. Louisiana sage is an herbaceous native perennial that is aromatic and very rhizomatous, with stems that grow from 1 to 3 ft (30 to 91 cm) tall. Leaves are mainly cauline, entire, lobed or pinnately incised, and borne on the stem.

Ecological Relationships and Distribution

Louisiana sage (fig. 2) occurs throughout North America in all vegetation types from sagebrush through alpine and tundra zones. This species does well on shallow as well as on deep, slightly acidic to basic soils. It prefers well-drained soil, but also grows in riparian communities and on other moist sites. Louisiana sage does well on disturbed exposed soils as well as on sites supporting some cover. As a pioneer species, it creates microenvironments suitable for the invasion of other species.

Plant Culture

Flowering occurs in mid to late summer, depending on location, with seed maturing in late August to early November. Seed can be collected by hand stripping, beating, or combining. Most native stands do not produce an abundance of seeds on a regular basis. Seed is cleaned by debearding and screening. There are about 2.5 million seeds per lb (5.5 million per kg) at 100 percent purity. Seed is generally marketed at 10 to 15 percent purity and 80 percent germination. Seed viability declines rapidly with more than 3 to 4 years of storage.

Seed can be drill seeded or broadcast seeded, followed by very shallow soil coverage. Drill seeding requires a purity of greater than 40 percent for seed to flow through most seeding units. Seed can be broadcast with as low as 10 percent purity, depending on the type of broadcaster used. Seed that is fall broadcast on disturbed soil generally does not require mechanical coverage because natural soil sluff is sufficient to bury the seed. Louisiana sage can be seeded as a single species or as a component of a mixture. It also establishes easily from sprigs.

Uses and Management

Louisiana sage plays an important roll in providing soil cover and stabilization in areas where it is adapted (Hermann 1966; McCulloch 1973). It can be an early invader on disturbed sites including mine spoils (Monsen 1975; Monsen and Plummer 1978). Where it is seeded or becomes established, it acts as a nursery crop that allows establishment of other species. Ellison (1951) considered it an important invader of overgrazed sheep range and as a soil stabilizer on the Wasatch Plateau in central Utah. It can be used to stabilize riparian disturbances including dry meadows and areas subjected to infrequent flooding.

Livestock, small and large game, and rodents use this forb (Hermann 1966; Kufeld and others 1973; McCulloch 1973). It has considerable tolerance to grazing and trampling; however, when occurring on shallow soils or disturbed sites, it should not receive



Figure 2—Louisiana sage.

extensive use or trampling from grazing animals. Stand density fluctuates, particularly at higher elevations where the species may be suppressed by overstory shading. It recovers well after fires and can be used to prevent the entry of weeds by providing ground cover after a disturbance.

Varieties and Ecotypes

There is one variety. 'Summit' was selected for its ability (1) to establish from sprig planting and direct seeding, (2) increase or spread rapidly by rooting, (3) provide quick cover and soil stabilization, (4) grow on harsh sites, and (5) create microenvironments suitable for the invasion of other species (Stranathan and Monsen 1986). 'Summit' is particularly useful as a ground cover or erosion control species for sites above 5,000 ft (1,500 m) elevation.

Family Compositae

Aster chilensis

Pacific Aster

Pacific aster is a native perennial of the compositae family. It is described by Harrington (1964) as developing short to long root stocks and stems that are usually less than 2.5 ft (0.8 m) tall, with long, linear pubescent leaves. Few to numerous heads occur with blue, violet, or rarely white flowers. Seeds or achenes are usually hairy with many white pappus bristles. Plants bloom from July to September. This is an extremely diverse species. Welsh and others (1987) consider Pacific aster a generalized taxon with no well-defined diagnostic features. Hitchcock and others (1955) recognized three subspecies: spp. *hallii*, which occurs in the Oregon Cascades, and in Washington west to the coast, spp. *chilensis*, which is found

throughout the Cascades and Sierras; and spp. *adscendens*, which occurs in the Great Basin and eastern Oregon, and on the Snake River plains.

Ecological Relationships and Distribution

Pacific aster (fig. 3) is a native perennial that can spread rapidly by seed or rhizomes. This forb occurs throughout the Intermountain region at elevations between 5,000 and 9,500 ft (1,500 to 2,700 m). It occupies areas from the sagebrush foothills to the subalpine zone (Harrington 1964). It is most commonly found on dry, open sites in the sagebrush-grass and pinyon-juniper types.

Plant Culture

Pacific aster can be established by direct seeding, sprigging, and with nursery or field-grown transplants (Stevens and others 1985c). Seed is best planted by broadcasting; however, if it is cleaned to at least 50 percent purity, it can be drilled. Picker or thimble seeders can be used to plant the uncleaned, trashy seed. Special care must be taken to ensure that seeds are not planted more than 0.25 inch (6 mm) deep. To ensure that viable seed is planted, seed should not be stored more than 3 years. Harvested seed usually consists of the achene and attached pappus. The pappus is removed by gentle hammermilling, or with a debearder. Seed is usually not cleaned to more than 50 percent purity, and most seed is sold at 10 to 14 percent purity. At 100 percent purity, a pound of seed consists of just over 2.5 million seeds (5.5 million per kg).

Seeds of Pacific aster ripen throughout the late summer and fall. Not all seeds ripen uniformly; consequently, considerable debris and immature seeds are often collected. Seeds can be separated from the debris with special cleaning equipment. Seed should be purchased based on the percent of viable seed.

Seeds of Pacific aster germinate readily. Nearly all viable seeds germinate within 15 days. Seedlings appear early. They are able to compete with most seeded herbs and persist under adverse conditions. Young plants usually do not attain large stature the first growing season, but they do form an extensive root system.

Although the seeds are small, they establish well with only minimum seedbed preparation if they are seeded with the pappus attached. Seeding with the pappus on, however, is very difficult.

Neither livestock grazing nor rodent and insect use have been observed to damage new seedlings. New plantings are not heavily used by rabbits and can be established where rabbit populations are high. The plant can also be seeded on unstable slopes because



Figure 3—Pacific aster in full bloom.

small plants do not attract heavy use and provide excellent ground cover.

Uses and Management

Pacific aster is one of the first forbs to “green up” in the spring, causing it to be highly sought by livestock and big game. Game and livestock do, however, make some use of this species during all seasons because the plants retain some green material most of the year (Hermann 1966; Kufeld and others 1973; Plummer and others 1968). Hermann (1966) and USDA Forest Service (1937) reported that Engelmann aster is more palatable than Pacific aster to most animals. Our observations indicate similar differences, but recognize that Pacific aster receives moderate to heavy seasonal grazing.

Pacific aster is one of the most widely distributed native forbs within the Intermountain region. Selections obtained from the low foothill sagebrush communities are well adapted to semiarid situations. Pacific aster is one of a few forbs that can be easily seeded within the arid region occupied by big sagebrush. It persists well, furnishes good midsummer forage, and can be used to control cheatgrass. It recovers well from wildfires and spreads naturally.

To date, Pacific aster has normally been seeded as a minor component of most seed mixtures, usually at 0.25 lb seed per acre (0.3 kg per ha). However, it can be seeded at higher rates of 2 to 5 lb per acre (2.2 to 5.6 kg per ha) to provide more summer forage. Pacific aster does not restrict seedling establishment of associated herbs, and its own seedlings are not impaired by the presence of other seeded species. Consequently, increasing the seeding rate of this plant usually results in a corresponding increase in plant density.

The strong rhizomes and root system enables the species to be very useful in stabilization of disturbed

areas. Pacific aster is a useful species for planting exposed sites with shallow soils, particularly mid-winter game ranges. It can be successfully seeded on areas that are difficult to treat with mechanical equipment. It is well suited to infertile, rocky soils and sites subject to erosion.

Pacific aster is a useful pioneer species and nurse crop. The plant is able to occupy harsh sites and improve surface stability, enhancing seedbed conditions for other species. New seedlings are able to establish amid the seemingly dense ground cover provided by this forb. It is not unusual to observe seedlings of other plants establishing and surviving within a clump of Pacific aster. Consequently, the plant is used to furnish cover on steep slopes where pinyon and juniper have been chained. The plant is also valuable for seeding or transplanting roadways, mines, and other major disturbances. Areas seeded to Pacific aster should not be grazed for at least two growing seasons following planting. Creeping rhizomes enable this species to withstand considerable grazing and trampling once plants are established. Pacific aster has only been sparingly used in controlled grazing studies, but it is apparent that this species can be managed to provide midsummer and winter forage. In addition, the plant can be seeded to control cheatgrass and to furnish needed cover on critical semiarid ranges.

Varieties and Ecotypes

There are no releases.

Family Compositae

Aster glaucodes

Blueleaf Aster

Blueleaf aster (fig. 4), a native perennial, has about the same forage value and seed characteristics as Pacific aster. However, its seeds are more than three times as large (500,000 per lb [1.1 million per kg]), and the species is more widely distributed, commonly occurring in all vegetative types from salt desert shrublands and saline seeps to spruce-fir forests. It furnishes an open spreading clump, with short seed stalks and wide leaves. It is well adapted to harsh sites (fig. 5) and tends to exist alone. This species is better adapted to calcareous soils and saline conditions than Pacific aster. When seeded with principal forage grasses, it does not provide a dominant cover. It is grazed by big game and livestock, but it is not heavily used. Like Pacific aster it persists amid heavy infestation of grasshoppers when other succulent herbs are usually consumed. If seed of both species were more available, they would be recommended for planting range, watershed, and wildlife habitats.



Figure 4—Blueleaf aster at seed maturity. This stand was established by broadcast seeding on a raw roadfill in the mountain brush type.



Figure 5—Blueleaf aster stabilizing a severely eroded cut.

Family Fabaceae

Astragalus cicer

Cicer Milkvetch

A native of Eurasia, cicer milkvetch is a perennial member of the pea or legume family. It has vigorous creeping rhizomes and a short taproot. The leafy, succulent, decumbent stems are fairly large in diameter. They grow to about 5.5 ft (1.7m) in length, and originate from crown and rhizome buds. Flowers are born in compact heads and are pale yellow to white. Blooming occurs in midsummer, and seeds mature in late fall. The inflated, bladder-shaped, leathery black pods contain several seeds. Seed pods persist on the plant into the winter.

Ecological Relationships and Distribution

Cicer milkvetch (fig. 6) is an introduced, long-lived perennial from northern Europe. It is bloat free and does not accumulate toxic alkaloids (Davis 1982a; Rumbaugh 1984; Rumbaugh and Townsend 1985; USDA Soil Conservation Service 1968, 1972a; Williams and others 1976). It is safe for grazing (Rumbaugh 1983).

This species has vigorous spreading rhizomes, good frost and drought tolerance, and produces considerable succulent forage with a high protein content and a low crude fiber level (Davis 1982a). It grows in slightly acidic and basic soils, and does especially well in soils derived from limestone. This forb establishes and grows on thin, infertile soils and on disturbed sites. Spring growth starts about 2 weeks later than alfalfa and continues about 2 weeks longer in the fall. Foliage is green and succulent throughout the summer and fall months. Basal leaves remain green through winter. This species has more frost tolerance than alfalfa and remarkable resistance to insects and disease.

Cicer milkvetch requires at least 13 inches (33 cm) of annual precipitation, and does especially well with 16 inches (40 cm) or more. It is tolerant of water tables within 3 ft (91 cm) of the surface and does fairly well on wet sites. It has some shade tolerance, and is well adapted to sagebrush-grass and pinyon-juniper sites with sufficient precipitation. It also does well in the mountain brush type (Plummer and others 1955; Rumbaugh and Townsend 1985) and in openings in aspen and subalpine areas.

Plant Culture

Cicer milkvetch can be broadcast or drilled seeded. There are about 113,000 seeds per lb (249,000 per kg).



Figure 6—Cicer milkvetch growing in association with smooth brome, Gambel oak, and mountain big sagebrush.

Seed should be inoculated with appropriate inoculant before seeding (Carleton and others 1971; Hafenrichter and others 1968), and should not be planted more than 0.25 inch (6.4 mm) deep. Because of its hard seedcoat and dormancy, seeding should be done in the fall. Scarification can improve seeding success. However, once seeds are scarified they will not retain viability over extended periods.

Seed of cicer milkvetch has been stored for up to 14 years without any loss of viability (USDA Soil Conservation Service 1968a). This species is easily transplanted. Cicer milkvetch has done well seeded in mixtures and has been successfully interseeded into various native and introduced grass communities (Rumbaugh and others 1981; Stevens and others 1981b). Because of its lower seedling vigor (Rumbaugh 1984), cicer milkvetch does best when seeded in well prepared seedbeds that are relatively free of competition. This species does not reach full productivity until the third year following seeding. Once established, cicer milkvetch is very competitive and long-lived. It has been demonstrated that cicer milkvetch can stimulate and increase forage production of associated species (Johnson and others 1983).

Uses and Management

Seed of cicer milkvetch is produced commercially and is generally available. Acceptable purity and germination for commercial seed is 95 and 85 percent. Cicer milkvetch is palatable to livestock and big game, and seeds are eaten by small birds, deer, rabbits, sage-grouse, and pheasants (Plummer and others 1968; USDA Soil Conservation Service 1968, 1972a; Wasser 1982). Once established, this species has excellent grazing tolerance. This species can be classified as a semievergreen because basal leaves are green all year.

The rhizomatous characteristics of cicer milkvetch, along with its semiprostrate nature and profuse flowering, make it ideal for use around summer homes, on disturbed sites, in campgrounds and parks, and in areas with high aesthetic value.

This species is useful as a forage and conservation plant, providing excellent ground cover and stabilizing eroding sites. It can be seeded for intensive pasture management. The plant has considerable value for seeding semiwet sites that are used by upland game birds for summer forage. It also provides winter and nesting cover for upland game birds.

Varieties and Ecotypes

'Lutana' was released in 1970 and has the characteristics described for the species. 'Monarch' was selected for its superior seedling emergence. 'Oxley' is a 1971 Canadian release (Rumbaugh and Townsend 1985).

Family Compositae

Balsamorhiza sagittata

Arrowleaf Balsamroot

Arrowleaf balsamroot (fig. 7) is a broadleaf perennial with a deep, woody taproot. It is the most abundant balsamroot in the Intermountain area. Simple deltoid or sagittate leaves are entirely gray-green and heavily pubescent. Flowering stems produce a few reduced leaves. Flowers or heads are usually borne solitary on extended seed stalks. Both disk and ray flowers are produced, but they lack a pappus (Welsh and others 1987). Flowering occurs in early April, and seed matures in late May and early June (Harrington 1964). Leaves dry up between late June and the end of July.

Ecological Relationships and Distribution

A native perennial forb, arrowleaf balsamroot can be found growing on well-drained silty to loamy soils in sagebrush, mountain brush, and ponderosa pine communities, and open slopes in aspen and coniferous forests. This forb is usually found at elevations between 1,000 to 9,600 ft (305 to 2,900 m) (Harrington 1964; Wasser 1982). It occurs in solid stands or mixed communities. Arrowleaf balsamroot is the most widespread species of balsamroot. It ranges from the Sierras east to Colorado and north to southern Canada on acidic and alkaline soils (Hitchcock and others 1955; Plummer 1977). It dominates many extensive foothill areas, often growing as nearly pure stands (USDA Forest Service 1937).

Arrowleaf balsamroot is intolerant of shallow water tables, but withstands brief periods of soil saturation. It is strongly drought resistant, winter hardy, and tolerant of semishade, open sunlight, and of grazing (Wasser 1982).

Plant Culture

Arrowleaf balsamroot is one of the first plants to initiate growth in the early spring. Plants flower in April and usually attain maximum stature in late April or May, and seeds ripen in May and early June. Seed heads are formed individually on extended solitary peduncles, and if plants are not heavily grazed, large quantities of seed can be produced. Seeds ripen uniformly and are large, with just over 55,000 per lb (120,000 per kg). Seed is easily harvested by hand stripping or beating. Extensive areas of level terrain and dense stands can be harvested with a combine or reel-mounted harvester (Plummer and others 1968; Stevens and others 1985c). Seed can also be produced under cultivation (fig. 7).



Figure 7—Seed increase planting of arrowleaf balsamroot.

Seeds lack a fluffy or bristly pappus common to many other compositae. Seeds are long, smooth, and easily cleaned. Wildland stands are often infested with seed damaging insects, and entire seed crops can be damaged. Seed should be carefully inspected prior to collection. Plummer and others (1968) suggest treating seed production areas with insecticides to reduce seed predation. However, treatment must be timed to avoid elimination of pollinators. Seed in storage should be treated to prevent insect damage. Seed stored properly in an open warehouse retained good viability after 5 years (Stevens and Jorgensen 1994).

Mature seed will remain on the plant for a short time, but is readily eaten by rodents (Everett and others 1978b). Immature and insect-damaged seed will persist on the plant for longer periods. Too often, the persisting poor-quality seed is mistakenly harvested and marketed. Immature and damaged seed may often be normal size. However, it is light weight and can be separated from fully developed seed by gravity, wind separation, or flotation seed cleaning techniques. Good quality lots will have 95 percent purity and at least 40 percent germination.

Arrowleaf balsamroot seeds can be drill seeded quite easily with conventional equipment. Seeds should not be placed more than 0.33 to 0.5 inch (8 to 13 mm) deep. Seeds can be broadcast planted but only if they are covered. Because of seed dormancy and rodent preference for this species, late fall seeding is recommended (Eddleman 1978; Everett and others 1978b; McDonough 1976; Young and Evans 1979). Arrowleaf balsamroot seeds are often planted alone or with slower developing herbs and shrubs. This species should not be seeded directly with more aggressive developing herbs, but should be planted in separate rows or

broadcast onto sites free of competition. If planted with grasses or other broadleaf herbs, arrowleaf balsamroot plants may survive, but would require 10 years or longer to reach maturity.

Although seedlings germinate and emerge quickly, young plants develop slowly. Even under ideal conditions thick, dense stands usually do not develop from artificial seedings. Causes for low return are not fully known, but insects and rodents can cause considerable damage. Seeded plants may produce only two to three small leaves for a number of years following planting. Plants are slow to increase in stature, but they are extremely hardy and persistent.

Uses and Management

Arrowleaf balsamroot is an important forage plant for deer, elk, cattle, and sheep, especially on spring ranges where it greens up early (Harniss and Wright 1982; Hermann 1966; Holecheck and others 1982; Kufeld 1973; Kufeld and others 1973; Mueggler and Stewart 1980; Plummer and others 1968). The plant is also grazed later in the season with considerable use made of the heads during and following flowering. In many plant communities, a major portion of total forage production is arrowleaf balsamroot.

Plantings of arrowleaf balsamroot do well when seeded within areas of its natural occurrence. Attempts to extend or seed this species on areas outside of its natural range or on mine or roadway disturbances have been unsuccessful. This forb is encountered in low, semiarid conditions with Wyoming big sagebrush, but has been difficult to seed in these circumstances, usually because of using unadapted ecotypes, heavy grazing, and competitive effects of associated species. The most successful seedings have occurred in the lower elevation mountains in sagebrush and mountain brush communities.

Arrowleaf balsamroot can be used to improve forage conditions on game and livestock spring and summer ranges. It undoubtedly has been eliminated from some situations, but is extremely hardy and persistent even under heavy use.

Because of a deep fleshy taproot, arrowleaf balsamroot can withstand drought, trampling, fire and considerable grazing pressure. Natural reproduction will occur if seeds are allowed to mature. Seeded areas should not be grazed for at least two growing seasons following planting. New plants are slow to mature, requiring 3 to 4 years to flower on the most preferred sites, and 7 to 8 or even 10 years on the lower precipitation sites.

Varieties and Ecotypes

There are no releases.

Like most other natives, arrowleaf balsamroot grows on many different soil types and in many precipitation zones. Consequently, various ecotypes likely occur. Considerable differences are noted among populations in regard to palatability, seed production, and drought tolerance. Seeds are normally produced each year from upper elevation sites where precipitation is more reliable; however, seeds should be acquired from sites similar to the area proposed for treatment. The genus also appears to lack genetic barriers to hybridization, and intergradation occurs when any two taxa exist together (Welsh and others 1987).

Family Compositae

Balsamorhiza macrophylla _____

Cutleaf Balsamroot

Cutleaf balsamroot has large leaves 12 to 24 inches (30 to 61 cm) long that are divided into broad, entire, or few-toothed segments 2 to 5 inches (5 to 13 cm) long (Welsh and others 1987). The leaves have long, soft hairs and a somewhat unpleasant odor.

Cutleaf balsamroot generally occurs at slightly higher elevations and in more moist conditions than arrowleaf balsamroot. It is not distributed as widely as arrowleaf balsamroot and is less palatable to grazing animals. Cutleaf balsamroot ranges from northern Utah and southeastern Idaho to western Wyoming and southwestern Montana (Hitchcock and others 1955). Seed collection, cleaning, and storage as described for arrowleaf balsamroot. Seeds are somewhat larger than those of arrowleaf balsamroot with about 33,000 per lb (73,000 per kg). Seed can only be stored for 3 years without significant loss of viability (Stevens and Jorgensen 1994). Cutleaf balsamroot is better adapted to areas of slightly higher elevations and more moist conditions than arrowleaf balsamroot. Neither species should be seeded in place of the other. Site differences are not easy to differentiate.

Family Compositae

Balsamorhiza hookeri var. *neglecta* _____

Hairy Balsamroot

Compared to arrowleaf balsamroot, hairy balsamroot has smaller leaves 4 to 12 inches (10 to 31 cm) long that are divided into narrow segments 0.5 to 2 inches (1 to 5 cm) long (Welsh and others 1987). These segments are often divided a second time into even smaller segments. The leaves are covered with coarse, short, stiff hairs.

This species has a more limited distribution than arrowleaf or cutleaf balsamroot, occurring from eastern Oregon to southwestern Nevada (Hitchcock and others 1955). Welsh and others (1987) report two varieties of Hooker balsamroot are found in Utah, these occur in separate regions, but grow on a variety of sites.

Seed collection, cleaning, and storage are as described for arrowleaf balsamroot. Seed production is much lower than for arrowleaf or cutleaf balsamroot. In addition, plants usually do not exist in large dense patches, but are scattered and intermixed with other herbs.

Plants usually grow as an understory with shrubs, and have been useful in seeding pinyon-juniper and mountain brush sites. Sources that grow in drier circumstances offer opportunity to select and develop materials adapted to sagebrush and salt desert shrublands.

Family Fabaceae

Coronilla varia

Crownvetch

Crownvetch (fig. 8) is an introduced perennial legume with strong rhizomes and a deep taproot (Leffel 1973). Variegated white to purple flowers start to blossom in early summer and blooming continues for 4 to 5 weeks. Seed matures in early fall in pencil-like pods that break into segments as they dry. Each segment contains one yellow to dark red, rod-shaped seed. Flowers are arranged in an umbrella or crown-like fashion. Basal leaves are green early in the spring and remain green into the winter.

Ecological Relationships and Distribution

Crownvetch is a long-lived, cold-tolerant perennial from the Mediterranean region. This species is not a true vetch because it does not have tendrils for climbing. It does, however, tend to climb if supported by shrubs like mountain big sagebrush, Gambel oak, or serviceberry. This forb does fairly well with 21 inches (530 mm) annual precipitation and thrives with over 30 inches (760 mm) of precipitation. Crownvetch exhibits some shade and fire tolerance. It prefers slightly acidic soils but has also done well on slightly basic calcareous soils. It does not persist on poorly drained soils.

Crownvetch can be seeded in mountain brush, ponderosa pine, and aspen communities. It persists well at lower elevations once established. Although it performs best when grown on fertile soils, it demonstrates unusual ability to persist, spread, and remain productive when planted on mine disturbances and sites lacking top soil. It is especially useful for stabilizing erosive sites. This species is very competitive. Over time it will dominate an area and exclude other species.



Figure 8—Crownvetch stabilizing a road cut.

Plant Culture

Seeds are produced in segmented pods. Cleaned seeds are separated from the pod, and should be inoculated with the proper rhizobium prior to seeding (Magness and others 1971; Wasser 1982). There are about 135,000 seeds per lb (298,000 per kg) at 100 percent purity. Acceptable purity and germination for commercial seed is 95 and 75 percent. Seeding is best accomplished in the fall on a well-prepared seedbed. Stratification requirements can be overcome with fall seeding. Seed can be drilled or broadcast, but it should not be covered deeper than 0.25 inch (6 mm). This forb can be seeded with other species. When seeded with a grass mixture, it is best seeded separately through the legume seedbox. Excellent establishment can be obtained from transplanting or sprigging. Seeding at a rate of 2 to 4 lb per acre (2.2 to 4.5 kg per ha) is satisfactory when seeded in a mixture.

Uses and Management

Crownvetch produces strong, spreading, fleshy rhizomes. This extensive system enables crownvetch to be an excellent soil stabilizer and an aggressive spreader. It has been used to stabilize watershed and mine disturbances at locations receiving over 16 inches (40 cm) of annual precipitation. The plant is characterized as having a succulent dark green appearance, profuse flowering, and excellent ground cover characteristics. These features make crownvetch a prime landscape species for summer home developments, roadways, campgrounds, and areas of high recreational use.

Palatable forage is produced by crownvetch for all classes of livestock and wildlife (Wasser 1982), with little or no bloat hazard (Leffel 1973; USDA Soil

Conservation Service 1978). Deer, elk, and livestock will paw through snow to find and use its semievergreen forage. Birds and rabbits use crownvetch for food and cover. Crownvetch has some poisonous characteristics (Shenk and others 1976). However, when used in conjunction with other species, poisoning has not occurred (Shultz 1984). Crownvetch is normally seeded as a component of a mixture to enhance forage production and quality. This species establishes slowly, and production is low the first or second year following seeding. Once established, it can withstand considerable grazing and trampling. It recovers from close grazing, but does not have the regrowth capabilities of alfalfa. When seeded in mixtures with other species, it will spread vegetatively, and will tend to dominate a community.

Varieties and Ecotypes

'Emerald', 'Penngift', and 'Chemung' have done well in mountain big sagebrush, mountain brush, and aspen communities. Emerald is the smallest in stature and produces less forage, but it is a more aggressive spreader.

Family Geraniaceae

Geranium richardsonii

Richardson Geranium

A member of the geranium family, Richardson geranium (fig. 9) is a perennial native forb, with flowers that are generally white with pinkish or dark veins. Stems are single or few and somewhat hairy and viscid. Leaves are large but thin. Flowering occurs in July and early August, and seed matures in September. The foliage gives off a distinctive geranium odor when crushed (USDA Forest Service 1937).



Figure 9—Richardson geranium.

Ecological Relationships and Distribution

Richardson geranium occurs in openings throughout the coniferous forest as an understory species in aspen and subalpine meadows (Judd 1962; USDA Forest Service 1937). It is the most widely distributed geranium in North America (Hermann 1966). The species is not restricted to any particular soil type, but usually occurs on fairly moist gravelly or sandy loams. However, it can be found on drier granitic soils and heavy clay loams (Judd 1962; USDA Forest Service 1937).

Plant Culture

Seed is generally produced yearly if plants are not grazed. Seed can be collected by beating it into a hopper or with a mechanical seed beater mounted on a vehicle. Seed is extracted from the collected material by hammermilling or with a debearder (Stevens and others 1985c). Seed can be stored for at least 5 years without substantial loss of viability. Acceptable germination is 60 percent. There are about 65,000 seeds per lb (143,000 per kg) at 100 percent purity. Seed can be cleaned to 60 percent or higher purity. Seed can be drilled or broadcast seeded on a prepared seedbed, preferably in the fall. Seeding depth should not exceed 0.25 inch (6 mm). This species can be seeded singly or as a component of a mixture of other forbs and grasses. It demonstrates excellent ability to spread by natural seeding. Seeds are small and can establish on a loose seedbed or on sites where litter has accumulated.

Uses and Management

Forage value for cattle and sheep is rated good to excellent during early growth stages, and poor to good later in the season. Forage value for elk (Kufeld 1973) and deer (Kufeld and others 1973), is greater than for livestock (Hermann 1966; Judd 1962; USDA Forest Service 1937).

The species develops a stout, woody root system that enables it to stabilize soil and withstand considerable grazing, trampling, and some drought. Seedings on fertile soils have been most successful. Attempting to seed or use this species on sites where it does not normally occur is not recommended. However, this forb spreads naturally and has successfully invaded roadway disturbances. Richardson geranium can persist with moderate to heavy grazing. Plants appear to be long-lived and spread well from natural seeding. Newly seeded stands should not be grazed for at least two growing seasons following planting. This species frequently increases with proper management. It persists well with seeded grasses, including smooth brome and intermediate wheatgrass. It is useful for adding diversity to mixtures, especially where shade from overstory species exists. Limited seed supplies restrict the use of this species.

Varieties and Ecotypes

There are no releases.

Family Geraniaceae

Geranium viscosissimum _____

Sticky Geranium

This species occurs in the same climatic and edaphic areas as Richardson geranium. Its forage value for cattle is rated from fair to good and from good to excellent for sheep, deer, and elk (Buchanan and others 1972; Kufeld 1973; Kufeld and others 1973; Mueggler and Stewart 1980). Seed is collected, cleaned, stored, and seeded in the same manner as described for Richardson geranium. Seeds of sticky geranium are a little larger with about 52,000 per lb (115,000 per kg). These two species hybridize on the Wasatch Plateau of central Utah (fig. 10) (USDA Forest Service 1937).

Sticky geranium (fig. 11) can be distinguished from Richardson geranium by its multiple, erect stems bearing deep purple to pink colored flowers, and its usually sticky and glandular herbage.

Varieties and Ecotypes

There are no releases.

Family Fabaceae

Hedysarum boreale _____

Utah Sweetvetch

Utah or northern sweetvetch (fig. 12) is a native perennial member of the legume or pea family that grows 10 to 30 inches (25 to 76 cm) tall and 30 to 80



Figure 10—Hybrid of Richardson and sticky geranium.



Figure 11—Sticky geranium.

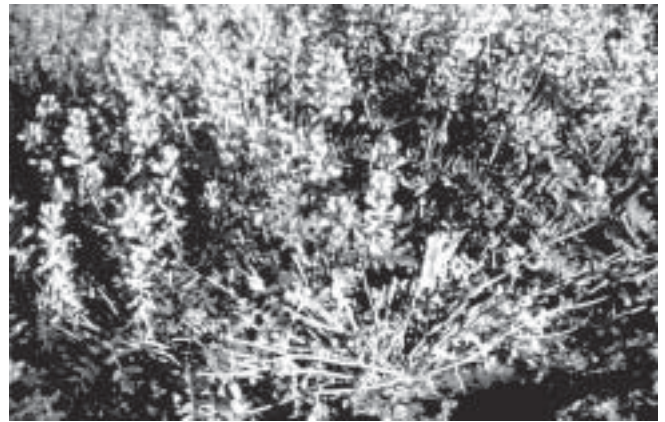


Figure 12—Utah sweetvetch.

inches (76 to 203 cm) wide. Blossoms are bright rose-pink to purple and very showy. Leaves are green above and grayish on the underside. Growth begins early in spring and provides a considerable amount of early spring forage that is highly palatable to both big game and domestic livestock. An abundance of forage is provided with some basal leaves remaining green throughout the winter (Rumbaugh 1983). This species produces a tap root (Welsh and others 1987). Some strains are rhizomatous (Ford and others 1984). This species has nitrogen fixing capabilities (Ford 1988; Ford and others 1989; Redente and Reeves 1981). Abundant seed is produced most years. Considerable variation occurs within the species, and there are a number of subspecies and varieties (Ford 1988; Northstrom and Welsh 1970, 1979; Rollins 1940). Utah sweetvetch is the most abundant sweetvetch in the Intermountain West.

Ecological Relationships and Distribution

Utah sweetvetch occurs in most Western States (Ford 1988). It has fair shade tolerance (Rumbaugh and Townsend 1985; Wasser 1982) and can be found in subalpine, aspen, mountain brush, ponderosa pine, pinyon-juniper, and big sagebrush types. In northern Utah it has been found in the shadscale saltbush type (Plummer and others 1968). Sweetvetch grows with 10 to 36 inches (25 to 91 cm) of annual precipitation on acidic or basic soils ranging from sands to heavy clays (Plummer 1977), making it well adapted to semiarid areas of the Intermountain West (Redente 1980).

This species has a stout, branched, woody taproot, thus it can take advantage of deep soil moisture, resulting in considerable drought resistance and winter hardiness. Rhizomatous accessions have been reported (Ford and others 1984, 1989; McKell and others 1979; Plummer and others 1968; Rumbaugh 1984).

Plant Culture

Flowering occurs in late May and June. Seeds mature in late July and early August. A segmented loment or pod is formed (fig. 13) that can be harvested by hand or with a combine. Seed has been successfully produced under cultivation. Seeds can be stored and seeded in or out of the pod. Seeds should be treated with an insecticide to control insect damage. There are about 33,000 seeds per lb (73,000 per kg) at 100 percent purity. Acceptable purity and germination in the commercial market is 90 and 60 percent. By extracting the seed from the pod, unfilled, damaged, and immature seed can be removed. Seed is extracted from the pod with a debearder or Dybvig. Heat and mechanical breakage resulting from improper use of



Figure 13—Segmented loment of Utah sweetvetch.

either machine can reduce viability of the seed lot. Seed can be stored up to 5 years without any significant loss in viability (Stevens and Jorgensen 1994).

Good results can be expected from direct seeding. Seeding should occur in the fall or early winter, with the seed covered at least 0.13 inch (3 mm) but not more than 0.38 inch (10 mm) of soil. Seeds should be inoculated with the appropriate inoculant (Redente and Reeves 1981; Rumbaugh and Johnson 1984). Seed can be drilled or broadcast. Utah sweetvetch should not be seeded where its seedlings are in direct competition with seedlings of aggressive species. If drilled, this forb should be seeded in rows separate from grasses. Utah sweetvetch does not produce strong seedlings. Germination is slow and seedling emergence follows that of many other species. Seedlings and young plants also develop slowly. Flowering does not occur until the third or fourth year following planting. Once established, this species is very persistent, particularly when seeded with other herbs. Plants can be established by transplanting in the early spring (Institute for Land Rehabilitation 1979).

Uses and Management

Livestock and big game make considerable use of Utah sweetvetch (Hermann 1966; Plummer and others 1968; Rumbaugh 1984; USDA Forest Service 1937; Wasser 1982). Spring growth provides succulent forage. Considerable green herbage is retained throughout the growing season, and basal leaves remain green through the winter (Redente 1980; Rumbaugh 1984). This species is thought to be a bloat-safe legume (Rumbaugh and Townsend 1985). It has considerable potential for improving big game and livestock ranges, and for stabilization of disturbed and eroding areas (Plummer and others 1968; Redente and Reeves 1981).

Seeded areas should not be grazed for at least 2 years following seeding. Once established, this species can withstand considerable use; however, continual use has reduced its density in some areas.

Varieties and Ecotypes

'Timp' exhibits excellent growth rate, seed production, and nitrogen fixing capacity. This variety is fairly widely adapted.

Family Compositae *Helianthella uniflora* _____

Oneflower Helianthella

There are eight species of *Helianthella* in North America (Weber 1952), with oneflower helianthella having the widest distribution. Plants are upright with erect heads. Seeds are flat and covered with

hair, whereas most sunflower seeds are thick and lack pubescence. Onewflower helianthella produces yellow flowers in late May and early June, and seeds mature in July (Hermann 1966).

Ecological Relationships and Distribution

Onewflower helianthella (fig. 14) ranges from Montana to Oregon and south to New Mexico, mainly in mountain brush, aspen, spruce-fir, and ponderosa pine types (Hermann 1966; USDA Forest Service 1937). It does well in full sunlight and partial shade, growing on dry hillsides, open woods, and intermixed in various shrub communities.

Plant Culture

Seed matures in July and can be collected by hand, stripping, mechanical beating, or combining. Seed is easily cleaned, by screening to remove debris. Seeds do not remain viable for more than 2 years (Stevens and Jorgensen 1994). There are just over 52,000 seeds per lb (115,000 per kg) at 100 percent purity.

Direct seeding by drilling or broadcasting has worked well. When seeding oneflower helianthella, seed should be covered no more than 0.38 inch (10 mm). Germination is rapid, and strong seedlings develop quickly. This species does well seeded in mixtures with other herbs. Reproduction from new seedlings usually occurs within 3 to 4 years after the initial planting.

Uses and Management

The leaves, flowers, and more tender portions of the stems of oneflower helianthella are eaten by big game and livestock. Palatability is rated as poor to fair for cattle and elk, and fair to good for sheep and deer (Kufeld and others 1973; Mueggler and Stewart 1980). This perennial provides considerable forage in the spring and through the summer.

Onewflower helianthella can be seeded in mixtures with other herbs to furnish diversity and forage. The plant grows on a variety of sites, occupying harsh open conditions, yet also doing well on moist, fertile soils in some shade. When seeded with native and introduced grasses, it persists well and provides useful forage. It will spread to colonize open disturbances, and can be used to beautify recreational sites and roadways. It usually does not provide a dense ground cover, but mixtures of oneflower helianthella with other herbs are useful for controlling erosion.

New seedlings should receive at least two growing seasons of nonuse following planting. Selective grazing of this species does not occur, and it can be easily maintained in a mixture with other herbs on summer ranges.



Figure 14—Onewflower helianthella in full bloom.

Varieties and Ecotypes

There are no releases.

Family Umbelliferae *Heracleum lanatum*

Cow Parsnip

There are about 60 species of *Heracleum* throughout the world. However, only one, cow parsnip, occurs in North America (Hitchcock and others 1961). Cow parsnip forms a compound umbel (fig. 15), with flowers occurring at the ends of long, hollow stalks. Plants are tall, often reaching 7 ft (2.1 m). The white to light yellow flowers bloom in July and early August. Seed matures in late August and early September. Roots are woody, short, jointed, and aromatic. Leaves are divided into three very large, irregularly toothed leaflets, each 4 to 10 inches (10 to 25 cm) long.

Ecological Relationships and Distribution

Cow parsnip is found from Alaska, eastward across Canada, and south through the Western States and to Georgia. In the Intermountain West, cow parsnip occurs in aspen, spruce-fir, and subalpine areas, and in meadows, with rich, loamy soils. This species prefers some shade and exists in open woodlands.

Plant Culture

Cow parsnip seeds are flat, obovate in shape, and fairly large, with just over 44,000 per lb (97,000 per kg). Collection of seed is best accomplished by hand stripping or beating. If allowed to mature, good seed crops are generally produced yearly. Seeds are easily cleaned by screening to separate them from debris.



Figure 15—Cow parsnip in full bloom.

Germination is generally low, and viability is not maintained for much more than 2 years (Stevens and Jorgensen 1994).

Seed can be broadcast or drill seeded, preferably in autumn before snowfall. Seed should not be covered more than 0.5 inch (1.3 cm) deep. Seeds are rather large and are difficult to seed in mixtures with smaller seeds. Seeds must be placed in seedboxes separate from smaller seeded species so that planting rates can be properly controlled. Seeds can be easily fractured during cleaning or mechanical planting. Seedlings usually establish and grow rapidly, and can persist when seeded with most herbs. Plants normally require 3 to 4 years to attain maximum size, but once established they remain highly productive.

Uses and Management

Cow parsnip is highly palatable to livestock and big game (Ellison 1951; Hermann 1966; USDA Forest Service 1937). It has considerable potential as an ornamental plant for summer homes, administration buildings, and recreational areas.

Reproduction is by seed only. Continual annual grazing will prevent seed production, reduce vigor, and result in elimination of this forb. Cow parsnip is a highly preferred species that requires deferred grazing. Seeded areas should not be grazed for at least two growing seasons following planting.

Varieties and Ecotypes

There are no releases.

Family Umbelliferae

Ligusticum porteri _____

Porter Ligusticum

Porter ligusticum (fig. 16) a North American native, is a member of the umbel or carrot family (Welsh and others 1987). Plants are perennial with a characteristic aromatic taproot. White flowers are borne in a terminal umbel which is often subtended by a whorl of three to eight lateral umbels. Flower stalks are hollow and may attain a height of 4 ft (1.2 m). Flowering occurs in July and early August. Seed matures in August and September.

Ecological Relationships and Distribution

Porter ligusticum is the most widespread ligusticum in the Intermountain West. It can be found in openings in aspen, spruce-fir, and subalpine types and as a component of the understory in aspen stands. Porter ligusticum prefers well-drained soils. It has fairly good drought tolerance and good winter hardiness, and can withstand considerable grazing (USDA Forest Service 1937).



Figure 16—Porter ligusticum growing in a subalpine forb community.

Plant Culture

If allowed to mature, good seed crops are generally produced yearly. Seed is collected by hand stripping or beating. Seed is flat, winged, and relatively easy to separate from debris by screening. Dried seeds are brittle and can be fractured or damaged by improper cleaning or mechanical seeding. There are about 70,000 seeds per lb (154,000 per kg).

Seed can be stored for up to 5 years without appreciable loss of viability (Stevens and Jorgensen 1994). Seed can be drilled or broadcast seeded. Fall seeding onto a disturbed seedbed has worked well if the seed is covered with soil. Seeds are heavy, irregularly shaped and do not flow well through most conventional seedboxes. However, when mixed with other seeds of the same size, uniform plantings can be achieved. Seeds are relatively large, and the gates of most seedboxes must be opened wide enough to assure passage. When this is done, seeds of smaller species may be planted too heavily. Consequently, this species is often planted separately from other seeds, and a carrier is added to aid in uniform planting.

Drill seeding at rates of 2 to 4 lb per acre (2.2 to 4.5 kg per ha) in separate rows from seeded grasses is recommended. Broadcast seeding is possible if followed by light harrowing or churning. Although studies have not identified specific ecotypic differences among populations, survival and growth rate differences strongly indicate distinct ecotypes exist. Seed lots should not be planted in different elevational zones than the collection site. Moving seed from aspen communities to sagebrush types is not advised.

Good germination and seedling establishment usually result from field plantings, but subsequent survival is often low. Plants are suited to grow with other species and persist well in mixtures once established. Some plantings have been conducted in the aspen and oakbrush communities, but this forb also exhibits usefulness in the upper sagebrush communities. It is often encountered in openings and on shallow soils, and can be seeded to improve forage conditions on somewhat harsh situations.

Uses and Management

Livestock, particularly sheep, and big game make considerable use of this species in spring and summer. It is highly sought out at all dates (Hermann 1966; Kufeld and others 1973; USDA Forest Service 1937). Seeded areas should not be grazed for at least 2 years following planting. Established stands should be allowed to produce seed periodically, as reproduction is entirely from seed.

Varieties and Ecotypes

There are no releases.

Family Linaceae

Linum lewisii ssp. *lewisii* _____

Lewis Flax

There are approximately 100 *Linum* species in the temperate regions of the world (Hitchcock and others 1961), with about 20 species occurring in the western United States. Lewis flax is a delicate, erect perennial sometimes reaching 3 ft (0.9 m) in height. Numerous glabrous stems grow from a single crown with a woody taproot. Flowers are generally sky blue (fig. 17), but also range from white to dark blue. The petals are caducous, dropping within 1 day of flowering. Flowers open in the morning and close by mid-afternoon (Howard and Jorgensen 1980). Flowering begins in May and extends through June. Spherical capsules that produce up to 10 seeds each mature in late July and August.

Ecological Relationships and Distribution

Lewis flax ranges from Alaska south to California and Texas (Harrington 1964). It is a perennial semievergreen that grows on well-drained soils ranging from moderately basic to weakly acidic (Wasser 1982). Lewis flax can be found in shadscale-saltbush, sagebrush grass, and pinyon-juniper communities, and in openings in mountain brush, aspen, and conifer types, especially on warmer south and west exposures. This species is intolerant of poor drainage, flooding, and high water tables (Wasser 1982).

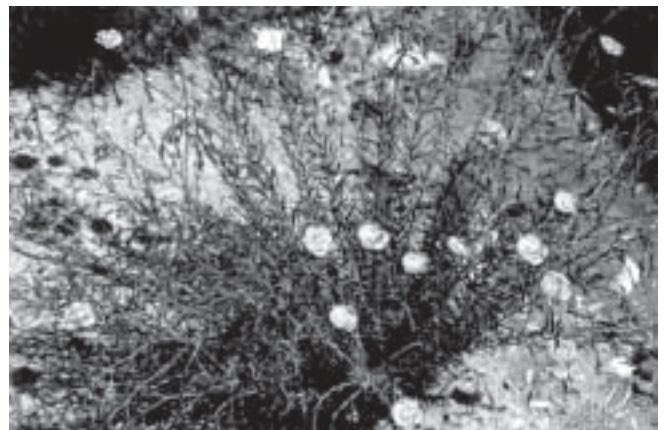


Figure 17—Lewis flax in full bloom.

Plant Culture

Lewis flax can be established easily from direct seeding. Seeding can be accomplished by aerial and hand broadcasting, drilling, and interseeding. Care should be taken to ensure that seeds are not covered by more than 0.13 inch (3 mm) of soil. Lewis flax has been successfully seeded in range, wildlife, roadway, mine disturbance, and landscape plantings. It establishes well when included in mixtures (McKenzie and others 1980; Plummer and others 1970a), and grows and reproduces well in association with other species (Stevens and others 1981b). However, young plants can be suppressed by competitive perennial grasses. This species does well when seeded in mixtures with shrubs. Generally, 0.25 to 0.5 lb per acre (0.3 to 0.6 kg per ha) is seeded in mixtures. Reproduction is entirely from seed. The species is well adapted to sagebrush, pinyon-juniper, and mountain brush communities, and is one of the few forbs that can be seeded successfully in the salt desert types (Monsen and Plummer 1978). Everett (1982) reported that Lewis flax was the superior forb in a number of pinyon-juniper seedings. It has been one of the most successful native forbs seeded in the sagebrush and pinyon-juniper communities in Utah. Seeding is best accomplished in fall or winter (Everett 1982; Howard and Jorgensen 1980). Seeds require an afterripening period to obtain maximum germination (Eddleman 1977; Stevens and Jorgensen 1994). Seed can be held in storage up to 10 years without any appreciable loss of viability (Stevens and Jorgensen 1994).

Seed can be collected by hand, with power-driven beaters, or with a combine. Seed production is generally high. Seed is also being successfully produced under cultivation. Natural reproduction is usually good, resulting in stable numbers and production even though individual plants are relatively short-lived (4 to 7 years). Flowering occurs over a 6 week period, causing seed to mature unevenly over an extended period of time. There are about 280,000 seeds per lb (617,000 per kg) at 100 percent purity.

Uses and Management

Lewis flax produces basal foliage from a woody taproot (Plummer and others 1968). This species can be classified as a semievergreen because some basal foliage remains green throughout the winter. Animals paw through the snow to reach the green growth in winter. Early spring growth is grazed by big game, upland game birds, and livestock. Forage value for livestock and big game is moderate to high, and birds and rodents seek out the seed (Everett and others 1978; Howard and Jorgensen 1980; Plummer and others 1970a). Lewis flax responds well to late summer and fall storms by producing new basal leaves.

Because it maintains green basal foliage year round, this species does not burn readily, and it can be used as a fire suppressant species. Lewis flax has the ability to compete with and spread in some cheatgrass communities. When seeded in mixtures, Lewis flax establishes and spreads well. It quickly occupies open areas and slowly suppresses annual weeds.

Flower color ranges from nearly white to dark blue. Profuse flowering occurs for about 6 weeks (Addicott 1977), beginning in mid-May. The flowering characteristics of this species make it a prime ornamental candidate. When seeded in a mixture, Lewis flax can help make a seeding more aesthetically pleasing.

Seeded areas should not be grazed for at least 2 years on better sites and 3 years on drier, poorer sites. Seed should be allowed to mature periodically. Individual plants are relatively short-lived (4 to 7 years). Abundant seed is produced when plants are not excessively grazed. Lewis flax will reproduce and remain in most seedings if properly managed.

Varieties and Ecotypes

'Appar' Lewis flax was released by the Utah Division of Wildlife Resources, the USDA Forest Service Intermountain Forest and Range Experiment Station, and the USDA Soil Conservation Service Aberdeen Plant Materials Center in 1980. This cultivar was named for A. Perry Plummer. It was initially selected for its appearance and competitiveness with native grasses. It is easily grown under agricultural conditions and has produced up to 700 lb of seed per acre (785 kg per ha) with irrigation. 'Appar' exhibits a wide adaptability to sites in the Intermountain area. It is recommended for sites receiving 10 to 23 inches (25 to 58 cm) of annual precipitation (Howard and Jorgensen 1980; Shaw and Monsen 1983a). Pendleton and others (1993) report that the origin of the cultivar appears to be European and that it is derived from a naturalized population of *Linum perenne*.

Maple Grove Lewis flax was released by the USDA Forest Service, Rocky Mountain Research Station, and the USDA NRCS Aberdeen Plant Materials Center. It is a selected germplasm of *Linum lewisii* that originated near Maple Grove, UT.

Family Umbelliferae

Lomatium triternatum _____

Nineleaf Lomatium

Nineleaf lomatium (fig. 18) is a member of the umbel or carrot family (Welsh and others 1987). It was formerly identified as *Lomatium simplex*. It has now been divided into two subspecies, *L. triternatum* spp. *platycarpum* and *L. triternatum* spp. *triternatum* (Hitchcock and others 1961; Welsh and others 1987).



Figure 18—Lomatium in full bloom.

This aromatic perennial forb, with yellow flowers and green leaves, grows to about 14 inches (36 cm) in height. It blooms in April and May, and seeds mature in July and August.

Ecological Relationships and Distribution

Nineleaf lomatium occurs in central and southwestern Colorado, Montana, southwestern Canada, and south from California, to Colorado (Hermann 1966; Hitchcock and others 1961; Welsh and others 1987).

Nineleaf lomatium prefers well-drained or dry rocky soils on flats, sunny open ridges, and slopes. *L. triternatum* ssp. *triternatum* occurs in mountain brush, ponderosa pine and aspen forests, and dry valleys from 5,200 to 8,500 ft (1,600 to 2,600 m). *L. triternatum* ssp. *platycarpum* is present in sagebrush-grass types, pinyon-juniper, mountain brush, ponderosa pine, lodgepole pine, and dry meadow communities from 4,300 to 9,500 ft (1,300 to 2,900 m) (Welsh and others 1987).

Plant Culture

Seed matures in July and August. It can be hand collected. Screening to remove debris is all that is generally required to clean field-harvested seed. Viability of freshly harvested seed is generally good and remains high for 3 to 4 years. There are about 42,000 seeds per lb (93,000 per kg) at 100 percent purity. Seed can be drilled or broadcast seeded. Seeding is best accomplished in the fall, with seed being covered not more than 0.25 inch (6.4 mm) deep. This species does well when seeded in mixtures with other herbs.

Uses and Management

Nineleaf lomatium is one of the first species to begin growth following snowmelt. Extremely early growth and development takes advantage of spring soil moisture and provides much needed spring succulence for big game and livestock. Deer, elk, antelope, cattle, and sheep make use of the foliage (Hermann 1966; Mueggler and Stewart 1980; USDA Forest Service 1937).

Large, deep taproots enable nineleaf lomatium to withstand considerable drought, grazing, and trampling. Newly seeded areas should be given at least two seasons of growth before they are grazed.

Varieties and Ecotypes

There are no releases.

Family Umbelliferae

Lomatium kingii _____

Nuttall Lomatium

Nuttall lomatium, (fig. 19) formerly referred to as *Lomatium nuttallii* (Welsh and others 1987), is a native perennial forb that can be found growing from sagebrush-grass up through the subalpine communities. It exists on basic and acidic soils (Plummer 1977; Welsh and others 1987). Nuttall lomatium is not as widely distributed as nineleaf lomatium. It does, however, occur on drier sites and may have more drought tolerance. Seed is best collected by hand. Viability is generally high. Seeds are large with approximately 12,500 seeds per lb (28,000 per kg). More



Figure 19—Nuttall lomatium setting seed.

than 70 percent germination can be expected even after 5 years of storage (Stevens and Jorgensen 1994). Seed is collected and cleaned in the same manner as described for nineleaf lomatium.

This species is readily grazed by big game during spring months. It is one of the first forbs to green up, thus providing much sought after spring and early summer succulence.

Family Fabaceae

Lupinus sericeus

Silky Lupine

Silky lupine (fig. 20) is a highly variable native perennial legume. Plants are usually 12 to 47 inches (30 to 120 cm) tall, growing from a branching caudex. Flowers and foliage are usually quite abundant. Flowers are large, blue, blue-purple, or white (Welsh and others 1987). Flowers emit a distinctive pungent odor. The leaves are large, palmately compound, often pubescent, and gray-green (Welsh and others 1987). Individual seedpods usually contain 3 to 5 seeds.

Ecological Relationships and Distribution

Silky lupine ranges from southern Canada south to New Mexico (Hermann 1966). It is common in the Great Basin and can be found in sagebrush-grass, pinyon-juniper, mountain brush, ponderosa pine, and aspen types. Welsh and others (1987) reported that silky lupine is one of the most widely distributed species in Utah, with four different varieties reported. It is most abundant in upper mountain brush and aspen communities. This species grows on basic, neutral, and slightly acid soils. It prefers open sunlight, but possesses some shade tolerance.

There are a number of perennial lupines in the Intermountain West. Most tend to intergrade with each other. Two common and abundant species are silky lupine and silvery lupine.

Plant Culture

Seed is usually ready to harvest in early September. Seed pods must be collected before they dry and seeds are shattered. Consequently, seed is collected by hand stripping of the complete inflorescence and, if in pure stands, by mechanical seed beaters or combines. Following collection, the pods need to be further dried before seeds can be extracted. During drying, collected material must be covered with a screen to prevent seed loss. As pods dry, they open, twist, and propel the seed a distance of 3 to 10 ft (0.9 to 3.0 m). Lupine seeds have considerable longevity. Silky lupine seeds have been stored for 20 years and still retained 72 percent germination (Stevens and Jorgensen 1994).



Figure 20—Silky lupine.

Seeds are rather large with only 13,000 per lb (29,000 per kg). Most seeds imbibe water when planted but some fail to germinate. Some seeds that fail to germinate are lighter in color than healthy seeds. Silky lupine should be seeded in the fall to meet stratification requirements. Seed can be drilled or broadcast, with seed covered not more than 0.25 inch (6.4 mm) deep.

Silky lupine establishes well when seeded on disturbed or depleted sites in acid or basic soils (Plummer 1977). Fairly strong seedlings are produced; however, full plant development can be somewhat slow, with flowers not being produced for 3 to 5 years following seeding.

Good numbers of seedlings appear from most plantings. However, plant numbers are generally reduced quite dramatically the first growing season. Plants that persist the first year are usually very hardy and will persist even under adverse conditions. Young plants are quite competitive and persist with some competition. To date, most range seedings have been conducted using seed collected from aspen communities. These sources are not suited to lower, drier elevations.

Uses and Management

Silky lupine is one native legume that has good potential for revegetation of ranges in upper sagebrush-grass, mountain brush, ponderosa pine, and aspen types. This species provides early spring succulence and is grazed by cattle, sheep, deer, rodents, and small mammals throughout the year (Hermann 1966; Holechek and others 1982; Kufeld and others 1973; Plummer and others 1968). It can be seeded in mixtures or in separate drill rows from grasses and other broadleaf herbs. It is extremely productive and provides not only useful forage but also soil protection

and erosion control. It persists with grazing, and does well as an understory species. It can be used in riparian disturbances and on dry meadows that are not flooded.

Silky lupine often recovers well when disturbed sites are protected for a number of years. Rodents gather and forage on lupine seeds and can interfere with seedlings and natural spread. Seeded areas should not be grazed for at least 2 years, and in some cases, 3 years following planting. Once established, this species has excellent grazing and drought tolerance.

Varieties and Ecotypes

There are no releases.

Family Fabaceae

Lupinus argenteus

Silvery Lupine

A major difference between silvery lupine and silky lupine is the presence of less pubescence on the leaves and stems of silvery lupine. Its flowers are predominantly blue-purple, blue, and white. Meeuwig (1960) reported that silvery lupine has outstanding forage, ground cover, and revegetation potential at higher elevations. Most of the perennial lupines readily hybridize (Hermann 1966). *Lupinus alpestris* is now included as part of the silvery lupine complex (Welsh and others 1987). Seed production, seed handling, seeding, and seedling establishment characteristics of silvery lupine are similar to those of silky lupine.

Silvery lupine occurs at higher elevations than does silky lupine. Major areas of occurrence are aspen, spruce-fir, and subalpine herblands (fig. 21).



Figure 21—Silvery lupine in a subalpine community.



Figure 22—‘Nomad’ alfalfa. Yellow- and blue-flowered alfalfa growing together on a pinyon-juniper site.

Poisonous Characteristics

Some lupines, including silky and silvery, have poisonous characteristics and can cause death if used improperly during some seasons of the year (Davis 1982b; Davis and Stout 1986; James and others 1980; USDA Soil Conservation Service 1968). Care should be taken with livestock where substantial quantities of lupine are available. Livestock that obtain forage of other species in addition to lupine are generally not adversely affected (USDA Soil Conservation Service 1972b). When planting lupine, care should be taken to ensure that it is seeded in mixtures with other species, and that large, solid stands are not established.

Family Fabaceae

Medicago sativa

Medicago falcata

Alfalfa

Sicklepod Alfalfa

Two species, *Medicago sativa* (alfalfa) and *M. falcata* (sicklepod alfalfa), were introduced to North America (Hansen 1913). Alfalfa is generally blue-flowered (fig. 22) and nonrhizomatous, whereas sicklepod alfalfa is generally yellow-flowered and somewhat rhizomatous.

Both species are perennials. Stems normally reach 11 to 40 inches (30 to 100 cm), depending on growing conditions. Stems are branched; some are ascending. Most range varieties form decumbent stems at the base of the plant. Varieties cultivated for hay production or irrigated pastures are normally more erect.

Leaves of alfalfa are glabrous to hairy, alternate, and pinnately trifoliate; the leaflets are serrate distally and oblanceolate to oblong. Flowers are small, usually less than 7 to 10 mm long. Fruits consist of several-seeded spiral pods (Harrington 1964). Plants produce an abundance of herbage, with growth beginning early in the spring.

Alfalfa is a complex taxon with nine recognized subspecies (Gunn and others 1978). These express intergrading morphologies and hybridize quite freely. The genus evolved in the Mediterranean region. The perennial mesophytic subspecies arose in Western and Central Asia (Lesins and Lesins 1979). Diploid ($2N = 16$) and tetraploid ($2N = 32$) forms commonly occur. Most cultivars are tetraploid (Rumbaugh and Townsend 1985). Lesins and Lesins (1979) report that the diploid populations of alfalfa originate from steep mountainous regions.

Miller and Melton (1983) described over 400 cultivars and strains of alfalfa in North America. Today there are many more. The origin of the 15 most commonly grazed populations are described by Rumbaugh (1982a). All dryland forage types are interspecific hybrids of alfalfa and sicklepod alfalfa (Rumbaugh and Townsend 1985) (fig. 23). These authors reported that sicklepod alfalfa contributes genes that increase drought tolerance, winter hardiness, and tolerance to grazing. Alfalfa germplasm enhances resistance to disease and insects and improves forage and seed production.

Most range and field varieties of alfalfa used in Western range plantings arose from the early efforts of Dr. N. E. Hansen (1913) of South Dakota. Early testing conducted by Dr. Hansen, led to identification of population with spreading root systems. This characteristic has subsequently been bred into field and range varieties (Rumbaugh and Pedersen 1979). Canadian scientists later advanced the usefulness of this species by breeding varieties with better grazing and cold tolerance (Heinricks 1963). Alfalfas were entered into extensive field plantings within the Intermountain region in the 1930's. Numerous field and range varieties have subsequently been developed.

Ecological Relationships and Distribution

Rangeland varieties of alfalfa are well adapted to areas that receive 10 inches (25 cm) or more of annual precipitation. They are especially well-adapted to sagebrush/grass, pinyon-juniper, and mountain brush (fig. 24) communities. They have been seeded and have performed fairly well in aspen, spruce-fir, and subalpine types. This forb is semievergreen, having green basal leaves throughout the winter. Growth starts in the spring when the plant is exposed from underneath the snow. Once grazed, regrowth of rangeland types is limited compared to that of irrigated alfalfas.



Figure 23—'Rambler' alfalfa seeded into rootplow strips in a Gambel oak-mountain big sagebrush community.

Seedling establishment is rapid, and seeding success rate can be high. Grazing stimulates rhizome production, which results in increased crown size and ground cover (Rosenstock and Stevens 1989).

Alfalfa is well suited to harsh sites and infertile soils. Under these conditions seedlings of few other herbs survive as well as alfalfa. Once established, alfalfa serves as an excellent nurse crop. Although plants begin growth early in the spring, they do not prevent the entry of other species. Alfalfa may produce considerable annual litter that provides a good cover for the seedbed. Once established, alfalfa is very persistent (Rumbaugh 1982b) (fig. 25), but little reproduction has occurred from established stands on rangeland sites (Rosenstock and Stevens 1989). Rhizomatous forms do spread vegetatively even under arid conditions.



Figure 24—'Ladak' alfalfa on a 27-year-old pinyon-juniper chained site.



Figure 25—Rehabilitated range 21 years following chaining of juniper-pinyon and aerial seeding. Thirteen grasses, shrubs, and forbs were seeded. After 21 years alfalfa is the predominant forb.

Plant Culture

Alfalfa is the most widely seeded rangeland forb in the Intermountain West (Rumbaugh 1984; Rumbaugh and Townsend 1985). Depending on the rangeland sites and seeding technique, it can be seeded in the fall or spring. Planting early in the spring usually produces good stands, but plantings in late fall or winter have been satisfactory in large restoration programs. Late winter plantings may prevent precocious germination (Plummer and others 1968), but alfalfa germinates quickly in early spring and may succumb to spring frosts.

Seed can be drilled or broadcast seeded, but it must be covered. Aerial seeding followed by anchor chaining or pipe harrowing and aerial seeding on snow over disturbed soil has produced excellent rangeland stands. Broadcast planting has often been more successful than drilling (Plummer and others 1968). Fall aerial seeding on a rough seedbed has resulted in excellent stands (fig. 25). Whether broadcast or drilled, seed should be covered 0.25 to 0.5 inch (6 to 13 mm) deep (Plummer and others 1968; USDA Soil Conservation Service 1971a).

Alfalfa is particularly adapted to drill or broadcast seeding in mixtures with other species. Seeds are rather small, round, and smooth. When mixed with grasses, seed sorting and separation can occur in the seedbox. Alfalfa seed usually does not separate when mixed with grasses if planted at a ratio of 1 to 5. Separate legume seedboxes are mounted on most drills. The legume boxes are designed to dispense the small alfalfa seed more accurately than the larger

seedboxes and eliminate seed separation when mixtures are planted.

Although alfalfa seeds should be planted slightly shallower than large seeded grasses, adequate stands normally appear when they are drilled together. Alfalfa seedlings develop rapidly and compete favorably with many grasses and other broadleaf herbs. Alfalfa seedlings, however, do not compete well with seedlings of crested and intermediate wheatgrass and smooth brome.

Because of the possibility of bloat, alfalfa should be seeded as a component of a mixture when planted in a pasture (Lorenz 1982). Up to 40 percent by weight of a grass-legume mixture has been seeded to alfalfa without causing bloat problems to livestock. Bloat has not been observed as a problem on mixed rangeland seedings.

Because alfalfa is highly utilized by livestock, big and small game, birds, rodents, and rabbits, a sufficient number of plants must be established to ensure the species is not eliminated by overuse. On most ranges, at least 2 lb of seed per acre (2.2 kg per ha) should be planted in the seed mix. Seed costs are generally not prohibitive, and under some conditions alfalfa should be planted at even higher rates. As seeding rates are increased, stand density also increases. Seeding alfalfa at rates exceeding 6 to 8 lb per acre (6.7 to 9.0 kg per ha) is unnecessary. There are about 220,000 seeds per lb (485,000 per kg). Purity is generally over 95 percent with germination at least 85 percent. Under warehouse storage seed longevity is excellent and little viability is lost after 25 years (Stevens and Jorgensen 1994).

Alfalfa is able to fix nitrogen, thereby improving soil fertility. Johnson and Rumbaugh (1981) reported that alfalfa appears able to fix nitrogen even during periods of drought when other legumes do not nodulate.

Uses and Management

Alfalfa is heavily grazed by livestock, big and small game, upland game birds, rodents, and rabbits during all seasons (fig. 26). The inclusion of alfalfa in a rangeland seeding can have a number of positive effects. It can (1) increase total herbage production, (2) increase production and protein content of associated species (Johnson and others 1983; Rumbaugh and others 1981, 1982), (3) extend the grazing season, both during spring and fall, (4) increase diversity (flora and fauna) of seeded communities, and (5) improve soil stability. Species growing in association with alfalfa are generally positively affected by its ability to fix nitrogen (Johnson and others 1983; Rumbaugh and others 1981, 1982). Consequently, alfalfa can be interseeded into established grass stands to improve vigor and herbage production.



Figure 26—Alfalfa seeding in a chained pinyon-juniper basin big sagebrush area. Deer use only on left, rabbit and deer use on right.

Alfalfa is compatible with native species in seedings in mountain brush, pinyon-juniper and big sagebrush communities. The forb has not noticeably diminished or eliminated native broadleaf herbs or grasses.

Regrowth capacity varies among varieties. Deep-rooted types possess better regrowth capabilities than rhizomatous range types. Alfalfa initiates growth early in the spring and remains green and productive as long as soil moisture permits. It can recover following grazing or clipping. It normally attains maximum production after most cool-season grasses cease growth. Certain strains of grass, including 'Latar' orchardgrass and 'Greenar' intermediate wheatgrass, mature when alfalfa is at the optimum stage of growth for harvesting as hay (Hafenrichter and others 1968). These species can be planted in mixtures to significantly extend the season of grazing and enhance total herbage production. Alfalfa also furnishes excellent fall green-up, and standing crops cure quite well. Consequently, this species has been used in wildlife seedings to attract and keep game animals from trespassing in agricultural fields. Areas seeded to alfalfa should not be grazed for a minimum of two growing seasons following seeding. Early use can result in poor survival and loss of vigor (Berdahl and others 1986). Drier areas may require additional time before stands fully establish.

It is not unusual for seedlings and young plants to succumb during the first 1 to 3 years following planting (Rosenstock and Stevens 1989). Once established, however, alfalfa has considerable longevity, resistance to grazing and trampling, and moderate shade tolerance. Kilcher and Heinrichs (1966b), Pearse (1965), Rosenstock and Stevens (1989), and Rumbaugh and

Peterson (1979) reported excellent stands persist 23 to 28 years after seeding on sites with 8 to 11.5 inches (20 to 29 cm) of precipitation. The Utah Division of Wildlife Resources has aerial seeded alfalfa on over 150,000 acres (60,700 ha) of game range during the past 30 years. At a few sites, there has been a major loss in plant density. Where a decrease in density has occurred, it has been a result of continuous heavy rabbit use and continual spring use by cattle. Similar results have been reported by Rumbaugh and Pedersen (1979) and USDA Soil Conservation Service (1971a). Rumbaugh (1982b) reported that stand density of eight different varieties was adequately maintained during a 25-year period, with proper spring grazing by cattle. Where insufficient seed is planted and plant density is low, considerable grazing pressure will reduce the stand. At least 2 lb. (0.9 kg) of seed per acre should be seeded to ensure sufficient density to sustain grazing.

Alfalfa generally receives more grazing pressure than other associated species and withstands greater use than other broadleaf herbs. Weakened stands recover readily when grazing pressures are removed. The deep taproot, large crowns, and extensive rhizomes enable the plant to persist over extended periods of drought.

New seedings can be damaged by continuous grazing by rabbits, rodents, livestock, or big game animals. Insects, including grasshoppers, have seriously defoliated alfalfa, often within a 2 to 5 day period. Attempting to seed alfalfa and palatable grasses in areas with high rabbit populations can be risky. Once established, mature plants can usually recover from cyclic periods of heavy use, but young seedlings cannot.

Alfalfa can be used to sustain big game animals during the early spring and summer months. Plantings established on pinyon-juniper sites in central Utah clearly attract deer and provide a substantial part of their diet, beginning in early March and continuing until early June (Rosenstock and others 1989). Wildland sites seeded to support big game should be grazed only lightly by livestock. If plants are subjected to stress by drought or excessive use by insects or rabbits, livestock grazing should be curtailed.

Alfalfa has been seeded on some rather arid sites, including sites dominated by Wyoming big sagebrush and shadscale saltbush. When seeded during years of average precipitation, plants usually establish. However, failures can be expected if seeding occurs during years with low precipitation. Plantings can be maintained under arid circumstances if grazed judiciously.

Varieties and Ecotypes

A number of strains of alfalfa—'Ladak', 'Rambler', and 'Nomad'—are adapted to ranges where annual precipitation exceeds 10 inches (25 cm) (Plummer and

others 1968; Rumbaugh 1982b). These strains produce much larger crowns than the usual field strains and have more complex root systems. In addition, they survive better from underground attacks by gophers and other rodents. Some plants also spread by stem layering. Consequently, these strains are superior for seeding rangelands (Plummer and others 1968).

'Ladak' is the best known and most widely used rangeland variety. If seeds of several strains are available, a mixture may be used. The varieties mentioned above have shown unusual persistence and production under heavy grazing and lower precipitation (Plummer and others 1968). Other cultivars—'Spreader', 'Spreader II', 'Rhizoma', 'Runner', 'Travois', 'Teton', and 'Drylander'—have also demonstrated good adaptability to wildland sites. Additional varieties are currently being developed for rangelands. A major concern is to improve drought tolerance so the forb may be planted in more arid environments.

Family Fabaceae

Melilotus officinalis

Yellow Sweetclover

The two most abundant sweetclovers on Western ranges are yellow sweetclover (yellow-flowered), and white sweetclover (white-flowered). Neither are native to North America. There are annual and biennial forms of each; however, most populations are biennials (Rumbaugh 1984; Smith and Gorz 1965). During the first season, only vegetative growth occurs; during the second season, long, well-branched stems 1 to 6 ft (0.3 to 1.8 m) tall (fig. 27) develop. Leaves are trifoliate, and dentate margined, with small narrow stipules. Flowering occurs on long narrow racemes, and single seeds are produced in straight smooth pods (Hermann 1966). After flowering and seed maturation, plants usually die.

Ecological Relationships and Distribution

Yellow sweetclover originated in Europe and Asia and is now distributed over most of the United States and Southern Canada. The species is especially adapted to disturbed sites. It has a strong seedling, fairly good drought resistance, and good winter hardiness (USDA Forest Service 1937; USDA Soil Conservation Service 1971b). It grows well with over 10 inches (25 cm) annual precipitation in aspen, mountain brush, ponderosa pine, big and black sagebrush, and pinyon-juniper types. Yellow sweetclover also does well in saline and alkaline soils and on many riparian sites (Plummer 1977; USDA Soil Conservation Service 1968, 1971b; Wasser 1982).

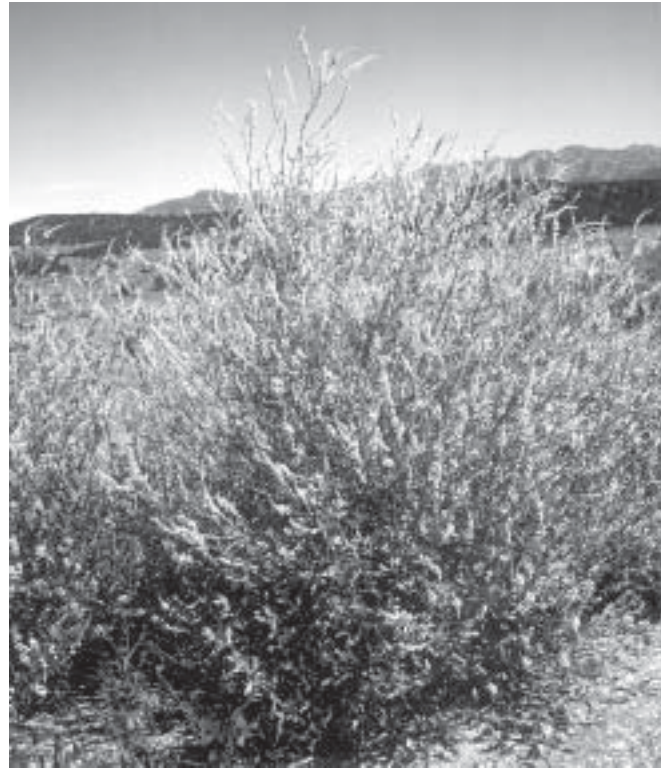


Figure 27—Yellow sweetclover.

Plant Culture

Seed production of yellow sweetclover is generally high. There are more than 250,000 seeds per lb (550,000 per kg). Germination is generally high, and good viability is retained for at least 2 years with warehouse storage. Adequate, inexpensive seed is generally available. Like most legumes, sweetclover seeds have a hard coat and are best seeded in the fall or winter. Seeds can lie dormant in the soil for years and then germinate when temperatures and moisture conditions are favorable. In central Utah, seedings more than 35 years old still retain some yellow sweetclover. Nichols and Johnson (1969) report that with 15 inches (38 cm) of precipitation, yellow sweetclover will reseed successfully. Seeds can be drilled or broadcast on relatively unprepared seedbeds. Best stand establishment occurs when seeds are planted 0.13 to 0.25 inch (3 to 6 mm) deep, preferably on a fairly firm seedbed.

Uses and Management

Yellow sweetclover is frequently seeded on Western rangelands (Rumbaugh and Townsend 1985). It is an effective erosion control species because it has an extensive, deep taproot system and a strong vigorous

seedling. It also produces a dense ground cover in 1 or 2 months and fixes nitrogen. Up to maturity, palatability is high for big and small game (Graham 1942; Kufeld 1973; Kufeld and others 1973; Mueggler and Stewart 1980; Plummer and others 1968; Rumbaugh 1984; USDA 1971b) and for livestock (Hermann 1966; USDA Forest Service 1937; USDA Soil Conservation Service 1971b), with forage quality reportedly higher than that of alfalfa (Magness and others 1971; Rumbaugh 1984). Waterfowl, upland game birds, and bees also use yellow sweetclover (Autenrieth and others 1982; Rumbaugh 1984; USDA Soil Conservation Service 1971b). The species has a very strong seedling that emerges in the spring, providing early succulence. Yellow sweetclover provides much needed live ground cover and forage during the critical first and second years. It can be seeded at 0.5 to 2 lb per acre (0.56 to 2.2 kg per ha), (Nichols and Johnson 1969; Plummer and others 1968; USDA Soil Conservation Service 1971b). Yellow sweetclover is generally seeded with perennials on disturbed sites. It furnishes initial cover and forage as slower developing herbs attain mature stature. It withstands heavy use and can reseed following fires or other disturbances.

Varieties and Ecotypes

There are three released varieties—'Goldtop', 'Madrid', and 'Yukon' (Wasser 1982). These varieties have not performed any better than the common seed sources. Most seed marketed is from uncertified common lots.

Family Boraginaceae

Mertensia arizonica

Tall Bluebell

Tall bluebell is the most widely distributed *Mertensia* in the Intermountain West (Higgins 1972; Mathews 1968). There are, however, other bluebells that are locally important (Hermann 1966). Different varieties of tall bluebell have been described, particularly from collections obtained in Utah (Cronquist and others 1984; Welsh and others 1987). Tall bluebell is a rhizomatous native perennial with a thick, woody root. It grows to a height of 2 ft (61 cm) and produces an abundance of pale blue to very dark blue flowers (fig. 28). Leaves are abundant and are borne on erect stems. Fruits are hard and consist of four nutlets (Cronquist and others 1984).

Ecological Relationships and Distribution

Tall bluebell occurs in fairly moist to well-drained soils in aspen, spruce-fir, ponderosa pine, and sub-alpine types, usually at elevations from 6,000 to

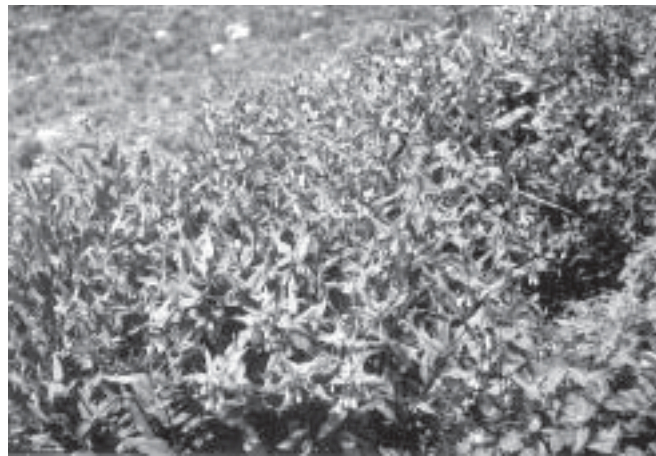


Figure 28—Tall bluebell in full bloom.

11,000 ft (1,800 to 3,400 m). The species can be found along streams in canyon bottoms, meadows, parks, and in scattered timber stands. It grows well in shade and open situations in pure stands as well as in mixed communities. Tall bluebell is present in all mountain regions of Utah, southwestern Wyoming, and northwestern Colorado (Cronquist and others 1984).

Plant Culture

Flowering occurs during midsummer. Seeds mature in September and can be collected by hand stripping, beating, and in pure stands with various types of combines. Germination is generally high (60 to 70 percent), with good viability being maintained for at least 5 years. Seeding is best accomplished in the fall on disturbed soil, with seed covered 0.25 to 0.5 inch (6 to 13 mm) deep. Tall bluebell can be seeded in mixtures with other herbs. It usually grows on fertile soils. When planted on disturbed, degraded sites it has not done well. Under good conditions, plants establish quickly and reach maturity in 3 to 5 years. Plants spread slowly by rhizomes, yet are very persistent and compatible with other native species when seeded in mixtures.

Uses and Management

Sheep, elk (Kufeld 1973), and deer (Kufeld and others 1973) seek tall bluebell and gain weight exceptionally well on the herbage. Cattle prefer the flower stalks but will make use of all plant parts (USDA Forest Service 1937). Sheep graze the herb whenever available. The bluebells are generally very showy and fairly easily seeded or transplanted, and are good soil stabilizers. Consequently, the plant is a good candidate for use in recreational areas, summer home sites, and areas with high aesthetic value and use. The plant furnishes such excellent forage that it should

be included in most seedings on adapted sites. However, the lack of sufficient seed currently curtails the use of this forb. This species has not done well if planted off site, particularly at lower elevations where it normally does not occur.

Newly seeded areas should not be grazed for at least 2 years. Large fibrous root systems, once established, allow tall bluebell to withstand periods of drought, grazing, and trampling. Concentrated use can occur if seedings are not properly managed.

Varieties and Ecotypes

There are no releases.

Family Fabaceae

Onobrychis viciaefolia

Sainfoin

Sainfoin (fig. 29) is a perennial, nonbloating, introduced legume that grows 1 to 3 ft (30 to 91 cm) tall, and produces white or pink to purplish pea-like flowers. Stems are semierect, originating from a branched root crown attached to a deep main taproot. Leaves are alternate, odd-pinnate and oblong to elliptic or oblanceolate (Rumbaugh and Townsend 1985; Welsh and others 1987).

Ecological Relationships and Distribution

Sainfoin was introduced into North America from Europe. It has been used primarily as a hay or pasture crop. However, the species demonstrates considerable usefulness for rangelands.

Sainfoin is adapted to sagebrush, pinyon-juniper, and mountain brush areas that receive at least 14



Figure 29—Sainfoin growing with crested wheatgrass and basin big sagebrush.

inches (36 cm) of annual precipitation. Sainfoin prefers well-drained, deep calcareous soils (Eslick 1968), exhibits fairly good salt tolerance (Jensen and Sharp 1968), and grows well in soils low in phosphorus (Rumbaugh and Townsend 1985).

Plant Culture

Single seeds are produced in pods and are marketed unshelled. There are about 26,000 unshelled seeds per lb (57,000 per kg). Unshelled seeds are best drilled, but can be broadcast if covered sufficiently. Seed should be covered at least 0.25 inch (6 mm) and not more than 0.75 inch (19 mm) deep (Jensen and Sharp 1968). Seeding is best done on a firm seedbed that is relatively weed free. For range seeding, it is best to seed in the fall. Seed should be inoculated with the proper rhizobium (Dubbs 1968). Seed is marketed with about 70 percent germination and 95 percent purity. When seeded in a mixture, about 2 to 5 lb per acre (2.2 to 5.6 kg per ha) is recommended. Seed can be stored up to 4 years without much loss of viability.

This species can be seeded individually or as a component of a mixture. A strong seedling is usually produced. Rate of growth following seeding is only fair on mesic sites. However, plants are quite persistent and hardy. Two years are required for flowering to occur under favorable conditions.

Uses and Management

Sainfoin is nonbloating and palatable to livestock, big game, and sage-grouse (Autenrieth and others 1982; Holder 1968; Rumbaugh 1984; Shaw and Cooper 1973; USDA Soil Conservation Service 1968a). Mule deer in Utah have been observed to prefer sainfoin hay over alfalfa hay. Sainfoin has a deep taproot and has wilt and drought hardiness equal to or slightly less than does 'Ladak' alfalfa (Dubbs 1968; USDA Soil Conservation Service 1968a). Some basal leaves remain green throughout most of the winter. Sainfoin starts growth early in the spring, usually prior to alfalfa. It continues to grow or remains green throughout the summer period. Once grazed or clipped, regrowth is limited. Characteristics that give sainfoin considerable potential in the Intermountain area as a forage crop include early greenup, cold and drought tolerance, nonbloating characteristics, high forage production potential, ability to grow with other species, and adaptation to calcareous soil.

Areas seeded to sainfoin should not be grazed for at least the first two growing seasons. Every 2 to 3 years, seed should be allowed to mature and seed naturally. Plants are persistent and withstand heavy clipping or grazing. Once established, this species also competes fairly well in mixed communities.

Varieties and Ecotypes

A number of improved varieties have been released, including 'Eski', 'Melrose', 'Nova', 'Onar', 'Remont', and 'Runemex'. All were released for cultivated pastures and for hay. 'Eski' is the most commonly seeded variety on ranges. This variety does well when seeded in upper pinyon-juniper, mountain big sagebrush, and mountain brush areas.

Family Umbelliferae

Osmorhiza occidentalis _____

Sweetanise

Sweetanise is an erect, perennial, aromatic native that grows up to 4 ft (1.2 m) tall (Welsh and others 1987) (fig. 30). Crushed leaves and seed give off a heavy licorice odor (Hermann 1966). It is a member of the umbel or carrot family and produces small umbels of yellowish-green flowers. Flowering occurs in May and June, and seed matures in September. Fruits are slender and sharp-pointed.

Ecological Relationships and Distribution

Sweetanise occurs from Western Canada south through Utah and Colorado. It grows well in shade, open areas, mixed communities, and in solid stands. Sweetanise prefers cool, moist woods, moist hillsides, valleys, and forest openings in aspen, spruce-fir, and subalpine types. It grows on basic, neutral, and slightly acidic soils.

Plant Culture

This species can be successfully established by direct seeding. Lack of a consistent seed source reduces seeding of this species. It establishes easily and spreads quickly from seed. Seeding is best completed in the fall. Seed should be covered, but not more than 0.25 inch (6 cm). Sweetanise does well seeded in mixtures. Seed is usually collected by hand, but dense stands can be mechanically harvested. Seeds are brittle and can be damaged during cleaning and seeding. Seeds can generally be cleaned by screening from harvested debris. There are about 30,000 seeds per lb (73,000 per kg). Seed should not be stored more than 2 years, or considerable loss in viability can occur. Thirteen year old seed is reported to exhibit 44 percent germination (Stevens and Jorgensen 1994). Seeds are large and usually must be drilled seeded to ensure proper soil coverage. Seeds are approximately the same length as some grass seed and can be planted in a mixture, depending on the species sown.



Figure 30—Sweetanise with mature seed.

Uses and Management

Cattle, sheep, and big game show a particular fondness for the foliage and for developing seeds of sweetanise (Hermann 1966; Kufeld 1973; Kufeld and others 1973; Plummer and others 1955; USDA Forest Service 1937). The plant is palatable and remains green throughout the grazing season. Consistent seed crops are produced yearly if seeds are allowed to mature before being grazed. Large, thick, woody roots allow the plant to withstand considerable use during dry periods. This species does not furnish a dense ground cover and is not recommended for erosion control. Heavy grazing can eliminate or reduce its density.

Seeded areas should not be grazed for at least 2 years following planting. A fairly strong seedling is produced, and the rate of growth is good. Seeds are generally produced the second year following planting. Maturing seeds are readily eaten by grazing animals. Some type of deferred grazing should occur to allow seeds to mature at least every 2 to 3 years.

Varieties and Ecotypes

There are no releases.

Family Scrophulariaceae

Penstemon palmeri _____

Palmer Penstemon

In North America there are over 200 native species of *Penstemon* (Hermann 1966; USDA Forest Service 1937). Many are short-lived herbaceous species

that spread readily by seed. A number are rhizomatous. Some penstemon are semievergreen, producing basal leaves that persist the entire year. They can be found in most vegetative types of Western North America.

Palmer penstemon (fig. 31) has long flowering stalks 20 to 55 inches (50 to 139 cm) tall with large showy pink blossoms that are produced in late spring and early summer. Seed matures in September. Flowers give off a pleasant fragrance that is unique among the penstemons, as they usually have little or no scent (Stevens and others 1985b).

Ecological Relationships and Distribution

Palmer penstemon is an evergreen native perennial that occurs in blackbrush, sagebrush-grass, pinyon-juniper, mountain brush, and ponderosa pine types of the Intermountain West. It is a fairly short-lived (4 to 5 years) pioneering species. Plants spread by seed. This species can be found growing on basic and acidic soils (Plummer 1977). It produces long seed stalks and an abundance of basal evergreen leaves that usually remain gray-green throughout the year. A large fibrous root system is produced. Palmer penstemon has considerable grazing tolerance and good drought tolerance.



Figure 31—Palmer penstemon in full bloom.



Figure 32—Broadcast seeding of Palmer penstemon on a roadside disturbance.

Plant Culture

Good results can be expected from drilled or broadcast seedings on disturbed soils and on raw and eroding sites (fig. 32) where it occurs naturally as an early invader. Seed can be drilled or broadcast onto disturbed soil, with covering not to exceed 0.15 inch (3 mm). Natural reproduction generally compensates for the short-life span of individual plants. Seed is generally produced in abundance. Some dormancy exists that allows seeds to accumulate in the soil until favorable conditions occur for germination and establishment.

Seeds of most penstemons, particularly Palmer penstemon, can be seeded in mixtures with most other herbs. Small vigorous seedlings appear early in the spring. They compete well and usually are not eliminated by competition from other species. When seeded heavily, considerable thinning or dieoff of young seedlings normally results. However, sufficient survival usually occurs to provide adequate stands. Palmer penstemon is particularly adapted to harsh situations and tends to dominate or establish on areas where other species fail. It is one of the few native broadleaf herbs that most consistently establishes from seeding. It is particularly important for its ability to establish and enhance the establishment of other plants on harsh sites.

All species of penstemon have small seeds that are easily cleaned to a purity that exceeds 90 percent. Palmer penstemon has 350,000 seeds per lb (770,000 per kg) at 100 percent purity. Seeds are so small that they are difficult to meter through most conventional drills. If seeded alone, a carrier is often used to regulate planting rates. Seeds can be mixed with seeds of most other species although some separation can occur in the seedbox. When seeded in mixtures, 1 to 3 lb per acre (1.1 to 3.4 kg per ha) are adequate.

Seeds can be collected by hand stripping or beating; pure stands can be combined. Seeds are cleaned by hammermilling and screening. Storage of up to 5 years has resulted in no significant loss in germination (Stevens and Jorgensen 1994). Seeds are being produced commercially.

Uses and Management

Palmer penstemon is eaten readily by deer and elk, especially during winter and spring months (Kufeld and others 1973; Plummer and others 1968). Basal leaves are green and succulent all year long. Cattle and sheep also make use of this species. The large, fibrous root system and large, succulent basal leaves provide considerable soil protection. This species is an early invader and does especially well on disturbed raw soils. Pink blossoms in late spring and early summer make this plant useful for beautification projects.

Because of seed dormancy, seeding should occur in the fall. Once established, stands are self-perpetuating. Seeded areas should not be grazed for at least two growing seasons following planting. Flowering and seed production often occur the second year following planting. This species has little shade tolerance, but grows as an understory with sagebrush. It is somewhat resistant to fire and trampling, but can be eliminated by excessive grazing.

Varieties and Ecotypes

'Cedar' was selected and released in 1985 (Stevens and others 1985b) for its wide area of adaptation, winter succulence, forage and seed production, and grazing preference by livestock and wildlife. 'Cedar' does well in blackbrush, salt desert shrub, sagebrush-grass, pinyon-juniper, and mountain brush types within the Intermountain region. Commercial seed is readily available and recommended for use.

Family Scrophulariaceae *Penstemon cyananthus*

Wasatch Penstemon

Wasatch penstemon (fig. 33) is a native perennial with bright semievergreen basal leaves. Plants develop from a primary taproot and produce several 2 to 3 ft (61.0 to 91.4 cm) long stems with deep blue to nearly purple flowers. Wasatch penstemon can be found on rocky soils, but is usually associated with more fertile, deeper soils that may be slightly acidic or basic. It occurs from the mountain brush type to higher elevations, including the subalpine zone. Flowering occurs from May through July. Seeds are formed in September. Seed processing and planting features are similar to those of Palmer penstemon and most other penstemons. Seeds are,



Figure 33—Wasatch penstemon in a mixed sub-alpine forb community.

however, somewhat larger with about 230,000 per lb (510,000 per kg) at 100 percent purity. This species is particularly important as a forage and cover plant, and establishes readily from artificial seeding. It persists under heavy grazing and can be seeded in mixtures with other herbs.

Family Scrophulariaceae *Penstemon eatonii*

Eaton or Firecracker Penstemon

Eaton or firecracker penstemon (fig. 34) is a bright red to scarlet-flowered perennial semievergreen native that occurs primarily on rocky soils. It occurs in



Figure 34—Eaton or firecracker penstemon.

mixed desert shrubs, sagebrush-grass, mountain brush, and aspen communities. This species forms a taproot. It is generally found on harsh, rocky sites; but it also occurs on more favorable sites. Seed collection, handling, and seeding techniques are similar to those described for Palmer penstemon. Seeds can be stored up to 12 years without much loss of viability (Stevens and Jorgensen 1994). Eaton penstemon is particularly useful for seeding in pinyon-juniper, mountain brush, and big sagebrush sites. It is not an abundant seed producer but establishes easily and is a useful forage species. Its brilliant flowers are extremely attractive and useful in landscape plantings. 'Richfield', a source-identified variety, has been released.

Family Scrophulariaceae

Penstemon humilis _____

Low Penstemon

This semievergreen native penstemon is a low-growing, 12 inch (30 cm) tall perennial forb with a matted, much-branched root system. Flowers are borne on short flower stalks and range in color from deep-blue to violet-blue. Foliage is light green. Low penstemon can be found in sagebrush-grass, pinyon-juniper, mountain brush, aspen, and subalpine communities, generally on gravelly, well-drained soils.

Planting procedures and seed collection are similar to those of other penstemons. This penstemon is eaten by wildlife and livestock and can be used to stabilize erosive sites.

Family Scrophulariaceae

Penstemon pachyphyllus _____

Thickleaf Penstemon

Thickleaf penstemon, as its name indicates, has broad, fleshy, thickened, bluish-green leaves covered with wax. Flowers are light purple to bluish-violet. Seeds are small with 335,000 per lb (739,000 per kg) at 100 percent purity. Seeds can be stored for up to 14 years without appreciable loss of viability (Stevens and Jorgensen 1994). Seeding requirements are similar to those of Palmer penstemon. This species occurs in eastern and northern Utah in salt desert shrub, sagebrush-grass, pinyon-juniper, mountain brush, and conifer communities. It is eaten by wildlife and livestock, and provides excellent soil protection.

Family Scrophulariaceae

Penstemon rydbergii _____

Rydberg Penstemon

This species occurs in mountain brush, aspen, coniferous forests, and open parklands on basic and acid



Figure 35—Rocky Mountain penstemon.

soils. Rydberg penstemon has a dark violet-purple flower and dark green basal leaves that are present throughout the year. It is highly sought by sheep and big game animals. Seed and seeding characteristics are similar to those of Palmer penstemon.

Family Scrophulariaceae

Penstemon strictus _____

Rocky Mountain Penstemon

This is a semievergreen penstemon that has an abundance of dark, shiny green leaves and blue to violet flowers borne on stalks 1 to 2.5 ft (30 to 76 cm) tall. Rocky Mountain penstemon (fig. 35) does well on rocky and sandy loam soils that range from weakly acidic to alkaline. This species does best with 15 to 20 inches (38 to 50 cm) of annual precipitation. Seeding and seed handling requirements are similar to those of Palmer penstemon. One variety, 'Bandera', has been released, and seed is being produced commercially. 'Bandera' was selected for its longevity and excellent forage and seed production. It is well adapted to mountain brush, ponderosa pine, and spruce-fir areas.

Family Rosaceae

Sanguisorba minor _____

Small Burnet

A member of the rose family, small burnet (fig. 36), is an introduced perennial with a basal rosette of pinnately compound leaves arising from a caudex and taproot. Numerous flowering stalks may grow from 2 to 20 inches (5 to 51 cm) in height. Flowers are



Figure 36—Small burnet.

formed in dense, terminal heads. Basal leaves remain green nearly the entire year. Growth starts in early spring, flowers appear in May and June, and seed matures in August and early September.

Ecological Relationships and Distribution

There are approximately 30 species of burnet, occurring primarily in Europe and the Middle East (Hermann 1966). Two species, western burnet and Alaskan burnet, are native to Western North America. They are locally valued as forage plants (Hermann 1966; Hitchcock and others 1961). Selections of small burnet from Mediterranean and Middle Eastern countries have been more widely adapted to sites in the Intermountain region than any of the Western North American species. Small burnet has proven to be well adapted to pinyon-juniper, basin big sagebrush, and mountain big sagebrush communities, and to drier exposures in the mountain brush and aspen types. Small burnet will grow well on acid or alkaline soils (Plummer 1977). The species is adapted to sandy and clay soils, with silty and loamy soils the most preferred (Wasser 1982). Small burnet has good winter hardiness and some fire and shade tolerance.

Introduction of *S. magnollii*, *S. dictyocarpum*, and *S. muricata* have exhibited characteristics similar to those of *S. minor* when grown on southwestern Idaho rangelands (Shaw and Monsen 1983a).

Plant Culture

Excellent seed production, high seed quality, and ease of seed processing and planting have contributed to the widespread use of small burnet. Aerial or hand broadcasting, drilling, and dribbling have all proven to be successful means of seeding. Seed needs to be

covered, but not more than 0.25 inch (6 cm) deep. Fall and winter seedings have proven to be the most successful. Because of the rapid rate of germination and seedling development, small burnet can usually be successfully established by spring seedings. Small burnet has been seeded widely throughout the West (Plummer 1977; Plummer and others 1970a,b; Stevens and others 1977). Following germination, growth is rapid, resulting in good ground cover within 1 or 2 years. A large amount of foliage and seed is usually produced, even during the first year of growth. Small burnet is an excellent species to seed in mixtures.

Seed lots of small burnet germinate between 80 and 95 percent, and retains high viability when stored for over 25 years (Stevens and Jorgensen 1994). Seeds undergo afterripening, with germination improving yearly up to 3 years following harvest (Stevens and Jorgensen 1994). There are 55,000 seeds per lb (120,000 per kg) at 100 percent purity. Seed is marketed at about 95 percent purity and 90 percent germination. Seedling emergence and establishment for small burnet is high (5 to 8 percent) compared to many other range species (Everett 1982).

Most plants appear to have a lifespan of 7 to 12 years, but some have persisted to 20 years (Plummer and others 1968; Stevens and others 1977b). Because seeds are readily eaten by rodents (Everett and others 1978b) and rabbits, little natural increase has occurred on many areas. Where seeds are allowed to mature and rodent and rabbit populations are low, reproduction will take place. Dense stands of small burnet have remained in some seedings for as long as 25 years. Vegetative propagation can be accomplished by dividing and transplanting the somewhat rhizomatous plants.

Uses and Management

Small burnet forage and seeds are highly preferred at all seasons by livestock, big game, rodents, and upland game birds (Autenrieth and others 1982; Wasser 1982). Birds and rodents also make considerable use of the seeds. Seed caches and resulting plants are common. Small burnet is particularly important in late winter, early spring, and late summer when other species provide less green forage. Plants produce an abundance of basal leaves that remain green and persist throughout the dry summer and winter months. Stand vigor and density may be reduced by selective grazing during these periods.

Once established, small burnet can compete fairly well with cheatgrass. This forb has done well on mountain brush, pinyon-juniper, and upper sagebrush sites. Although it exhibits useful attributes for the drier sagebrush and desert shrublands, it is not adapted to areas receiving less than 10 inches (25 cm) of moisture. Under favorable circumstances,

seedlings will establish when planted on dry sites. However, seedlings often fail if seeded when spring moisture is low. Mature plants are hardy and competitive and will persist, once established, on areas receiving 8 to 10 inches (20 to 25 cm) of moisture. Currently, some ecotypes express much better drought tolerance and longevity than most cultivated strains. These selections offer opportunity to expand the use of this forb to drier environments.

Seeded areas should not be grazed for at least 2 years following seeding. Because plants live from 7 to 12 years, every effort should be made to ensure that seed crops are not grazed and are allowed to mature every 3 to 4 years.

Small burnet can be seeded, grazed, and maintained in mixed grass and broadleaf herb plantings. Too often, the species is heavily grazed with livestock in the spring and early summer, and later grazed by game animals in the fall and winter periods. Use can be expected during any season as the plant retains some green foliage throughout the entire year. Rodents, insects, and game animals will forage on the plant whenever it is available. Consequently, livestock grazing must be regulated to compensate for wildlife uses. The plant should be seeded heavy enough to lessen concentrated use and satisfy animal needs.

If seeded in mixtures with perennial grasses, the species can diminish in density because it is short-lived. Competitive grasses and heavy grazing can prevent natural seeding. Sufficient plants have persisted on most wildlife plantings where livestock grazing has been controlled.

Varieties and Ecotypes

'Delar' small burnet was released in 1979. It is recommended for sites in the Intermountain region that receive at least 12 inches (30 cm) of annual precipitation. It will, however, establish and do fairly well with as little as 10 inches (25 cm) of precipitation. Forage production is excellent, even the first growing season. Under irrigation 'Delar' has produced up to 1,050 lb seed per acre (1,177 kg per ha) (Howard 1981).

Additional selections are being investigated. There are some selections that do well with as little as 7 inches (18 cm) of annual precipitation, but these strains are not commercially available.

Family Compositae

Senecio serra

Butterweed Groundsel

This native perennial is a member of the sunflower family. It grows in clumps of several stems 2 to 6 ft (0.6 to 1.8 m) tall and has a woody base. It produces

numerous yellow heads about 0.25 inch (1.0 cm) in diameter with black-tipped bracts (Welsh and others 1987). Flowering occurs in May to July.

Ecological Relationships and Distribution

A native in all Western States, butterweed groundsel (fig. 37) can be found in plant communities ranging from sagebrush to subalpine. Welsh and others (1987) describe two varieties with somewhat separate areas of occurrence. *Senecio serra* var. *serra* exists in the sagebrush, pinyon-juniper, mountain brush, lodgepole pine, and spruce-fir communities at 6,000 to 10,000 ft (1,800 to 3,000 m). *Senecio serra* var. *admirabilis* grows in ponderosa pine and subalpine meadow communities (Welsh and others 1987). Both varieties are early colonizers of disturbed sites and grow on sites ranging from open, dry slopes with sandy to gravelly loam soils to forest openings. Both varieties grow well in association with wheatgrasses, bromes, wildryes, and a large number of forbs.



Figure 37—Butterweed groundsel in full bloom.

Plant Culture

Seeds usually mature in September, and can be collected by hand stripping or by using small paddles to beat them into collection trays. Seeds are attached to a white pappus that should be removed to facilitate seeding. This can be accomplished by mechanical debearding and screening. Seeds are very small, with just under 3.5 million per lb (7.7 million per kg) at 100 percent purity and with the pappus removed. Seed is best broadcast planted unless the pappus is removed, after which seed can be drilled. Acceptable purity and germination is 50 to 70 percent.

This species does well when seeded in mixtures with other herbs because it has a fairly strong seedling. Fall seeding is preferred. Seed should not be covered more than 0.13 inch (3 mm).

Uses and Management

Butterweed groundsel is grazed extensively by sheep, cattle, and big game (USDA Forest Service 1937). It greens up early in the spring and retains a large amount of green growth late into the summer. It can tolerate considerable grazing, trampling, and drought. It persists well in partial shade and frequently remains green late in the season. Deer and elk (Kufeld 1973; Kufeld and others 1973) make good use of it in the spring and early summer. Cattle and sheep may forage on the entire plant late in the season when the leaves are partially dry. Because of its woody base and stout, fibrous, rhizome system, this species does an exceptionally good job of stabilizing disturbed soil. It can be used to plant both dry and wet sites, although it does not tolerate prolonged flooding. This species can be seeded in disturbed riparian sites where the water level has been lowered by down cutting of the channel. It establishes well from broadcast seeding and can be planted with a grass-forb mixture. Young plants persist well amid competition, but the plants are slow to attain maximum stature. Because it is slow to achieve dominance, it can be seeded with slower developing shrubs and trees without limiting their survival.

Young plantings are usually not adversely effected by grazing. Plants normally require 2 to 3 years to fully establish. When planted with a grass mixture, this forb persists equally well and does not require special management. Established stands should be allowed to set seed periodically.

Varieties and Ecotypes

There are no releases.

Family Compositae *Solidago canadensis*

Canada Goldenrod

A native perennial composite, Canada goldenrod (fig. 38) produces stems 1 to 6 ft (0.3 to 1.9 m) tall that grow from creeping rhizomes. Flowering occurs from July to October. Pale golden-yellow flowers occur along only one side of the curved flowering stalk. Basal leaves are deciduous or become withered at the time of anthesis (Welsh and others 1987).

Ecological Relationships and Distribution

Canada goldenrod occurs from southwestern Canada to New Mexico and California in pinyon-juniper, mountain brush, ponderosa pine, and aspen-spruce-fir types. It occurs along riparian areas, in moist places and forest openings, and on dry slopes. It grows on basic, neutral, and slightly acidic soils.

Plant Culture

Flowering occurs during midsummer, and seeds mature in October. Generally, an abundance of seeds are produced each year. Seeds are best collected by hand stripping or beating. The pappus can be removed from the seed using a debearder. Seeds are then separated from the debris with a screening type cleaner. The seed pappus is generally removed to facilitate seeding. Cleaned seeds can be drilled or broadcast planted. Uncleaned seeds can only be hand broadcast. Seeds should not be covered more than 0.13 inch (3 mm) deep. Good results can be expected



Figure 38—Canada goldenrod.

from broadcast seeding on prepared seedbeds and on disturbed or eroding soils. Once established, plants spread well from creeping rhizomes. Wildland collected seed lots are generally highly viable. Only fresh seed should be planted because viability declines with 1 year of storage. This species does well when seeded in mixtures with other herbs because it has fairly vigorous seedlings. More successful stands usually establish from fall seedings.

Uses and Management

Canada goldenrod is palatable to livestock and big game. Some use is made at most seasons. Plants green up early in the spring and remain green longer in the fall than most associated species. Canada goldenrod invades disturbed areas and provides an effective ground cover. It can be used to control erosion on extremely disturbed areas and is often used in watershed plantings. This species can be used to beautify recreational areas, summer home sites, administrative areas, and other areas with high aesthetic value. It is adapted to semiwet situations and can be used to treat riparian disturbances where dry and semiwet sites are closely aligned. Canada goldenrod establishes well by transplanting and can be used to provide immediate ground cover. It persists with heavy trampling and grazing disturbances.

Canada goldenrod usually occurs in aspen and conifer forest communities. It recovers well following burning, logging, and grazing. Established stands should be allowed to set seed periodically. Newly seeded stands should not be grazed for at least 2 years following planting.

Varieties and Ecotypes

There are no releases.

Family Malvaceae

Sphaeralcea grossulariifolia _____

Gooseberryleaf Globemallow

There are approximately 200 species of globemallow; about 20 are native to Western North America (Hermann 1966). A member of mallow family, the genus is variable and complex, and its taxonomy has been extensively revised (Jefferies 1972; Kearney 1935; Welsh and others 1987). Gooseberryleaf globemallow (fig. 39) is a densely, gray-green, pubescent perennial. Leaves are gooseberry-like. Floral stalks grow from 1 to 2.5 ft (30 to 76 cm) tall. Plants develop a branched taproot, and a near-surface fibrous root system. Flowers have showy orange to reddish petals (Hitchcock and others 1961). Flowering occurs from May to July, and seed matures unevenly from June to August.

Ecological Relationships and Distribution

This species is a drought-tolerant native forb that occurs in blackbrush, shadscale, rabbitbrush, sagebrush, and pinyon-juniper communities, and occasionally in the mountain brush zone on sites receiving 8 to 12 inches (200 to 300 mm) of annual precipitation (Stevens and others 1985c). It is common on disturbed and burned pinyon-juniper sites (Everett 1982; Plummer and others 1968). It ranges throughout the West from Washington to Arizona (Welsh and others 1987).

Gooseberryleaf globemallow prefers full sunlight. It exhibits good winter hardiness, grazing tolerance, resistant to burning, and considerable drought resistance. Gooseberryleaf globemallow is found in alkaline soils and tolerates moderate salinity, but not sodic soils (Pendery and Rumbaugh 1986).

Plant Culture

Gooseberryleaf globemallow can be established on harsh sites. It is one native forb that has been successfully seeded in blackbrush, shadscale, pinyon-juniper, and sagebrush communities and in disturbances with basic soils (Monsen and Plummer 1978; Plummer 1966, 1977).



Figure 39—Gooseberryleaf globemallow.

Seeds can be collected by hand or with mechanical strippers. They are easily cleaned. There are just over 500,000 seeds per lb (1.1 million per kg) at 100 percent purity. Seeds should be dusted with an appropriate insecticide to prevent destruction by weevils (Pendery and Rumbaugh 1986). Seed viability is, however, maintained for up to 15 years without any significant loss (Stevens and Jorgensen 1994). Page and others (1966) reported that low germination results from a combination of low fill and a hard seedcoat impregnated with nonwettable substances. Mechanical or acid scarification can increase germination. It can be seeded on disturbed and burned pinyon-juniper areas. Because the species has fairly strong, competitive seedlings and a moderate growth rate, it can be seeded in mixtures with other species. Fall and winter seeding is recommended (Monsen and Plummer 1978). Seeds can be drill seeded and should be planted at depths of 0.25 inch (6 mm). Seeds may lie in the soil for years and germinate when conditions are suitable (Plummer and others 1968). This species can be successfully transplanted and will reproduce from stem cuttings (Everett 1982).

Uses and Management

Forage value of gooseberryleaf globemallow is rated as good for sheep and cattle (Hermann 1966; Wasser 1982). Preference or palatability is rated as none to fair for cattle and sheep (Hermann 1966), and fair to excellent for antelope (Hancock 1966; Smith and Beale 1980), elk, and deer (Kufeld 1973; Kufeld and others 1973; Urness and McCulloch 1973). Antelope especially prefer this herb when it is flowering (Pendery and Rumbaugh 1986). Protein content during winter and early spring has been found to be high, ranging from 10 to 20 percent (Pendery and Rumbaugh 1986; Urness and McCulloch 1973). Gooseberryleaf globemallow greens up early in spring and will green up again in autumn after fall storms.

This species establishes well on disturbed sites from seed or from transplanting. Because of its drought resistance, continuous, colorful flowering, and ease of establishment, this species has been recommended for use in dryland ornamental landscaping (Natural Vegetation Committee 1973). Gooseberry globemallow is quite competitive and can be used to suppress cheatgrass and other annuals. It is one of only a few native herbs that can be seeded on low elevation Wyoming big sagebrush and shadscale sites.

Following germination gooseberry globemallow produces strong and persistent seedlings. It has a deep taproot. Plants are tolerant of grazing, but can be weakened by close grazing in late spring. Drought tolerance is excellent, but plants should not be grazed following extended periods of drought. Plant density tends to fluctuate from year to year.

Varieties and Ecotypes

There are no releases.

Family Malvaceae *Sphaeralcea coccinea*

Scarlet Globemallow

Scarlet globemallow (fig. 40) is a low-spreading, native perennial with creeping rhizomes (Arnow 1971; McKell and others 1979; Welsh and others 1987). It prefers clay soils and can be found on hills and dry plains in blackbrush, shadscale-greasewood, sagebrush, pinyon-juniper, mountain brush, and ponderosa pine communities from Southern Canada to Texas and Arizona (Hermann 1966; Welsh and others 1987).

Scarlet globemallow exhibits considerable drought resistance, and establishes especially well on disturbed sites. This species can be successfully seeded or transplanted in blackbrush, shadscale, black greasewood, sagebrush, and pinyon-juniper types. It is particularly useful for planting on disturbed sites, as it is drought tolerant and can spread by rhizomes. It is well suited to adapted sites where wildfires frequently occur.

Palatability for livestock and big game is rated from poor to good (Hermann 1966; Kufeld 1973; Kufeld and others 1973; McKell and others 1979; Wasser 1982).

Varieties and Ecotypes

There is one released germplasm, 'ARS 2936'.



Figure 40—Scarlet globemallow.

Family Fabaceae

Trifolium

Clovers

Taylor (1985) reported that about 250 species of true clovers occur throughout the world. All species possess the typical papilionaceous legume flower with 10 stamens. Leaves usually consist of three leaflets. Most have simple taproots; some produce stolons or rhizomes. About one-third are perennials and the others are annuals. About one-third are self-pollinated; the others are cross-pollinated and require bees for pollination (Taylor and others 1980). All species are able to fix nitrogen if nodulated with strains of *Rhizobium* (Allen and Allen 1981).

Within the contiguous United States, clovers are most important as range plants from the Rocky Mountains west to the Pacific Coast (Crampton 1985). Approximately 65 species occur in the Western States. Most species, particularly many annuals, are abundant in the central valley of California (Crampton 1985; Küchler 1977).

Although native perennial clovers are found abundantly throughout the mountains, meadows and wetlands of the Intermountain area, and to a lesser extent in the drier sagebrush habitats (Crampton 1985), few natives have been utilized in range revegetation efforts. Most clovers of agricultural interest were introduced from Europe. There are about 15 species that are used in North America (Hermann 1953; Hollowell 1960). Most are adapted to temperate climates and are used to improve irrigated or native meadow pastures. Because they are legumes, clovers are particularly useful in fixing atmospheric nitrogen and enhancing soil fertility. A cool, moist climate is required for the best growth (Taylor 1985). Spring and fall periods are favorable for adequate growth in the Intermountain area. Various species demonstrate usefulness on a variety of sites, and future trials will undoubtedly result in more widespread use of different clovers.

Most clovers are quite palatable, shade tolerant, and tolerant of flooding for short periods. Consequently, they are useful for seeding semiwet meadows, and as understories in conifer forests and aspen stands. All species attract use by wildlife and can be planted to supply forage for extended periods. Most species demonstrate good regrowth and, thus, withstand heavy grazing.

Seeds are small and include a high percentage of hard seeds. Seeds should be treated with an inoculum to assure establishment.

Family Fabaceae

Trifolium fragiferum

Strawberry Clover

Strawberry clover was introduced to the West from Eurasia and the Mediterranean region (Forde and others 1981). It is not known when it was introduced into the United States, but specimens were collected in 1878 in Pennsylvania.

Strawberry clover is a low-growing stoloniferous perennial used primarily as a pasture legume (Townsend 1985). Stems are decumbent to creeping and root at the nodes. Plants are less than 10 inches (25 cm) tall. White to pink flower heads are borne at the ends of each seed stalk (Gillett 1985; Harrington 1964; Hermann 1966). The flower and seed head resemble a strawberry—hence the name. Plants are pubescent or glabrous. The leaves are congested on auxiliary peduncles that are curved and ascending (Bendixen and others 1960).

Ecological Relationships and Distribution

Strawberry clover has spread or been seeded throughout North America and has become naturalized in some locations (Townsend 1985). It is noted for its ability to grow on wet saline or alkaline soils and has demonstrated adaptability to wet meadows, streams, and seeps. Bendixen and Peterson (1962) report that strawberry clover withstands flooding because the stolons exhibit a tropic response that causes the tips to be elevated above the water level. Light, oxygen deficiency, and atmospheric conditions also influence the tropic response.

Strawberry clover is not hindered by wet-saline conditions; consequently, it is very useful on many seeps and salty sites at a wide range of elevations. Seedlings are not suppressed by high osmotic conditions that depress the growth of white clover (George and Williams 1964).

Plant Culture

Strawberry clover can be drill or broadcast seeded on a prepared seedbed. Seed coverage should be shallow, less than 0.25 inch (6.4 mm). When seeding irrigated pastures, a planting depth of about 0.50 inch (13 mm) is recommended (Townsend 1985). Seeds are small with about 290,000 seeds per lb (650,000 per kg) at 100 percent purity. They require planting into a firm seedbed. Evers (1982) found that drill seeding

produced only slightly higher yields than broadcasting. Seeding rates vary depending on seeding methods, but acceptable stands are achieved with 6 to 8 lb per acre (6.7 to 9.0 kg per ha) when seeded alone, and 2 to 4 lb per acre (2.2 to 4.5 kg per ha) when planted in a grass mixture.

Strawberry clover seedlings are easily established and grow rapidly. The plant establishes well with minimal seedbed preparation. Successful stands establish from broadcast seeding and natural spread. This clover does well when seeded in mixtures with grasses. When planted in mixtures under irrigation, herbage production can be increased and better distributed throughout the growing season (Peterson and others 1962).

Uses and Management

Forage and seeds of strawberry clover are used extensively by livestock, big and small game, and upland game birds.

Strawberry clover is especially well suited to close and continuous grazing (Raguse and other 1971), and when seeded on most rangeland sites, tends to attract heavy use. In vitro digestibility compares favorably with white clover, red clover, and alfalfa (Reed and others 1980).

This forb can be successfully seeded onto depleted riparian habitats, degraded meadows, and inland saltgrass areas. It can be used to stabilize streambanks, erodible soils, and related disturbances. It is particularly useful for seeding disturbances on saline soils and sites subjected to frequent periods of flooding.

Varieties and Ecotypes

No selection or cultivar has been developed for rangeland uses, although various cultivars have been developed for pasture seedings in the United States (Peterson and others 1962).

Family Fabaceae

Trifolium hybridum _____

Alsike Clover

Alsike clover is a native of northern Europe that was introduced into the United States in about 1839 (Townsend 1985). It was thought to be a hybrid of red and white clover—hence its species name “hybridum”. It is well adapted to high elevations within the Intermountain region where conditions are cool and moist. It is a short-lived perennial, but can be managed to reseed and maintain itself. Alsike clover is an excellent hay and pasture species (Townsend 1985), but is also useful as a range forage species. It is adapted to sites that are too wet or acidic for red clover or alfalfa (Townsend 1985). Plants establish well from either

spring or fall plantings. Drilling or broadcast seeding on a firm seedbed is recommended. Planting with grasses to improve forage productivity is a common practice (Grable and others 1965).

Seeding in mixtures at a rate of 2 to 4 lb per acre (2.2 to 4.5 kg per ha) produces excellent stands. There are approximately 68,000 seeds per lb (150,000 per kg). Seeds have a hard seedcoat, but this does not prevent good establishment even from spring seedings.

No cultivars have been developed for rangeland conditions in the United States, but two Canadian cultivars, ‘Aurora’ and ‘Dawn’, have been developed for pasture plantings.

Family Fabaceae

Trifolium pratense _____

Red Clover

Red clover is perhaps the most widely used pasture clover in the United States. It is generally grown in mixtures with grasses for intense pasture management. It is also grown for hay or silage production, or as a soil improvement crop. Plants produce nitrogen that favors growth of companion species and improves soil conditions (Smith and others 1985).

Red clover can be used as a short-term perennial or winter annual to furnish immediate forage and improve soil fertility. It requires 20 or more inches (51 cm) of annual precipitation, but it is well suited to cut over timber lands and moderately acid soils (Hafenrichter and others 1968). It can be used to improve meadows and degraded riparian sites.

Hafenrichter and others (1968) reported that the commercial varieties—‘Kenland’, ‘Pennscott’, ‘Dollard’, and ‘Lakeland’ are well adapted to conservation plantings in the Northwest. None have been extensively evaluated for range sites in the Intermountain area.

Family Fabaceae

Trifolium repens _____

White Clover

White clover is a shallow rooted perennial with creeping stems that root at the joints. This introduced European species has become naturalized in North America in fairly moist areas on medium and high elevation mountain ranges. White clover is winter hardy and can withstand more extreme temperatures than either red or alsike clover (USDA Forest Service 1937). Livestock and wildlife make good use of this species. Areas of adaptation include sites with fertile and well-drained soils that are moist throughout the growing season, and along streams. It has good soil stabilization characteristics. White clover is generally seeded in a mixture with perennial grasses.

Family Compositae

Viguiera multiflora var. *multiflora* —

Showy Goldeneye

There are about 150 species of *Viguiera*. Most species occur in the new world (USDA Forest Service 1937). Two varieties of goldeneye, showy goldeneye and Nevada goldeneye, occur within the Intermountain region (Welsh and others 1987).

Showy goldeneye (fig. 41), a member of the sunflower or compositae family, is a perennial native forb growing from a short, branched, woody taproot. It is usually 1 to 3 ft (30 to 91 cm) high with leaves commonly more than 0.25 inch (6 mm) wide and 0.50 to 0.75 inch (12 to 19 mm) long. Two or more showy, yellow, sunflower-like blossoms (heads) are borne on each plant. Flowering begins in July. Seed matures in late August and September. Basal leaves elongate and green up shortly following snowmelt (Welsh and others 1987).



Figure 41—Showy goldeneye.



Figure 42—Showy goldeneye in an aspen opening.

Ecological Relationships and Distribution

Showy goldeneye is a very attractive perennial, that occurs throughout the Intermountain West at elevations between 3,500 to 11,000 ft (1,100 to 3,400 m) (Stevens and others 1985c). Showy goldeneye can be found from moderately moist habitats to dry, open, rocky slopes in sagebrush-grass, pinyon-juniper, mountain brush, aspen (fig. 42), spruce-fir, subalpine, and often in riparian communities (Welsh and others 1987).

This species is not restricted to full sunlight, but can be found in partial shade and in densely wooded areas (Arnow 1971; Plummer and others 1955). Showy goldeneye can be found on a wide variety of soils ranging from heavy clays to gravel (USDA Forest Service 1937), and from acidic to basic conditions (Plummer 1977). It establishes quickly on disturbed sites, has a rapidly developing seedling, and competes well with annuals and perennials.

Plant Culture

Each showy goldeneye plant can support numerous, golden yellow, sunflower-like heads that generally produce an abundance of seeds. Seeds are collected by hand, mechanical beating, or stripping. Viability of wildland lots is only fair. Seed can be stored up to 7 years without any major loss in viability (Stevens and Jorgensen 1994). There are just over 1,000,000 seeds per lb (2.2 million per kg) at 100 percent purity.

Showy goldeneye develops strong seedlings. Plants establish quickly, and can spread from seed. Showy goldeneye will invade disturbed sites and may quickly become the dominant species. Seeds can be broadcast or drilled with equal success. Seeds should not be planted more than 0.25 inch (6 mm) deep. Seeding is best accomplished in the fall or winter. The species does well when planted as a component of a mixture (Stevens and others 1981b).

Principal Areas of Use

Showy goldeneye is an early spring-greening forb that is sought by big game (Kufeld 1973) and livestock. Foliage and flower heads are readily consumed by cattle, sheep, deer, and elk. Birds also make considerable use of the seeds.

Strong seedlings and a rapid rate of growth enable showy goldeneye to be seeded in conjunction with other species. These features also contribute to its establishment and spread into annual communities.

Profuse flowering of this species makes it a prime candidate for summer home sites, campgrounds, administration sites, and other areas with high aesthetic values. This species has potential as an erosion control species on disturbed and burned sites.

Newly seeded areas should not be grazed for at least 2 years following planting. Established stands should be allowed to set seed every 3 to 4 years.

Varieties and Ecotypes

There are no releases.

Family Compositae *Viguiera multiflora* var. *nevadensis* _____

Nevada Goldeneye

Compared to showy goldeneye, Nevada goldeneye has narrower leaves (usually less than 5 mm wide) and can be found on drier sites in southwestern Utah, Nevada, and California. It occurs with pinyon and juniper, Wyoming and basin big sagebrush, black sage, and various saltbushes. Plummer (1966) recommends it as a candidate species to be used in seeding areas in the salt desert shrublands. Coles (1982) reported that Nevada goldeneye rapidly invaded Wyoming and basin big sagebrush burns in southwestern Utah. He further reported that mule deer tend to seek out and concentrate on areas with high densities of Nevada showy goldeneye. The species invades roadsides and other disturbed areas. Seed production and seeding procedures are similar to those described for showy goldeneye.