

APPENDIX A

Description of selected plant species used in reclamation.

Needlegrasses Green needlegrass (*Stipa viridula*);

Needleandthread (*Stipa comata*).

Characteristics: Needleandthread - cool-season bunchgrass.

Uses: Wildlife: Green needlegrass - good forage; one of the first grasses of its associations to start spring growth and remain green until mid summer, thus supplying forage over a long period (Hassell and Barker 1985). Needleandthread - forage value varies among regions, at different seasons, and with plant associates (Hassell and Barker 1985). It is valuable because it greens up and produces new growth in summer and fall with sufficient precipitation; but it is considered only fairly good for spring and fall grazing compared to other grasses, because of coarseness and its leaves toughen early. The long awns and sharp-pointed seed may be mechanically injurious to grazing animals (especially sheep).

Adaptation: Green needlegrass is found from low elevations in the Northern Great Plains up to 2,730 m in Wyoming and Montana. It thrives on clayey soils and fractured shale of bottomlands, flats, and benches; it is less common on loams and sandy soils (Hassell and Barker 1985). It also thrives in pioneer succession on coarser textured, disturbed soils. It grows native on overflow, silty, and clayey sites (Thornburg 1982). Moderately tolerant of flooding and short-term submergence; drought resistance is nearly equal to western wheatgrass, but less than blue grama (Wasser 1982). Green needlegrass is extremely winter hardy; weakly tolerant of shade; is tolerant of moderately alkaline soils and is weakly to moderately tolerant of soil salinity (Hassell and Barker 1985).

Needleandthread - common on dry, sandy, or gravelly plains, mesas, and foothills, and sometimes extends into mountains up to elevations between 1,210-2,575 m.

Establishment: Diverse species of *Stipa* are generally characterized by highly dormant seeds.

Green needlegrass - practical methods so far include using aged seed and planting in the late fall (Hassell and Barker 1985).

Indian ricegrass (*Oryzopsis hymenoides*)

Characteristics: Perennial bunchgrass; particularly adapted for winter forage, it does best when harvested in fall and winter (Hassell and Barker 1985). Highly palatable to wildlife and all classes of livestock; it cures exceptionally well and provides nutritious winter feed.

Uses: Wildlife - forage. Reclamation - appears suited to sites where sterile coarse materials are available for a seedbed after surface mining; however, few, if any breeding programs focus on Indian ricegrass as a primary species.

Adaptation: Widely adapted on arid lands over most of western rangelands, it grows on high southerly exposures and on desert floors in association with shadscale and winterfat (Hassell and Barker 1985). Occurs on sand dunes, sandy plains, canyons, hillsides, foothills, exposed ridges, and dry sandy, rocky, or shale mountain sites (Hafenrichter et al. 1968). Occurs at elevations between 610 and 3,050 m. Has many different ecotypic populations which are somewhat site specific.

Establishment: Strains generally show improved germination in 3 to 4 yr old seed (Hassell and Barker 1985).

Management: It will benefit from livestock use if it is moderately grazed in the winter and early spring. However, livestock should be removed while there is still enough moisture to allow recovery, growth and seed production. Stands deteriorate rapidly under spring grazing.

Seed Production: Seeds mature early and are subject to shattering. Indeterminant maturity makes seed harvest difficult.

Alfalfa

Characteristics: Roots readily reach water tables 10 to 15 ft below ground, forage is highly productive (Lorenz et al. 1982). Many varieties of alfalfa vary greatly regarding resistance to disease and insects, winter hardiness, drought hardiness, tolerance of grazing, and rooting habits. Prostrate and decumbent cultivars developed for pasture yield less herbage, but generally withstand grazing better and maintain stands better under particularly dryland grazing conditions (Heinrichs 1975).

Uses: Nutritious forage for wildlife and livestock. Commonly used for hay production and for pasture on mesic sites and on irrigated and subirrigated lands with good drainage (Lorenz et al. 1982).

Adaptation: Well adapted to seeding with grasses. Lowe et al. 1972 characterized recommended alfalfa cultivars (for grazing) as having 1) low-set crowns, 2) a procumbent growth habit, 3) drought tolerance 4) marked fall dormancy, 4) slow recovery from cutting, and 6) high degree of winter hardiness. Berdahl et al. (1986) concluded desirable traits for alfalfa to survive dryland grazing are slow regrowth after grazing and dormancy during long dry and cold.

Silver sagebrush (*Artemisia cana* Pursh)

Characteristics: Small, evergreen shrub, grows in cool season, but flowers in the warm season (Wasser 1982). Plants produce shallow to deep, well-branched roots, sprouting at the base; some plants layer and some are rhizomatous. Species highly aromatic.

Uses: Wildlife - forage with good palatability to deer, elk, and antelope, especially in winter and when snow covers low growing vegetation (Beetle 1960; Eddleman 1977).

Adaptation: Species commonly occurs on most soil texture classes, except dense clays; probably more vigorous in medium-textured soil (Wasser 1982). Tolerant of weakly acid to moderately basic and weakly saline soils. Tolerant of imperfect drainage, high water tables, and flooding; tolerance varying somewhat by subspecies but some forms quite tolerant. Good drought tolerance, but species generally requires more moisture than big sagebrush. Strong winter hardiness. Be certain of adaptation before using plant material from habitats differing much from planting site. Somewhat intolerant of shade. Good tolerance of close grazing and injury or severing of stems due to sprouting habit.

Establishment: Plant seed on the surface or very shallowly; better germination reported with light (Wasser 1982). Hardwood cuttings, cultured in greenhouse and hardened before out-planting on surface mined soils, gave better stands and survival than direct seeding in Wyoming-Colorado investigations and were more tolerant than other species to wildlife browsing (Booth and Schuman 1981).

Management: Reduce competition in preparing a seedbed and protect from grazing during seedling establishment (Wasser 1982). May be advantageous to plant sagebrush and grasses in separate or alternate rows, strips, or patches.

Fringed Sagebrush (*Artemisia frigida*)

Characteristics: Native; cool season half-shrub; perennial, but stems are annual and spread from woody base; moderately deep taproot; generally low-growing, but may reach 46 cm (Soil Conservation Service 1988).

Uses: Wildlife - it is a fair plant for deer and antelope, fairly nutritious in winter; has good erosion control characteristics; is valuable in high altitude revegetation projects (adapted to high elevations and can establish on infertile soils) (Soil Conservation Service 1988).

Adaptation: Flowers in late summer or fall; resumes growth very early in spring; common to areas receiving 31-41 cm of annual precipitation; soils - coarse to medium textured, well-drained, dry, and somewhat rocky; tolerant of weakly acid, weakly saline, or moderately basic soils (Soil Conservation Service 1988).

Establishment: Best when shallowly seeded in areas receiving adequate moisture (receive snowmelt); seed at depths equalling four times the seed diameter and at 20-30 PLS per square foot (Soil Conservation Service 1988). Other species in the mix should be non-competitive.

Seed Production: Seed has been harvested from native stands, but cultivation and management techniques are still being developed (Soil Conservation Service 1988).

Black sagebrush (*Artemisia nova*)

Characteristics: Semievergreen; persistent leaved, aromatic, low shrub (Wasser 1982).

Moderately deep and extensive, well-branched, generalized root systems. New growth resumes in late April.

Uses: Wildlife - forage with fairly good palatability, particularly to deer and antelope (Wasser 1982). Species optionally included in seed mixtures for revegetating big game ranges in shadscale and mountain brush types. Shows potential for use in stabilizing disturbed lands and revegetating livestock ranges.

Adaptation: Common on relatively shallow, rocky, and sometimes calcareous soil/sites, usually in well-drained, medium-textured soils (Wasser 1982). Intolerant of wet sites and shallow water tables. Strong drought tolerance; poor grazing tolerance associated with palatability and weak sprouting habit. Established plants exhibit good competitiveness, indicating fair compatibility with most associates (Beetle 1960; Thornburg 1982; Plummer et al. 1968).

Establishment: Plant achenes 0.6 cm deep. Under ideal growing conditions 1 to 2 PLS per square foot should prove adequate on rangelands (Wasser 1982); 10 to 20 PLS per square foot (1/2 to 1 lb PLS per acre) might be adequate drill rates for full stands on average rangeland sites. Higher rates are needed when broadcasting and when seeding severe, erosive, and critical sites. Plant either in late fall and winter or use seed pretreated to enhance germination (i.e., placed in moist blotters at 32 to 38 degrees F for 10 days) in spring (Plummer et al. 1968; Deitschman 1974).

Management: Remove competing vegetation prior to or when planting seed or plants. Protect from grazing during seedling establishment.

Seed Production: Heads in July, flowers in September, and fruit matures in October in Wyoming (Wasser 1982).

Big sagebrush (*Artemisia tridentata*)

Characteristics: Small to medium-sized; cool season, evergreen shrubs (Wasser 1982); polymorphic species with several subspecies and forms.

Uses: Wildlife - forage; nesting cover and/or food for sage grouse and small mammals.

Adaptation: Species variably adapted to moderately deep, well-drained, near-neutral, salt-free soils (Wasser 1982). Wyoming subspecies on shallower, lower slope or foothill benchland sites with thinner, variably coarse to fine-textured soils in intermediate precipitation zones, but often drier due to shallow and exposed soil/sites (Wasser 1982).

Species highly drought-resistant, less so in seedling stage (Wasser 1982).

Establishment: Either broadcast seed on the surface or plant at very shallow depth of about 0.6 cm. Seeds germinate within 4 to 30 days or longer (Wasser 1982).

Management: Prepare seedbed and reduce competition before or during seeding, protect from grazing, and control aggressive weedy growth where feasible during establishment.

Fourwing saltbush (*Atriplex canescens*)

Note: Although fourwing does well in the first few years of establishment here in Wyoming, it tends to die out after 5-6 years. Thus its use is discouraged.

Characteristics: One of the most widely distributed and important native shrubs on rangelands in the West and across the Great Plains, its range extends from below sea level to above 2,440 m (Soil Conservation Service 1988). It is extremely variable (Stutz and Carlson 1985), for example it varies from deciduous to evergreen, depending on climate (Soil Conservation Service 1988). Fourwing has stout stems. Resistance of young seedlings to insects and disease is poor and tolerance to shading is only fair.

Uses: Wildlife: provides browse for deer, antelope, and elk as well as food and cover for sharp-tailed grouse, gray partridge, other upland game birds, rabbits, songbirds, and various small mammals (Soil Conservation Service 1988). It provides nutritious winter forage on many areas. Reclamation: important, provides a shrubby species to increase species diversity.

Adaptation: adapted to most soils but is best suited to deep, well-drained loamy or sandy soils; will grow on dense clays; is more tolerant of saline conditions and less tolerant of sodic soils (Soil Conservation Service 1988); and does well on rockier soils (Redente et al. 1980). Under saline conditions, plants take up salts and accumulate them in their scurfy leaf coverings - the salt is later washed off the plants by precipitation (Soil Conservation Service 1988). This species has considerable tolerance to boron; does not tolerate high water tables; is extremely drought resistant and has fair shade and fire tolerance. Its ability to withstand extreme cold varies with the ecotype.

Fourwing grows in areas with 20-38 cm of annual precipitation and can be found at elevations up to 2,590 m.

Establishment: begins growth in spring and early summer; fruit matures 3 to 4 months after flowers have formed; spreads by seed but may also root sprout or layer (Soil Conservation Service 1988). Stands may take 3 years to establish, but once established the plants are moderately competitive and compatible with other species. Fourwing can also be established by transplanting in the spring, direct seeding, or by stem cuttings. An adapted cultivar or local seed

should be used to ensure an ecotype compatible with the site. Seed should be after-ripened for 10 months and dewinged before planting. On moist, fine soils seed should be planted 1/2 to 3/4 in deep; on drier or coarser soils, 3/4 in is adequate. Seeding rates of 1/2 to 5 lbs per a is recommended for rangeland seedings. Dewinged seed is preferred for easier control of planting depth. There is no prechill requirement and seeding can take place in spring, midsummer, late fall or winter, depending on ecotype. Seedling vigor is outstanding.

Management Considerations: A winter grazing of deferral system is recommended once the stand is established (Soil Conservation Service 1988). Rabbits, rodents, and grasshoppers can do damage to a stand. The branches are brittle and trampling by livestock may also injure plants. Proper use for browse is approximately 50% of the current years growth. Damaged plants recover if rested, but production decreases until recovery is complete. Maximum plant performance is better maintained if it is used as winter forage only, but it can be grazed from late spring through the growing season into winter. When eaten liberally by livestock, it can cause bloat and scours.

Seed Production: Seeds are harvested in late October or November by shaking or hand stripping into bags, baskets, or onto canvas (Soil Conservation Service 1988). Seed can also be harvested using a backpack vacuum. The newly harvested seed is stored in a cool, dry place. About 10 months after-ripening is required following harvest before the percent germination can be determined. De-winging is recommended just prior to planting; if done before, it can hasten after-ripening and may result in shorter viability. Seed is dewinged by running through a hammermill (1500 rpm) equipped with a 1/4-in screen, then by running through a fanmill to the desired grade.

Shadscale (*Atriplex confertifolia*)

Characteristics: native; low-growing, somewhat spiny shrub often found on saline or alkaline soils; cool season perennial; deciduous leaves; forms round clumps with erect, spiny stems and branches; deep taproot (Soil Conservation Service 1980).

Uses: Wildlife - used by antelope, deer, small mammals and birds as forage and cover (Soil Conservation Service 1988). The seed is also consumed by small mammals and birds.
Reclamation - its adaptation to thin soils and its ability to persist under severe growing conditions makes it a good species for reseeding disturbed soils.

Adaptation: does well on nearly all soils including alkaline, does better on clayey textures and does not do well on sandier sites (Soil Conservation Service 1988). Shadscale begins growth in late spring and seeds mature in late fall. It grows primarily on dry slopes, flat areas, ridges, and valley bottoms. It is one of the most drought tolerant shrubs and can persist with only 10 cm of precipitation.

Establishment: Seed germination is the major problem in establishment (Soil Conservation Service 1988). Seeds should be de-winged, scarified and planted in the winter, spring or early summer. Plant seeds at a depth of 1/2 in. Seedlings may be used and mulch can be applied to aid in establishment. Germination will continue for 2-3 years after seeding due to the hard seed coat. The highest germination and best growth have been reported for diploid ecotypes. Undamaged embryos extracted from seedcoats have repeatedly shown high germination in as little as seven days. Unscarified seed showed much lower (13 percent) germination rates after much longer periods (1470 days). Seed are viable up to 6 or 7 years although viability varies with seed source.

After-ripening and treatment with water (to remove a water soluble germination inhibitor) is recommended as stratification treatment.

Management: It is grazing resistant (Soil Conservation Service 1988).

Seed Production: Seed is harvested by hand from natural stands in late fall and processed using a hammermill and air screen cleaner (Soil Conservation Service 1988). Propagation by stem cuttings has worked well. Stem cuttings root well from late winter through summer. Treatment with indole-3-butyric acid (IBA) powder at 0.3% will improve rooting success.

Winterfat (*Ceratoides lanata*)

Note: Although winterfat establishes well, it is a decliner on mine lands in Wyoming. Excessive use as a reclamation species is discouraged.

Synonyms: white sage, wintersage, feathersage, sweetsage, lambstail.

Characteristics: low-growing, suffrutescent, long-lived; cool season; half-shrub with a central woody stem arising from a woody crown (Soil Conservation Service 1988). Annual secondary stems are woolly and branched. Winterfat has an extensive fibrous root system as well as a deep penetrating tap root. This shrub grows rapidly, is widely adapted, and effectively binds soil (McArthur et al. 1979).

Uses: **Wildlife:** utilized extensively by rodents, rabbits, antelope, elk, bighorn sheep, and deer (Soil Conservation Service 1988). It rates good to fair forage for deer and is eaten readily by desert bighorn sheep and by elk on the few sites where it occurs at higher elevations. **Erosion control:** good erosion control if planted in a mixture to provide a higher plant density. It germinates easily and provides rapid growth on critically eroding sites. **Reclamation:** important as a pioneer species and establishes well on drastically disturbed sites or poorly developed soils such as those found on mined lands.

Adaptation: grows well on a wide range of soils, but does better on more basic or limey soils (Soil Conservation Service 1988). It is tolerant of weakly or moderately saline soils but is intolerant of acid soils. Winterfat will not tolerate flooding or persistently wet conditions. Winterfat is common in the 18-51 cm precipitation zones. It has good cold tolerance when mature, but is somewhat susceptible to frost in the seedling stage. Found up to 3050 m in elevation and occurs from open desert shrub communities to pinyon-juniper and other woodland sites.

Establishment: Sow seed less than 1/4 in deep (Soil Conservation Service 1988). Although it can be broadcast on the surface of moist soils, seeds may germinate under snow or even on seed stalks during humid, warm periods following freezing temperatures. If drilled, it should be seeded at a depth of 1/16 to 1/4 in and covered or pressed into a firm seedbed. Mulching can be beneficial. In mixes, a rate of 1/2 to 1-1/2 lbs per a drilled or 1-1/2 to 3 lbs per a broadcast (in mixes of 10 to 20 lbs per a) is recommended. If seeded in areas where annual weeds (cheatgrass, etc.) are prevalent, the recommendation is to seed in a mixture of vigorous, adapted grasses. Winter or early spring plantings have proven to be the most successful. Studies have shown that winterfat seedlings can survive freezing and do well at cool temperatures but have slow growth during summer.

Management: excellent tolerance to grazing in winter; however, no more than 25% of the growth should be removed in the growing season and not over 50% in the dormant period, less in spring (Soil Conservation Service 1988). It requires weed control whenever possible and areas

seeded to winterfat should be removed from use by livestock and by wildlife if possible. Seed winterfat in rows or strips to improve survival and establishment.

Seed Production: Under favorable conditions, plants produce seed the first growing season (Soil Conservation Service 1988). Collection of seed is best accomplished by hand removal although combine harvesting has been done successfully. Seed must be cleaned prior to seeding.

Threshing of seed from bracts is commonly practiced, but it damages the seed and reduces establishment and seedling vigor. Perhaps optimal establishment would be from unthreshed seed.

Viability of seed rapidly decreases after storage for 1 to 2 years even under good storage conditions. Germination of good seed averages 85 to 90%. Seeds per pound will vary but averages 125,000 with bracts intact. Hammermilled seed with bracts removed averages 200,000 seeds per pound.

Mountain mahogany (*Cercocarpus montanus*)

Characteristics: true mountain mahogany is a relatively tall deciduous shrub; it is a native, cool season plant; and roots are deeply and extensively branched (Soil Conservation Service 1988).

Uses: Wildlife - excellent browse plant for deer and mountain sheep; rated good to fair for elk (Soil Conservation Service 1988). Erosion control - combined with associated vegetation in natural stands, it usually makes good erosion control cover. It grows on rocky calcareous soils, however mountain mahogany needs high fertility the first two to three years of establishment.

Adaptation: grows on well-drained coarse to rocky soils found in the mountains and foothills of the West where mean annual precipitation is 25-64 cm (Soil Conservation Service 1988).

Although seedlings need shade to survive, this plant is most often found on sunny, open slopes.

This is a highly variable species and use of local materials is recommended. It tolerates mildly acid or mildly basic soils but does not do well under saline conditions. Mountain mahogany has a moderately strong drought tolerance. It is tolerant of winter browsing, but may succumb to close cropping during the growing season. It is very competitive when fully established.

Establishment: when used in mixes, it should be planted at 1/4 lb to 1 lb per a (twice this rate when broadcast) (Soil Conservation Service 1988). Mulch may be used and prove beneficial.

Cuttings can be used but should be hardened prior to setting out in spring. The new sprigs may need irrigation if planted late in the year. True mountain mahogany needs two months of frost-free weather to become established. Timing of plantings is important to get maximum germination and growth. This species is compatible with a variety of other species. See viability lasts about 5 years but can vary with the year of collection. Dormancy rates also vary with seed source. Germination rates may be improved by soaking the seed in sulfuric acid or by moist prechilling the seed. Seed is generally planted in the fall, but treated seed can be planted in early spring. Sprigs are usually set out in the spring after hardening. Plants are very slow to establish and generally have a high mortality rate the first two seasons; however, older plants are very hardy and resistant to defoliation and adverse soil conditions.

Management: When planting this species, competitive vegetation should be removed and the area protected from use by livestock and big game whenever possible to allow the plants to become established (Soil Conservation Service 1988). Only moderate use should be made of established stands.

Seed Production: Seed production from cultivated plants requires 4 to 5 years before new plants bear seed (Soil Conservation Service 1988). Seed harvest is light until plants reach 90-122 cm in height. Good harvesting methods are needed.

Antelope bitterbrush (*Purshia tridentata*)

Synonyms: quininebrush, deerbrush, blackbrush, and antelopebrush.

Characteristics: deciduous native shrub, with smooth red twigs arising from branched stems (Soil Conservation Service 1988). This species tends to be polymorphic, ranging from prostrate to erect. They are early deciduous in some ecotypes and nearly evergreen in others. It spreads by seed or by layering. The root system has both finely branched and fibrous roots as well as very deeply penetrating feeder roots.

Uses: Wildlife - leaves and twigs are choice food for mule deer, and fair for antelope and elk (Soil Conservation Service 1988). Use is primarily in winter, but it is also substantial in late summer and fall. The protein content averages 12% in spring and declines to about 8% in winter.

Wherever it occurs, bitterbrush is generally one of the most important species in big game ranges.

The seed of bitterbrush have little value to birds, but are an important food source to rodents and small mammals. Reclamation - Bitterbrush is one of the easier shrubs to establish from seed, but it is extremely susceptible to rodent and small mammal damage the first few years. Once established, it provides both wildlife food and cover, as well as aesthetic beauty on a reclaimed site. This shrub can also be utilized as a barrier or as a component of a living snow fence. It can also be used for roadside beautification and in recreation areas.

Adaptation: adapted to a wide range of soils but is best suited to deep, well-drained medium to coarse textured soils (Soil Conservation Service 1988). It is considered to be a phreatophytic (has deep roots that tap ground water) species. It grows up to 3350 m in elevation and in the 20-86 cm precipitation zone. This shrub tolerates moderately acid or moderately basic soils and nonsaline conditions. It has good tolerance to drought and to cold; does poorly when frequently flooded; is not tolerant of shade and is easily killed by fire. Tolerance to grazing or browsing is moderately strong, especially in winter.

Establishment: begins growth in early spring to early summer (Soil Conservation Service 1988).

Seedling vigor is average and it is compatible with other species and moderately competitive. Use local seed, as this species is highly polymorphic. Stands can be established by transplanting or by seeding. Seed should be planted 1 in deep at a rate of 1/2 to 1 lb per a drilled or 2 to 3 lbs per a broadcast. Stratification and prechilling may help germination but are not necessary. The time to seed is late fall or early winter. Establishment is slow and it may take 5 to 10 years for a stand to produce sufficient forage. However, the stands tend to be long-lived. Transplanting should be done in early spring using dormant, fresh stock.

Cool-moist stratification (-2 to 5 degrees C) overcomes the germination inhibitor in the seed coat (Young and Evans 1976). Cool-moist stratification can be satisfied in as little as two weeks under optimum conditions, longer if seeds are placed under moisture stress (Young and Evans 1981).

A lone seedling emerging from a given spot or hill is less likely to survive than a seedling in a group, possibly as a result of mutual protection from heat or in breaking through the soil crust during emergence (Halls et al. 1957). Several browse seeds planted at each spot may do better than a single seed.

Management: Grazing and browsing may need to be reduced on new stands until the seedlings are 20-25 cm tall to allow time for establishment (Soil Conservation Service 1988). Once established, the stands may benefit from periodic close browsing in winter.

Seed Production: Seed of bitterbrush ripens quickly (4 to 7 days after bloom) and falls within a week after ripening. Seed can be harvested any time after the late bloom stage. Seed must be hand harvested by stripping or flailing the branches with a paddle, allowing the seed to fall into containers or onto cloth or canvas laid out on the ground. The heavy, teardrop-shaped seed is easily processed and cleaned with a hammermill or debarker to remove the husks and trash. A simple, two screen fanning mill finishes the cleaning process.

Skunkbush sumac (*Rhus trilobata*)

Synonyms: squawbush, quailbush, threeleaf sumac, aromatic sumac, and lemonade sumac.

Characteristics: dense, native shrub varying in height; cool season; polymorphic; and wide in its distribution (Soil Conservation Service 1988). It has deep, extensively branched roots with shallow, spreading rhizomes.

Uses: Wildlife - provides wildlife habitat and forage (Soil Conservation Service 1988). At least 25 species of birds, including grouse and quail, as well as some species of small mammals eat the fruit, especially in winter and fall. It is browsed readily by deer, antelope, and elk. Reclamation - skunkbush sumac is useful in reclamation, erosion control, and beautification. Its drought resistance, vigorous deep roots, thicket forming habit and ease of establishment make it an excellent choice for direct seeding or clump transplanting in reclamation projects.

Adaptation: found up to elevations of 2740 m; along limestone outcrops, creeks, on dry hillsides, and in open forests (Soil Conservation Service 1988). It can grow on a wide range of soils, but prefers slightly alkaline, rocky, and gravelly soils. It does well on sands and other well-drained soils and does not tolerate flooding or high watertables. It is tolerant of both drought and cold, and is moderately tolerant of salt and alkali if the site is well-drained. Its moisture requirements are 25 cm of annual precipitation. Skunkbush sumac is winter hardy in its northern range and competes well with other shrub species once established.

Establishment: Seed should be planted 1/2 to 1/4 in deep in fall, depending on soil texture and moisture content (Soil Conservation Service 1988). Fall and winter seedings are reported to do the best. When planted in spring or summer, a moist prechill of 30 to 90 days is required. Acid scarification also improves germination. Seed should be planted at rates of 1 to 2 lbs per a if included in mixes. It is not feasible to seed it as a full stand species. Cuttings can be used and have been reported to do well. They should be 1- or 2-year old stock, 20-25 cm tall, and spaced about 1.8 m apart. Slow stand establishment from seed is common and may take 10 years or longer to reach maturity. Transplants develop more rapidly.

Management: New stands may need protection from grazing (Soil Conservation Service 1988). Moisture collecting pits or mulching with wood chips will increase survival and growth. Conservative grazing or browsing pressure is recommended, but periodic close use can improve production and cover.

Seed Production: Fruit ripens from July to September and about 8,000 seed per lb is produced (Soil Conservation Service 1988). It is stripped by hand into buckets, then the seed is separated from the fruit coat by maceration, with or without water. Seeds are dried before or after separation. Typically fruit is macerated with water using a Dybvig and light scarification, then

cleaned using a standard air-screen seed cleaner. Planting seed in the fall naturally stratifies the seed. Artificially stratified seed should be planted in May.

Rabbitbrush (*Chrysothamnus* spp.)

Uses: Rubber rabbitbrush (*Chrysothamnus nauseosus*) performs well when seeded on minesoils, providing diversity and cover to the new plant community (Munshower 1994).

Establishment: *C. viscidiflorus* - seed viability is often very low despite the tremendous numbers of seeds produced; many embryos apparently abort or otherwise fail to develop (Young 1988).

Willows (*Salix* spp.)

Establishment: Willow cuttings 30-38 cm long from last year's growth (root and grow more vigorously than older stem segments) are the most desirable for restoration of stream bank vegetation (Melton et al. 1983). Collect cuttings while plants are still dormant and store in a moist cool environment until just before planting. Cuttings can be rooted before planting by placing them in water or wet sand and aeration of the water will greatly increase rooting.

Plant cuttings in an open slit in the ground about 25 cm deep, at an angle of about 45-60 degrees with the ground surface (Melton et al. 1983). Lift the soil and, while the planting tool is still in the ground, insert the cutting. When the tool is removed, the soil will surround the cutting (apply slight foot pressure over the slit to ensure good soil-plant contact and to eliminate air pockets). Cuttings should be planted top end up with several buds exposed to the atmosphere.

Chokecherry (*Prunus virginiana*)

Characteristics: height varies; may grow as either individual plants or, more often, as a dense thicket; stems are numerous and loosely branched from the base (Soil Conservation Service 1988). The root system is composed of shallow rhizomes and a few deep feeder roots. This species sprouts readily, especially after fire or pruning.

Uses: Wildlife - chokecherry provide very good forage and cover for wildlife including small mammals, bears, many game birds, and songbirds (Soil Conservation Service 1988). Cattle and sheep may be poisoned by the hydrocyanic acid in the leaves; however, the twigs do not contain the acid and big game relish this species as a browse plant. Reclamation - chokecherry has potential for surface mineland reclamation and for revegetating depleted game ranges.

Adaptation: grows well on moist sites in open areas, or seeps in the foothills, mountains and along steep canyon walls (Soil Conservation Service 1988). It grows on almost all soils except dense clays; it does not tolerate poor drainage, prolonged spring flooding or a consistently high water table. Chokecherry does best on deep, fertile, and either silty or sandy soils. It is common in the 31-76 cm precipitation zones. Acidic conditions (pH = 5.0) are tolerated, but it also does well on basic or saline sites. It will not tolerate alkaline soils. It is winter hardy, cold tolerant, and will grow in shaded spots, but produces better quality flowers and fruit on open sunny sites. Drought tolerance is fair, but prolonged dryness will reduce fertility, lifespan and disease resistance. Grazing tolerance is moderate.

Establishment: chokecherry is strongly competitive with many herbaceous plants, but is compatible with most woody non-evergreen species (Soil Conservation Service 1988). Sow or transplant this species; if seeded, plant 1/2 in deep on fine or medium textured soils and 1 in deep on coarser soils. Unstratified seed should be seeded in the fall, stratified (moist prechill) seed in

the early spring. Seedlings are only moderately vigorous but have a high survival rate. Transplanting is quicker in establishing a stand since unstratified seed may take up to 120 days to germinate. Stock should be 30-60 cm tall and should be watered until established.

Management: Grazing, weeds, and rodents should be controlled during establishment (Soil Conservation Service 1988).

Seed Production: fruit ripens starting in July to August (Soil Conservation Service 1988). Fruit should be collected when fully mature, just as it turns purple to dark purple. The average number of cleaned seeds per pound is 4790. There are about 20 lbs of seed in 100 pounds of fruit.