

Idaho Roadside Revegetation Handbook

Prepared for:



The Idaho Transportation Department

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Introduction

INTRODUCTION

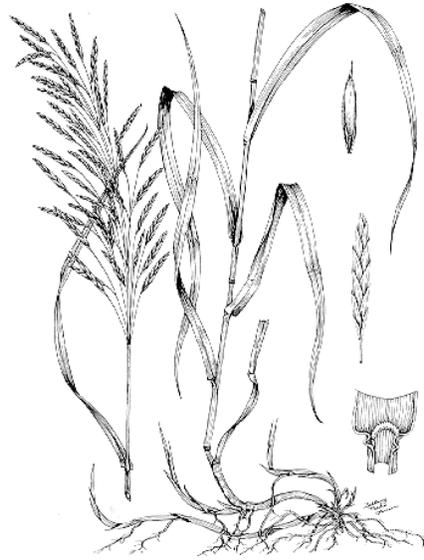
Surface erosion, sedimentation, and shallow-seated slope failures in Idaho present a significant challenge to roadway construction and maintenance. Soil losses from such slopes deplete an important natural resource, induce excessive maintenance such as ditch and culvert clean-outs, and may adversely effect the quality of surface water in the state. Road construction and maintenance activities throughout the state are requiring greater attention to erosion and sediment control concerns due to environmental and economic pressures. Vegetation can be planted to reduce soil loss by holding soil particles in place, filtering soil particles out of run-off, intercepting raindrops, slowing overland flows, and maintaining infiltration. In Idaho, vegetation patterns and community distributions are quite complex due to precipitation extremes, topographic relief, climatic variations, and cultural practices. Precipitation zones can be used to identify species suitable for revegetation that are indigenous to specific construction sites.

This guidebook will summarize the characteristics and preferred environments of commonly used grass, grass-like, forb, legume, shrub, and tree species for roadside reclamation in Idaho. Native, introduced, and other species adapted to Idaho will be included. A potential species list was determined from numerous published and unpublished works to include field guides, seed catalogs, soil surveys, roadside plant establishment evaluations and input from the Idaho Transportation Department's roadside manager, district vegetation foreman and design manual. Plant materials included n the potential plant list have root and shoot growth habits that are resistant to the forces of erosion and have the ability to colonize disturbed sites. The format was created to include a title page, brief introduction, table of contents, page for each species, quick reference tables, a reference list, and appropriate enclosures in an appendix. The species page features a line drawing of the plant, a vegetation distribution map, and a species description

which includes life span, growth habit, origin, vegetation characteristics, habitat requirements, and soil stabilization properties.

The data represented in this guidebook are a summary of observations of revegetation specialists, information from research publications, and field surveys. Compiling available vegetation data into one comprehensive guidebook serves as an extremely useful tool for roadside managers locally and regionally. The revegetation guidebook can also serve as a reference to other reclamation, restoration, horticulture, and landscape projects throughout Idaho.

Grasses



Crested Wheatgrass

Agropyron cristatum



Richard W. Scott (1995)

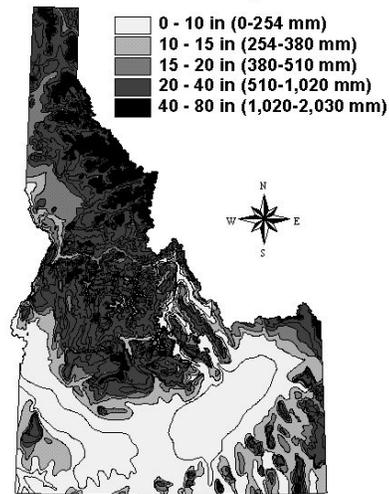
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are flat. Spikelets are flat. Rhizomatous at precipitation zones above 14 in (36 cm), and roots reach a minimum depth of 8 in (20 cm). Grows 24-39 in (60-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 0-18 in (0-460 mm).

Elevation zone. Below 7,000 ft (2,735 m).

Habitat & Climate requirements. Adapted to the climatic conditions in the arid regions of the Intermountain West that have frost-free periods greater than 120 days.

Soil type. Well-drained, moderately coarse, or medium-textured soils with a minimum depth of 10 in (25 cm). Intolerant of silty soils.

APPLICATIONS:

Roadside suitability. Little maintenance is required. Adapted to grazing, traffic, and disturbed sites. Used on mine spoils and roadsides. Tolerates drought, cold, and fire.

Establishment. Germinates and establishes readily, seedlings develop slowly, good seed producer.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 10-20 lb PLS per acre (11.2-22.4 kg/ha). There are 200,000 seeds per lb (440,000 seeds per kg).

Thickspike Wheatgrass

Agropyron dasystachyum



Richard W. Scott (1995)

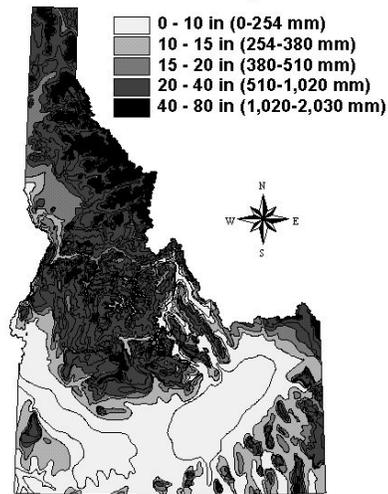
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season and creeping. Leaves are green to blue-green, narrow, smooth with slightly curled margins. Roots are fibrous to 10 in (25 cm) deep with rhizomes. Grows 16-32 in (40-80 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-20 in (200-510 mm).

Elevation zone. Ranges from 3800 to 10,000 ft (1159 to 3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the northern Intermountain region.

Soil type. Well-drained, shallow to deep, coarse- to fine-textured, sandy soils.

APPLICATIONS:

Roadside suitability. Forms a thick mat of roots in the upper 8-15 in (20-38 cm) of soil. Used for soil stabilization and to suppress weeds. Tolerates drought, fire, and weakly acidic to moderately alkaline soils.

Establishment. Germinates readily and has good seedling vigor. Not recommended to seed with strongly competitive plants.

SEEDING RECOMMENDATIONS: Plant in early spring to late fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 6-8 lb PLS per acre (6.7-9 kg/ha). There are 154,000 seeds per lb (338,800 seeds per kg).

Intermediate Wheatgrass

Agropyron intermedium



James Stubbendieck et al. (1997)

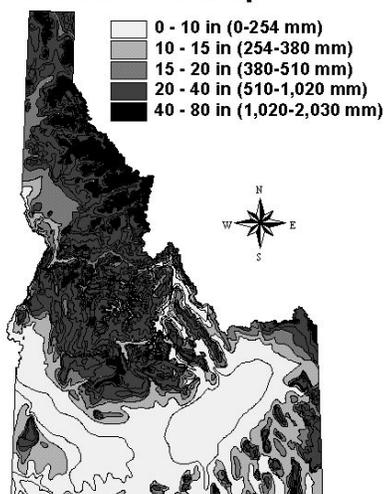
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are tapering, strongly veined, and green. Roots can reach a minimum depth of 20 in (51 cm). Grows 2-4 ft (.6-1.2 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 14 in (360 mm).

Elevation zone. Ranges from 3,500-9,000 (1,068-2,745 m).

Habitat & Climate requirements. Adapted to semi-humid conditions.

Soil type. Well-drained, medium- to fine-textured soils.

APPLICATIONS:

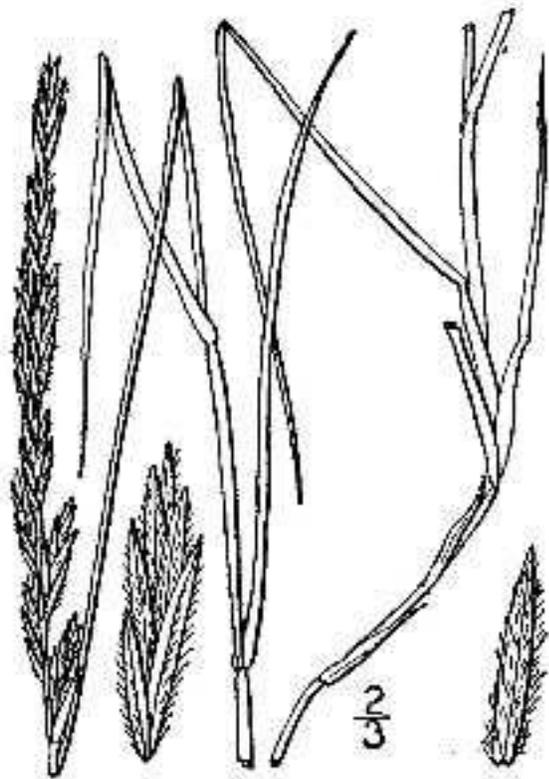
Roadside suitability. Robust. Commonly used for roadside revegetation and restoration of disturbed sites. Tolerates moderate drought.

Establishment. Reproduces from seeds, tillers, and rhizomes. Excellent seedling vigor and stand establishment.

SEEDING RECOMMENDATIONS: Plant in the fall or early spring at a depth of 0.5-1 in (1.3-2.5 cm). Seed 8 lb PLS per acre (9 kg/ha). There are 88,000 seeds per lb (193,600 seeds per kg).

Streambank Wheatgrass

Agropyron riparium



Britton, N.L. and A. Brown (1913)

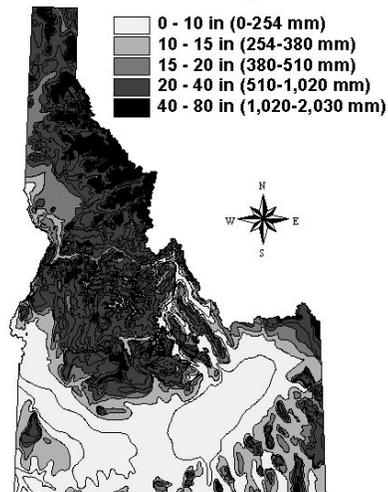
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season and creeping. Leaves are short, narrow, smooth, and somewhat curled at the margins. Rhizomatous roots that can reach a minimum depth of 18 in (46 cm). Grows 16-32 in (40-80 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-25 in (250-640 mm).

Elevation zone. Ranges from 3,800-10,000 ft (1,159-3,050 m).

Habitat & Climate requirements. Adapted to the climatic conditions of the Northern Great Plains and the Intermountain West.

Soil type. Fine- to medium-textured, well-drained soils.

APPLICATIONS:

Roadside suitability. Requires minimal maintenance. Used to suppress weeds and stabilize banks, roadsides, and eroded areas.

Establishment. Germinates quickly and has excellent seedling vigor. Not recommended to seed with strongly competitive introduced species.

SEEDING RECOMMENDATIONS: Plant early spring or late fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 6-8 lb PLS per acre (6.7-9 kg/ha) There are 156,000 seeds per lb (343,200 seeds per kg).

Siberian Wheatgrass

Agropyron sibiricum



A.L. Haferrichter et al. (1979)

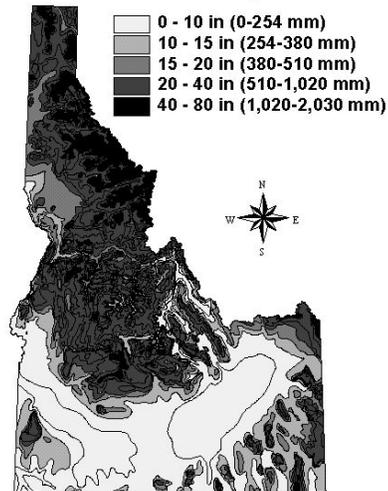
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Fine-leaved, cool-season grass. Roots are extensive with weak rhizomes when annual precipitation exceeds 14 in (36 cm), and reach a minimum depth of 10 in (25 cm). Grows 24-35 in (60-90 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-12 in (150-300 mm).

Elevation zone. Below 7,000 ft (2,135 m).

Habitat & Climate requirements. Adapted to areas with a frost-free period less than 120 days.

Soil type. Well-drained, shallow to deep, moderately coarse to fine-textured loamy or sandy soil.

APPLICATIONS:

Roadside suitability. Weed barrier and competitive with introduced grasses. Tolerates drought and fire. Also tolerates weakly acidic to moderately alkaline soil, as well as saline soils.

Establishment. Poor seedling vigor but is easy to germinate.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a rate of 6-8 lb PLS per acre (6.7-9 kg/ha). There are 170,000 seeds per lb (374,000 seeds per kg).

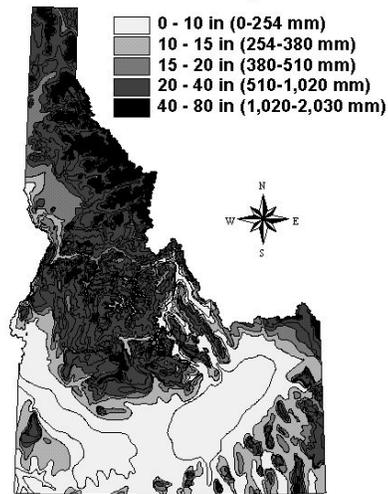
Western Wheatgrass

Agropyron smithii



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-14 in (250-360 mm).

Elevation zone. Ranges from 1,000-9,000 ft (305-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions.

Soil type. Well-drained, heavy and fine to very fine soils.

APPLICATIONS:

Roadside suitability. Aggressive, resistant to environmental stress, and is used for erosion control. Tolerates cold, moderately saline, and weakly acidic soils.

Establishment. Poor germination rates, low seedling vigor, aggressive once established, and very persistent.

SEEDING RECOMMENDATIONS: Plant in fall or spring. Seed 10-15 lb PLS per acre (11.2-16.8 kg/ha). There are 110,000 seeds per lb (242,000 seeds per kg).

LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are blue-green and coarse with prominent veins. Inflorescence is a spike with hairy sheaths. Roots are fibrous with strong and spreading rhizomes and can reach a minimum depth of 20 in (51 cm). Grows 12-36 in (31-91 cm) tall.

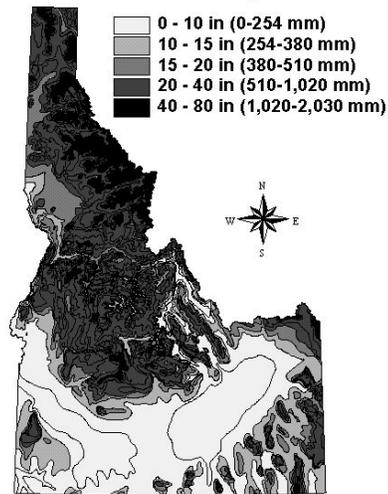
Bluebunch Wheatgrass

Agropyron spicatum



Richard W. Scott (1995)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-40 in (260-1,010 mm).

Elevation zone. Ranges from 500-10,000 ft (153-3,050 m). Low plant vigor on poor sites above 6,500 ft (1,983 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout sagebrush, ponderosa pine, mountain brush, and juniper lands.

Soil type. Well-drained, medium- to coarse-textured soils over 10 in (25 cm) deep including very sandy soils or thin, rocky sites and on very steep slopes.

APPLICATIONS:

Roadside suitability. Not compatible with aggressive introduced grasses. Tolerates cold, shade, drought, and fire. Intolerant of high water tables and poor drainage.

Establishment. Several years are required to gain full productivity.

SEEDING RECOMMENDATIONS: Plant in fall. Seed 6-8 lb PLS per acre (6.7-9 kg/ha). There are 120,000-150,000 seeds per lb (264,000-330,000 seeds per kg).

LIFE SPAN: Perennial, long-lived.

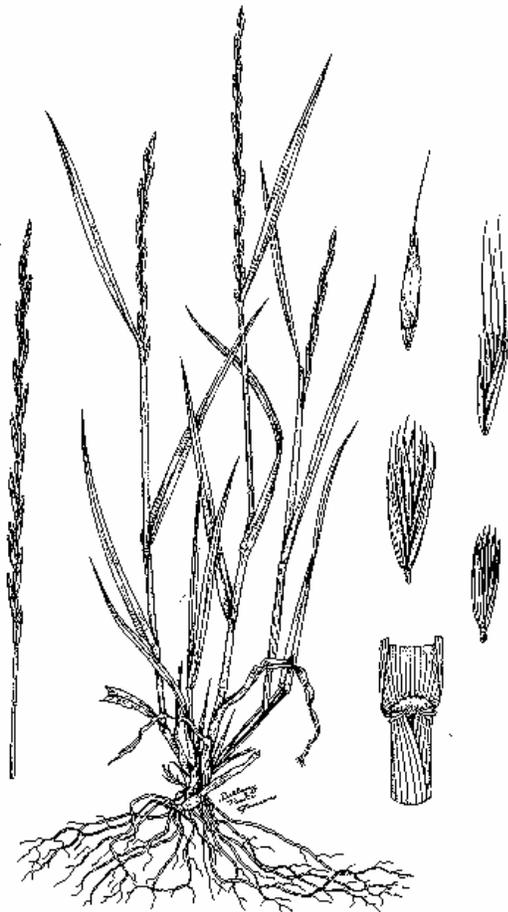
GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are green to blue, lax, and flat to inrolled. Roots are extensive with strong tillers and rhizomes in high rainfall areas and can reach a minimum depth of 10 in (25 cm). Grows 1-2 ft (.3-.6 m) tall.

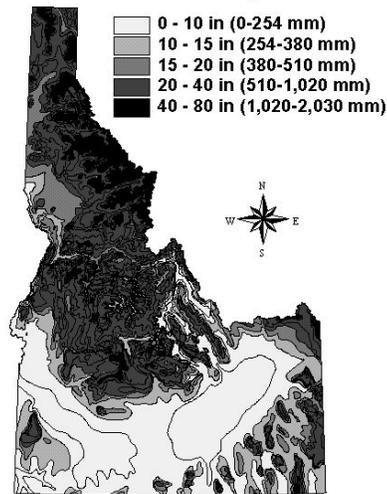
Slender Wheatgrass

Agropyron trachycaulum



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-30 in (300-760 mm).

Elevation zone. Ranges from 4,500-12,000 ft (1,373-3,660 m).

Habitat & Climate requirements. Adapted to a wide range of soil moisture conditions of the Intermountain Northwest and Northern Great Plains. Withstands temperatures to -40 F (-40 C).

Soil type. Well-drained, clay loam, loam, and sandy loam soils with a pH of 6.0-9.0.

APPLICATIONS:

Roadside suitability. Commonly used for reclamation. Tolerates saline.

Establishment. Good seedling vigor, germination rate, genetic variability, and establishment.

SEEDING RECOMMENDATIONS: Plant in early fall at a depth of 0.25-0.75 in (0.6-2 cm). Seed 6-8 lb PLS per acre (6.7- 9 kg/ha). There are 159,000 seeds per lb (349,800 seeds per kg).

LIFE SPAN: Perennial, long-lived.

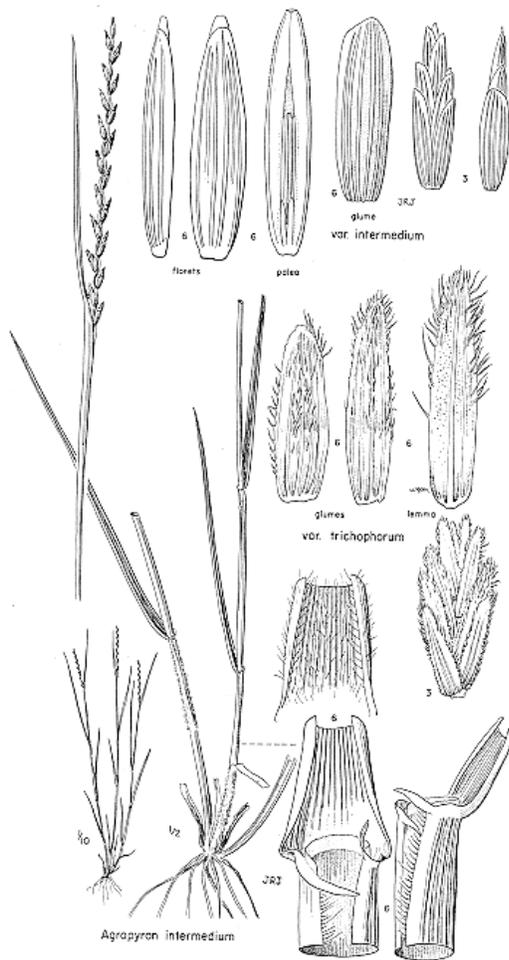
GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season, erect, and tufted. Seed stalks and stems have a reddish to purple base. Roots are fibrous extending 20 in (50 cm) with tillers and very short rhizomes. Grows 24-30 in (61-76 cm) tall.

Pubescent Wheatgrass

Agropyron trichophorum



R.H. Mohlenbrock (1972)

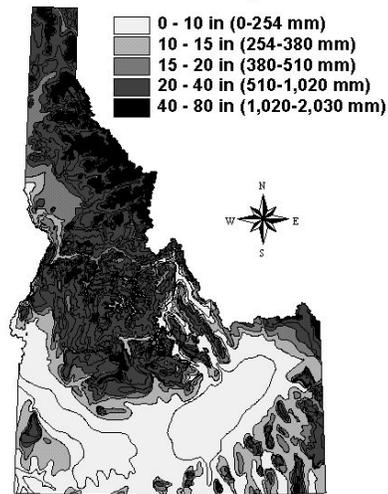
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season, robust, and strongly rhizomatous. Roots can reach a minimum depth of 20 in (51 cm). Grows 13-14 in (33-36 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 11-16 in (280-410 mm), 12 in (310 mm) below 3,500 ft (1,068 m) in elevation and 10 in (250 mm) above 3,500 ft (1,068 m).

Elevation zone. Wide range.

Habitat & Climate requirements. Adapted to a wide range of climatic conditions along foothills within semi-humid to semi-arid environments.

Soil type. Well-drained, loamy, clay soils.

APPLICATIONS:

Roadside suitability. Aggressive and remains green in the summer. Used primarily for permanent seedings and erosion control. Tolerates drought and slightly acidic, neutral, or mildly alkaline soils.

Establishment. Easy germination. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.5-1 in (1.3-2.5 cm). Seed 10-12 lb PLS per acre (11.2-13.5 kg/ha). There are 100,000 seeds per lb (220,000 seeds per kg).

Oats

Avena sativa



A.M. Powell (1994)

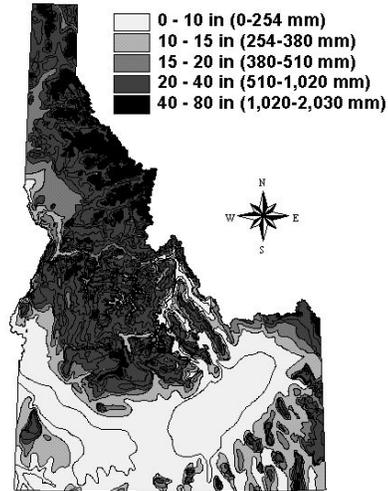
LIFE SPAN: Annual.

GROWTH HABIT: Weak bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season, tufted grass. Roots reach a minimum depth of 8 in (20 cm). Grows 13-26 in (33-66 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 13 in (330 mm).

Elevation zone. Up to 7,000 ft (2,135 m).

Habitat & Climate requirements. Temperate areas of the West. Requires a minimum 90 frost-free days and can tolerate temperatures as low as -23 F (-45 C).

Soil type. Medium-textured, moist soils with a neutral pH.

APPLICATIONS:

Roadside suitability. Excellent nurse, cover, or temporary erosion control crop that develops with little competition to establishing perennials. Tolerates drought.

Establishment. Generally good germination and is adapted to a wide range of environmental conditions.

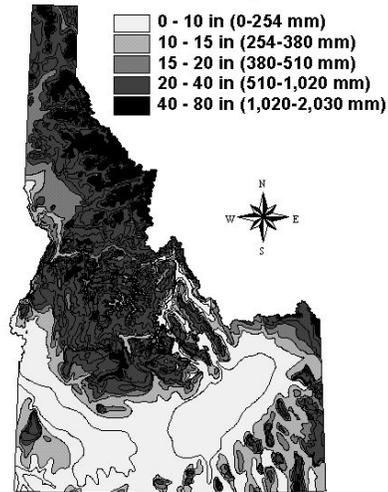
SEEDING RECOMMENDATIONS: Plant in early spring. For crops, seed 60-100 lb PLS per acre (67.2-112.1kg/ha). There are 14,000 seeds per lb (30,800 seeds per kg).

Mountain Brome

Bromus carinatus



Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-16 in (300-410 mm).

Elevation zone. Ranges from 500-10,000 ft (153-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of semi-arid conditions across the Intermountain area. Withstands temperatures to -40 F (-40 C).

Soil type. Clay to sandy loam soils with a pH of 5.5-7.5.

APPLICATIONS:

Roadside suitability. Reaches full productivity in 1-3 years. Used for conservation work. Winter-hardy and moderately sensitive to saline. Tolerates shade and drought. Intolerant of high water tables.

Establishment. Establishes quickly and has a low fertility requirement. Reseeds itself readily.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 10 lb PLS per acre (11.2 kg/ha). There are 78,000-100,000 seeds per lb (171,600-220,000 seeds per kg).

LIFE SPAN: Perennial, short-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season grass with coarse culms and broad leaves. Roots can reach a minimum depth of 12 in (31 cm). Grows 15-30 in (38-76 cm) tall.

Smooth Brome

Bromus inermis



James Stubbenieck et al. (1997)

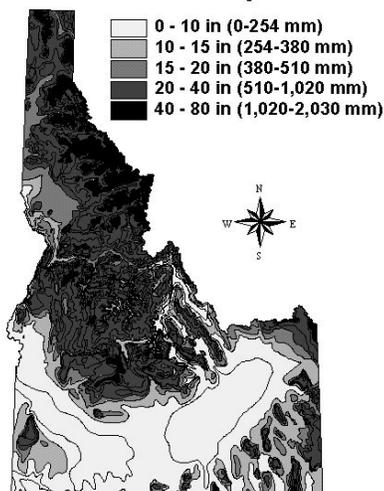
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season and strongly rhizomatous. Leaf blades are smooth and broad 0.2-0.5 in (5-10 mm). Roots can reach a minimum depth of 12 in (31 cm). Grows 13-25 in (33-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-18 in (300-460 mm).

Elevation zone. Above 4,000 ft (1,220 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the Intermountain West. Withstands temperature to -40 F (-40 C).

Soil type. Well-drained, deep, fertile, clay loam to sandy loam with neutral pH.

APPLICATIONS:

Roadside suitability. Aggressive, low-growing, and vigorous. Used for erosion control and weed suppression. Tolerates shade.

Establishment. Germinates readily and seedlings grow rapidly. Moderate to high fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 8 lb PLS per acre (9 kg/ha). There are 125,000 seeds per lb (275,000 seeds per kg).

Columbia Brome

Bromus vulgaris



Patricia A. Patterson et al. (1985)

Clinton H. Wasser (1982)

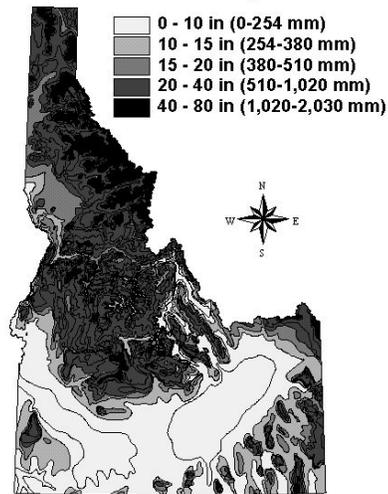
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool season. Plants are tall, pubescent, and robust. Leaves are broad. Inflorescence is a narrow drooping panicle. Thick, fibrous roots that reach a minimum depth of 8 in (20 cm). Grows 18-47 in (45-120 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 11-20 in (270-510 mm).

Elevation zone. Ranges from 2,500-5,500 ft (762-1,675 m).

Habitat & Climate requirements. Adapted to cool, wet winters and warm dry summers. Requires a minimum 100 frost-free days and can withstand temperatures to -23 F (-44 C).

Soil type. Volcanic ash, sandy loam, and deep, well-drained loess.

APPLICATIONS:

Roadside suitability. Used for erosion control and weed suppression where shade is a factor.

Establishment. Resistant to fire and has 43-86% germination in the first year. Seedling vigor is high with a moderate spread rate.

SEEDING RECOMMENDATIONS: Plant in the fall or early spring at a depth of 0.25 in (0.61 cm). There are 79,600-119,500 seeds per lb (175,120-262,900 seeds per kg).

Pinegrass

Calamagrostis rubescens



James Stubbendieck et al. (1997)

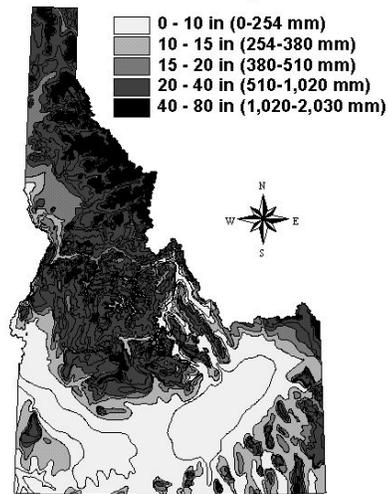
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaf blades are scabrous, flat, or somewhat rolled. Inflorescence is a dense, long, cylindrical, purplish panicle. Roots are strong and well developed with creeping rhizomes, and can reach a minimum depth of 7 in (18 cm). Grows 24-40 in (60-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 18-40 in (460-1,010 mm).

Elevation zone. Ranges from 0-10,000 ft (0-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions in the Northwest. Requires a minimum 100 frost-free days, and can tolerate temperatures to -28 F (-48 C).

Soil type. Well-drained, fine and medium-textured soils.

APPLICATIONS:

Roadside suitability. Used for soil cover. Tolerates drought and fire.

Establishment. Difficult to germinate. Not very aggressive.

SEEDING RECOMMENDATIONS: Plant in the fall or early spring. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha) where topsoil is present. There are 2,646,000 seeds per lb (5,821,200 seeds per kg).

Orchardgrass

Dactylis glomerata



A.S.Hitchcock (1971)

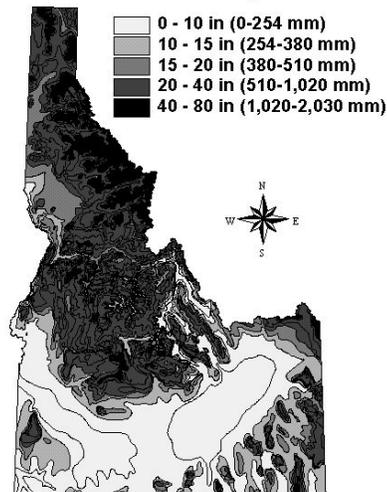
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are basal and abundant. Stems are leafy and upright. Roots are medium-sized, fibrous, and can reach a minimum depth of 12 in (31 cm). Grows 24-47 in (60-120 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 11-20 in (280-510 mm).

Elevation zone. Ranges from 6,500-9,000 ft (1,983-2,745 m).

Habitat & Climate requirements. Adapted to subhumid climatic conditions. Requires 145 frost-free days and tolerates temperatures to -43 F (-56 C).

Soil type. Well-drained alluvial soils that are medium to moderately fine-textured.

APPLICATIONS:

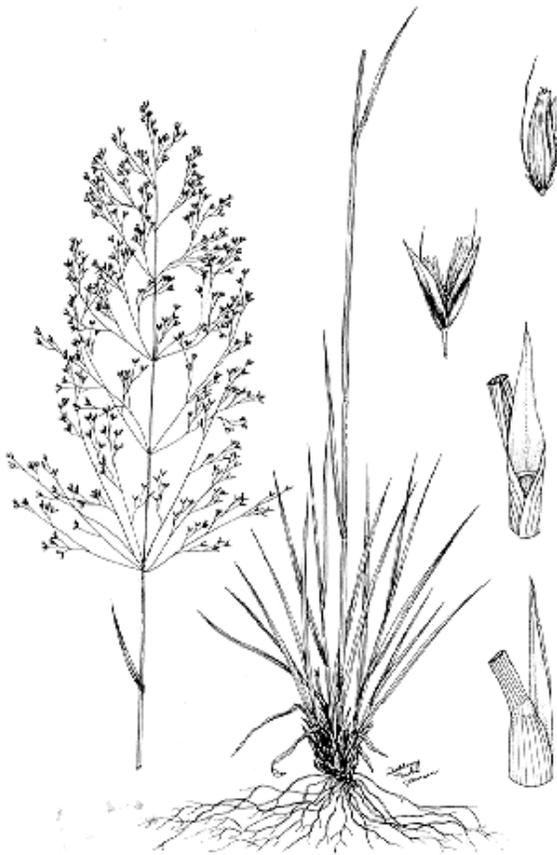
Roadside suitability. Persistent. Used for erosion control. Tolerates shade, drought, and fire. As well as moderately acidic to mildly alkaline soils. Intolerant of saline soils.

Establishment. Medium germination rate. Slow seed spread rate, but high seedling vigor.

SEEDING RECOMMENDATIONS: Plant in early spring or fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 2-3 lb PLS per acre (2.2-3.4 kg/ha) There are 654,000 seeds per lb (1,438,800 seeds per kg).

Tufted Hairgrass

Deschampsia caespitosa



James Stubbendiek et al. (1997)

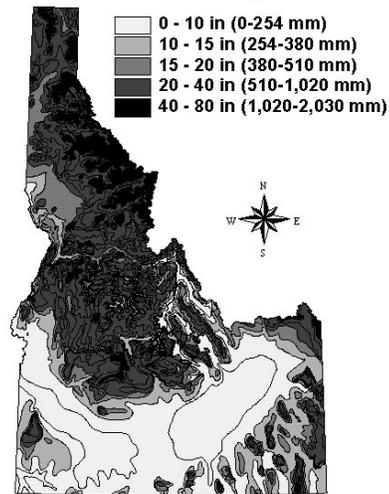
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season and densely tufted. Leaves are abundant and vary in texture from fine to very coarse. Inflorescence is a diffuse panicle. Roots can reach a minimum depth of 14 in (36 cm). Grows 18-24 in (45-60 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 20-40 in (510-1,010 mm).

Elevation zone. Ranges from 5,000 -13,000 ft (1,525-3,965 m).

Habitat & Climate requirements. Adapted to a wide range of cool conditions in open mountain areas of most western states. Withstands temperatures to -40 F (-40 C).

Soil type. Wet or hydric clay to sandy loam soils with acidic to basic pH levels.

APPLICATIONS:

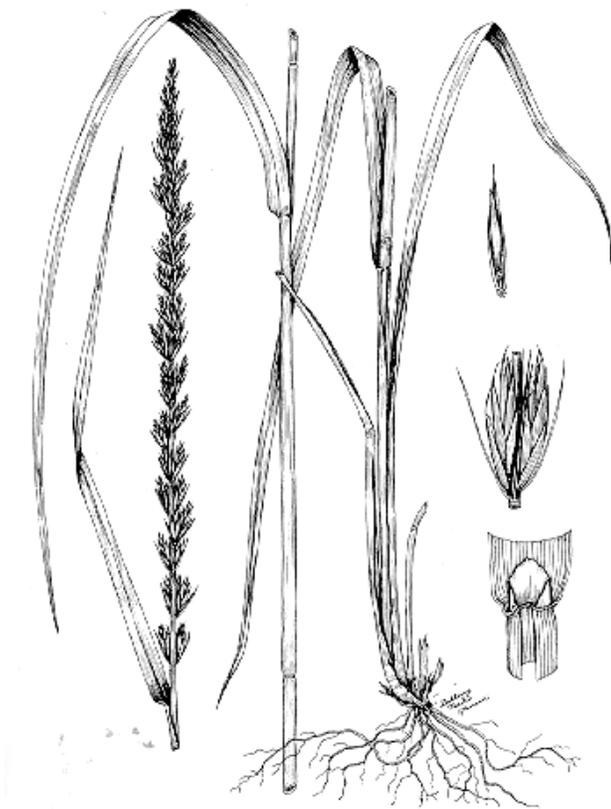
Roadside suitability. Pioneer species on disturbed sites. Used for shoreline stabilization, wetland enhancement, restoration, and filter strips.

Establishment. Slow to establish, low seed production and moderate seedling growth. Low to moderate fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 1,500,000 seeds per lb (3,300,000 seeds per kg).

Basin Wildrye

Elymus cinereus



James Stubbendiek et al. (1997)

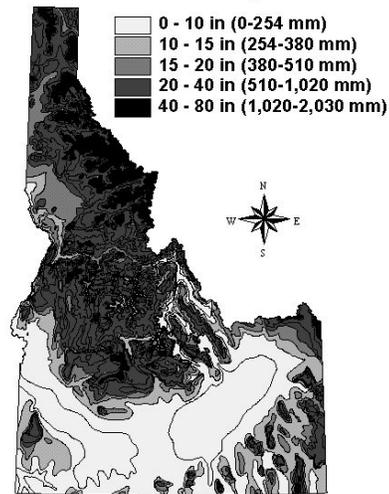
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season, erect, robust, and slightly spreading. Leaves are flat. Roots can reach a minimum depth of 16 in (41 cm). Grows 2-8 ft (.6-2.4 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 5-20 in (130-510 mm).

Elevation zone. Ranges from 0-9,000 ft (0-2,745 m).

Habitat & Climate requirements. Adapted to areas with wet winters and dry summers. Often associated with of juniper, mountain brush, and aspen communities.

Soil type. Clay to loamy soils with moderately course- to moderately-fine-texture. Also withstands sandy areas.

APPLICATIONS:

Roadside suitability. Poor competitor. Plant separately from other species. Tall, spreads by short, thick rhizomes. Tolerates drought, salty, and alkaline soils.

Establishment. Slow to establish, fair seedling vigor, and good germination. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.5-0.75 in (1.3-2 cm). Seed 9 lb PLS (10.1 kg/ha). There are 130,000 seeds per lb (286,000 seeds per kg).

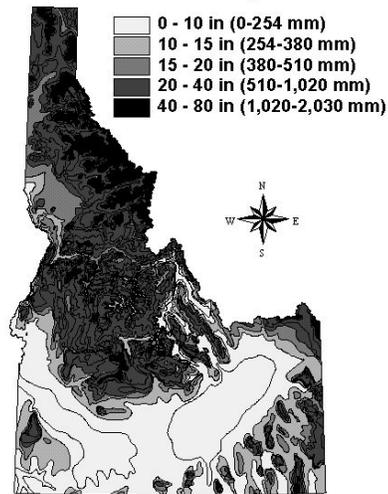
Blue Wildrye

Elymus glaucus



Richard W. Scott (1995)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-40 in (300-1,010 cm).

Elevation zone. Ranges from 0-6,000 ft (0-1,830 m).

Habitat & Climate requirements. Adapted to the climatic conditions of semi-shaded areas from the coast to the mid-montane. Withstands temperatures to -30 F (-34 C).

Soil type. Deep, clay loam to sandy loam soils with a pH of 5.5-7.5.

APPLICATIONS:

Roadside suitability. Compatible with woody plants, provides quick effective ground cover, and is used for erosion control. Tolerates shade and moderate salinity.

Establishment. Rapid seedling growth and 90% germination in the first year. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 9 lb PLS per acre (10.1 kg/ha). There are 124,000-155,000 seeds per lb (272,800-341,000 seeds per kg).

LIFE SPAN: Perennial, short-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Broad leaved, robust with dense, fibrous roots that can reach a minimum depth of 12 in (31 cm). Grows 24-47 in (60-120 cm) tall.

Tall Fescue

Festuca arundinacea



R.H. Mohlenbrock (1972)

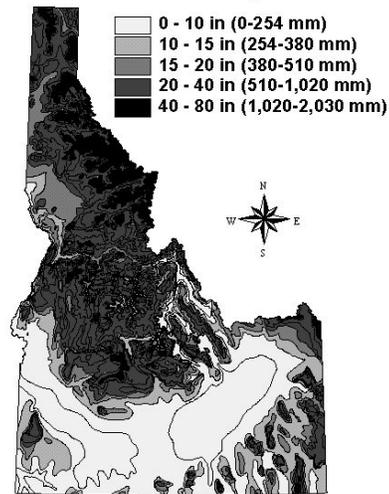
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season and robust. Leaves are broad. Roots are coarse, tough, and abundant and can reach a minimum depth of 12 in (31 cm). Culms stand 20-80 in (50-200 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-40 in (380-1,020 mm).

Elevation zone. Ranges from 500-10,000 ft (152-3048 m).

Habitat & Climate requirements. Adapted to subhumid areas.

Soil type. Deep, loamy, clay, poorly-drained soils with pH 5.5-7.0.

APPLICATIONS:

Roadside suitability. Winter-hardy, invasive, and remains green in dry summers. Used to stabilize cuts, fills, dikes, and deep waterways.

Establishment. Easy to establish, rapid germination rate, and good seedling vigor. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 6-8 lb PLS per acre (6.7-9 kg/ha). There are 227,000 seeds per lb (499,400 seeds per kg).

Idaho fescue

Festuca idahoensis



James Stubbendieck et al. (1997)

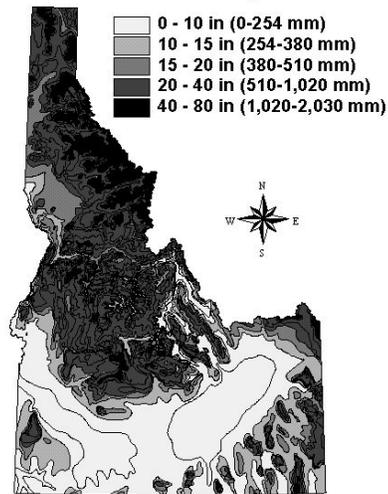
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are basal, bluish green, and fine. Stems grow primarily from the base. Roots can reach a minimum depth of 14 in (36 cm). Grows 12-39 in (30-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-40 in (250-1010 mm).

Elevation zone. Ranges from 800-12,000 ft (244-3,600 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions.

Soil type. Medium-textured, fairly dry, well-drained, moderately deep, sandy, or gravelly loams. Coarser soils on steep north slopes.

APPLICATIONS:

Roadside suitability. Low-growing and is used to compete against cheatgrass. Tolerates slightly saline and alkaline soils.

Establishment. Good germination, low seedling vigor, and slow to establish.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 4-8 lb PLS per acre (4.5-9 kg/ha). There are 450,000 seeds per lb (990,000 seeds per kg).

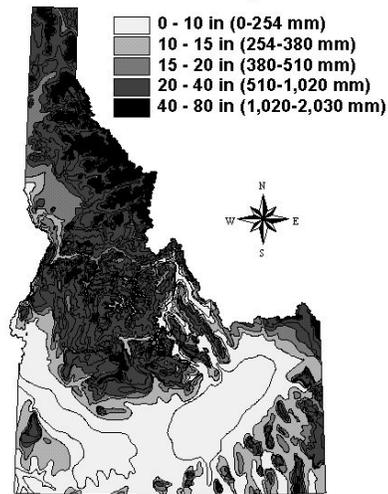
Hard Fescue

Festuca longifolia



C.E. Hubbard (1954)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-40 in (300-1,010 mm).

Elevation zone. Ranges from 500-12,000 ft (152-3600 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions.

Soil type. Shallow, well-drained, clay-to-sandy soils with a pH of 5.5-7.5.

APPLICATIONS:

Roadside suitability. Low-growing, persistent, and competitive. Good soil binder. Used for soil protection on roadsides, ditchbanks, airport runways, and skid trails. Tolerates drought and medium-acidic to mildly alkaline soils.

Establishment. Good seed production and germination, slow seedling growth with a moderate fertility requirement.

SEEDING RECOMMENDATIONS: Plant in spring or early fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 10 lb PLS per acre (11.2 kg/ha). There are 565,000 seeds per lb (1,243,000 seeds per kg).

LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Leaves are very fine and abundant. Roots are densely fibrous and can reach minimum depths of 10 in (25 cm). Grows 12-14 in (30-35 cm) tall.

Sheep Fescue

Festuca ovina



L. Brown (1979)

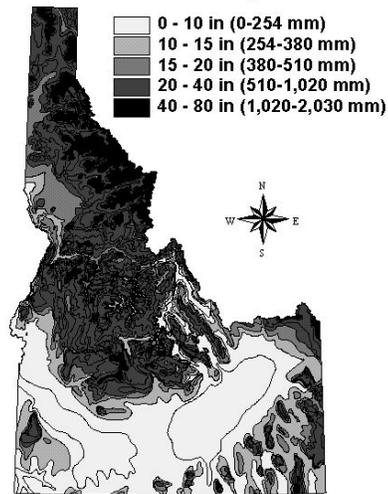
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season with low top production. Leaves are blue-green, fine, and short. Roots can reach a minimum depth of 10 in (25 cm). Grows 8-16 in (20-40 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 9-24 in (230-610 mm).

Elevation zone. Ranges from 3,500-11,000 ft (1,068-3,355 m).

Habitat & Climate requirements. Adapted to the climatic conditions of open woods and stony slopes. Withstands temperatures to -40 F (-40 C).

Soil type. Shallow, clay, sandy loam, sandy, gravelly soils with a pH of 5.5-7.5.

APPLICATIONS:

Roadside suitability. Competes aggressively with weeds, provides ground cover, and has excellent root growth. Used for bank stabilization. Tolerates drought and moderate salinity.

Establishment. Good germination rate, good seed production, and slow to establish but persistent. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or spring. Seed 3-10 lb PLS per acre (3.4-11.2 kg/ha). There are 680,000 seeds per lb (1,498,200 seeds per kg).

Red Fescue

Festuca rubra



A.S. Hitchcock (1971)

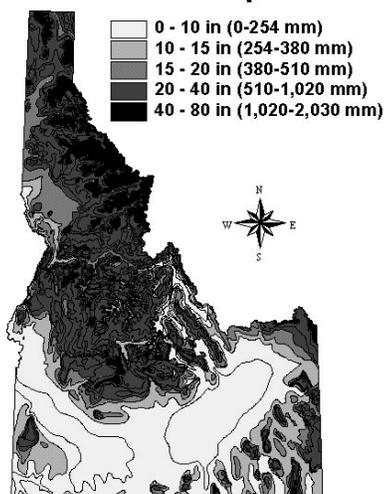
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native to eastern US, but not to Idaho.

VEGETATIVE CHARACTERISTICS: Leaves are fine. Roots are weakly rhizomatous and can reach a minimum depth of 12 in (31 cm). Grows 16-39 in (40-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 18-40 in (460-1,010 mm).

Elevation zone. Ranges from 3,700-8,000 ft (1,128-2,438 m).

Habitat & Climate requirements. Adapted to cool, moist, climatic conditions.

Soil type. Well-drained, sandy, or gravelly soils with a pH of 5.5-6.5.

APPLICATIONS:

Roadside suitability. Low growing, hardy, and competitive. Used for stabilizing roadsides, waterways, slopes, banks, cuts, and fills. Tolerates shade and salt.

Establishment. Develops slowly. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Turf application, 4 lb PLS per acre (4.5 kg/ha). There are 615,000 seeds per lb (1,353,000 seeds per kg).

Rough Fescue

Festuca scabrella



James Stubbendieck et al. (1997)

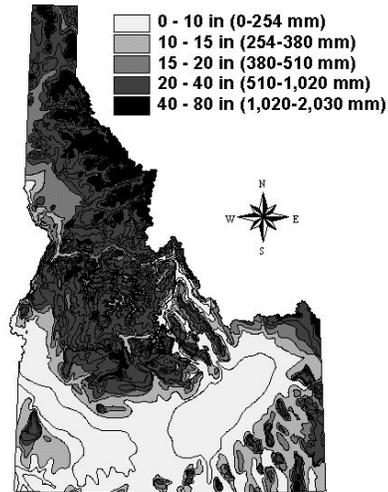
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect and tufted. Leaves are prominently ridged and mostly basal. Roots can reach a minimum depth of 14 in (36 cm). Grows 12-48 in (30-122 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 20-40 in (510-1,010 mm).

Elevation zone. Up to 10,000 ft (3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions. Requires 90 frost-free days and tolerates temperatures to -38 F (-53 C).

Soil type. Deep, dry, medium- and coarse-textured soils.

APPLICATIONS:

Roadside suitability. Forms an extensive fibrous root system.

Establishment. Easily established. Stands take 3-4 years to fully develop.

SEEDING RECOMMENDATIONS: Plant at a shallow depth. Seed 16 lb PLS per acre (18 kg/ha). There are 200,000 seeds per lb (440,000 seeds per kg).

Barley

Hordeum vulgare



A.S. Hitchcock (1971)

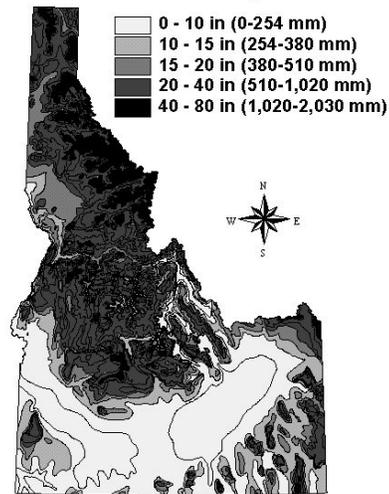
LIFE SPAN: Annual.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Blades are flat, with an erect spike inflorescence. Roots can reach a minimum depth of 12 in (31 cm). Grows 23-47 in (60-120 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12 in (300 mm).

Elevation zone. Up to 7,000 ft (2,135 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions.

Soil type. Medium- to fine-textured with neutral pH.

APPLICATIONS:

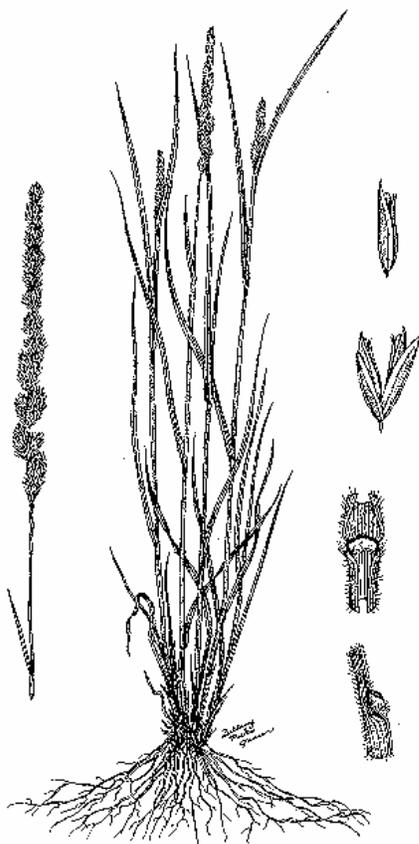
Roadside suitability. Used as a cover or nurse crop. Perennials will out-compete. Moderately tolerates drought and alkaline or saline soils.

Establishment. Excellent initial germination.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. For crops, seed 60-100 lb PLS per acre (67.2-112.1 kg/ha). There are 12,500 seeds per lb (27,500 seeds per kg).

Prairie Junegrass

Koeleria cristata



James Stubbendieck et al. (1997)

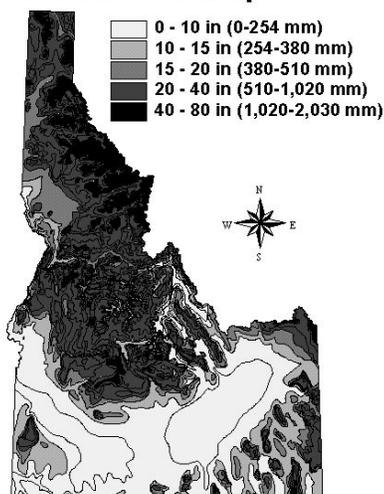
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season, erect, and tufted. Leaves are basal, short, and dense. Roots can reach a minimum depth of 20 in (51 cm). Grows 12-24 in (30-60 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-20 in (300-510 mm).

Elevation zone. Up to 7,500 ft (2,288 m).

Habitat & Climate requirements. Temperate zones. Requires a minimum 150 frost-free days and minimum winter temperatures to -40 F (-40 C).

Soil type. Well-drained, shallow, deep to very deep clay loam, silty-to-sandy soils with a pH of 6.5-8.0.

APPLICATIONS:

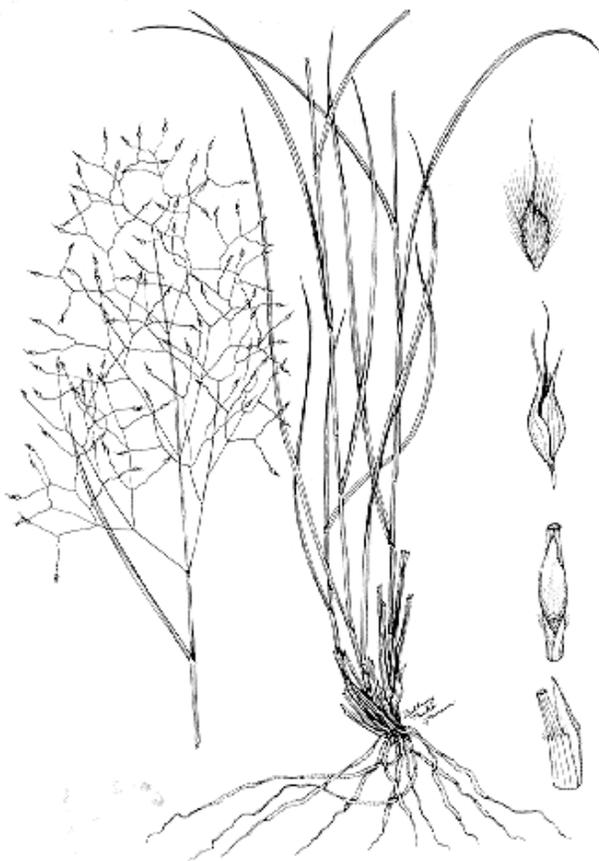
Roadside suitability. Fairly tolerant of drought, fire, shade, and saline conditions.

Establishment. Good germination rate and slow to moderate seedling growth with a low-to-moderate fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 700,000-2,315,400 seeds per lb (1,540,000-5,093,880 seeds per kg).

Indian Ricegrass

Oryzopsis hymenoides



James Stubbendieck et al. (1997)

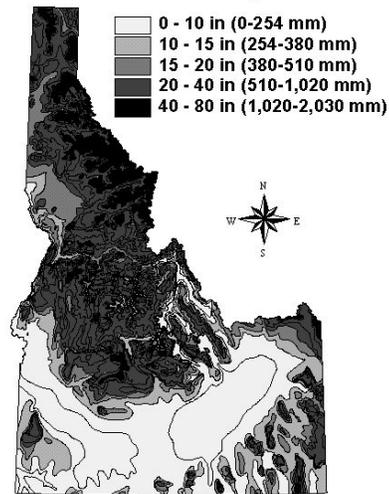
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Warm- or cool-season and densely tufted. Leaf blades are slender and involute. Inflorescence is a diffuse panicle. Roots are fibrous, deep, and well developed, and can reach a minimum depth of 18 in (46 cm). Grows 4-24 in (10-60 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 0-15 in (0-380 mm).

Elevation zone. Ranges from 0-8,200 ft (0-2,500 m).

Habitat & Climate requirements. Arid and semi-arid climates throughout the Intermountain West.

Soil type. Well-drained, coarse-textured, sandy loams.

APPLICATIONS:

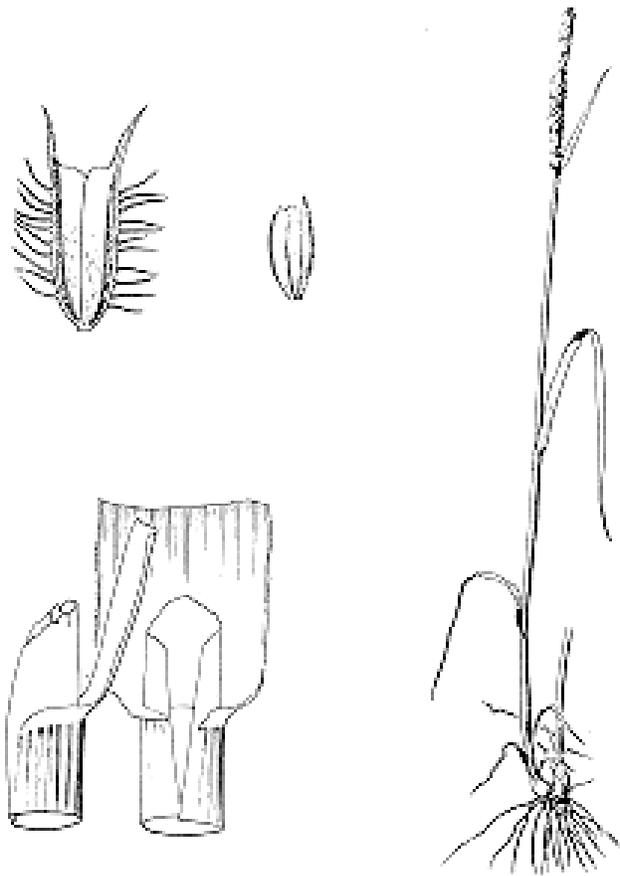
Roadside suitability. Hardy and reduces wind erosion on sandy soils. Used for land reclamation. Tolerates drought, fire, and weak salinity. Intolerant of shade.

Establishment. Difficult to germinate and slow to establish.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 3 in (8 cm). Seed 6-8 lb PLS per acre (6.7-9 kg/ha). There are 141,000 seeds per lb (310,200 seeds per kg).

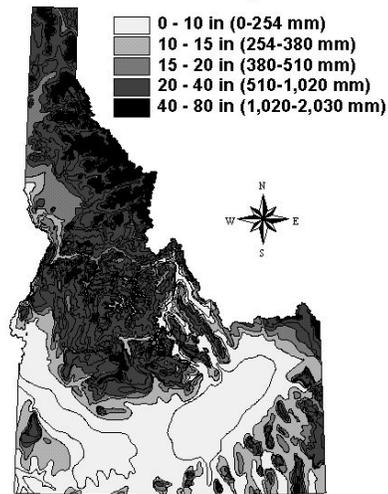
Timothy

Phleum pratense



Patricia A. Patterson et al. (1985)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 16 in (410 mm).

Elevation zone. Up to 8,400 ft (2,560 m).

Habitat & Climate requirements. Adapted to cool humid areas in the temperate zone of the west. Withstands temperatures to -40 F (-40 C).

Soil type. Poorly-drained, alluvial, clay-to-sandy loam soils with pH of 5.0-7.5.

APPLICATIONS:

Roadside suitability. Used for hay and erosion control. Tolerates shade and moderate levels of salinity.

Establishment. Good germination rate, moderate seedling growth, establishes cover quickly with a moderate fertility requirement. Tolerates shade and moderate levels of saline.

SEEDING RECOMMENDATIONS: Plant in fall or spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 1,300,000 seeds per lb (2,860,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Clums 19-39 in (50-100 cm) tall, from a swollen or bulblike base, forming large clumps. Blades are elongate, with a crowded spikelet inflorescence. Roots will reach a minimum depth of 10 in (25 cm).

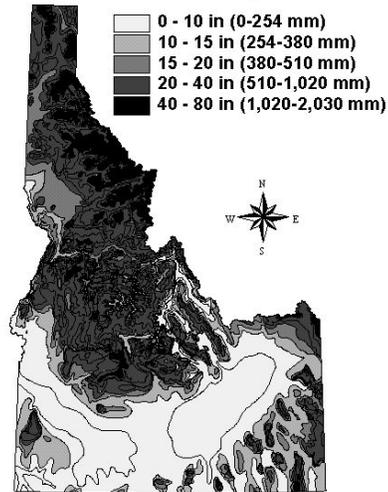
Canby Bluegrass

Poa canbyi



J. Looman (1983)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 9-20 in (230-510 mm).

Elevation zone. Up to 5,000 ft (1,525 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the Intermountain area.

Soil type. Well-drained, dry, rocky, and sandy soils of medium-texture with neutral pH.

APPLICATIONS:

Roadside suitability. Low-growing, vigorous, and a good competitor for cheatgrass. Tolerates drought.

Establishment. Difficult to establish and slow-to-moderate seedling growth.

SEEDING RECOMMENDATIONS: Plant in late fall at a depth of 0.25 in (0.6 cm). Seed 5 lb PLS per acre (5.6kg/ha). There are 926,000 seeds per lb (2,037,200 seeds per kg).

LIFE SPAN: Perennial, long-lived.

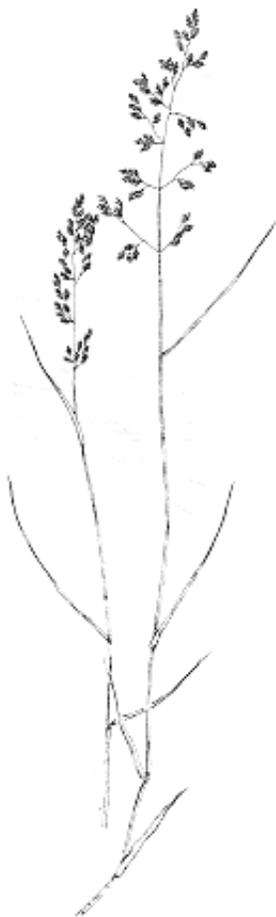
GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are basal and abundant. Roots are shallow and fibrous, reaching a minimum depth of 10 in (25 cm). Grows 13-24 in (33-61 cm).

Canada Bluegrass

Poa compressa



R.H. Mohlenbrock (1972)

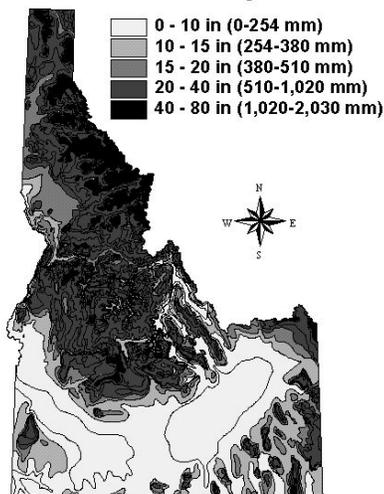
LIFE SPAN: Perennial, short-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are short. Inflorescence is a panicle. Stems are flat. Roots are fibrous with short rhizomes and stolons and a minimum rotting depth of 1 in (2.5 cm). Grows 6-20 in (15-50 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-40 in (380-1,010 mm).

Elevation zone. Adapted to a wide range.

Habitat & Climate requirements. Adapted to the climatic conditions of dry sites. Withstands temperatures to -40 F (-40 C).

Soil type. Shallow, poor, dry, clay-to-sandy loam soils with a pH of 5.0-7.5.

APPLICATIONS:

Roadside suitability. Short, hardy, and requires little maintenance. Considered a weed on fertile, moist pastures designed for high productivity. Used for erosion control on roadsides, ditch banks, and borrow pits. Tolerates shade and moderate salinity.

Establishment. Slow to establish. Rapid seedling growth and medium germination rate. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 1-4 lb PLS per acre (1.1-4.5 kg/ha). There are 2,500,000 seeds per lb (5,500,000 seeds per kg).

Nevada Bluegrass

Poa nevadaensis



R.H. Mohlenbrock (1972)

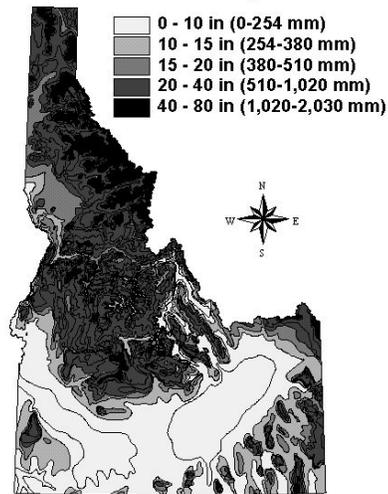
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool season. Erect and tufted. Branches are loose. Inflorescence is a narrow panicle. Roots can reach a minimum depth of 10 in (25cm). Grows 20-40 in (50-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-15 in (250-380 mm).

Elevation zone. Wide range.

Habitat & Climate requirements. Adapted to moist sagebrush and ponderosa pine areas throughout the Intermountain West.

Soil type. Well-drained, sandy, or loamy soils.

APPLICATIONS:

Roadside suitability. Tolerates medium-acidic to alkaline soils.

Establishment. Moderate to difficult to establish with slow to moderate seedling development. Excellent competition when established.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. There are 1,082,000 seeds per lb (2,380,400 seeds per kg).

Kentucky Bluegrass

Poa pratensis



James Stubbendieck et al. (1997)

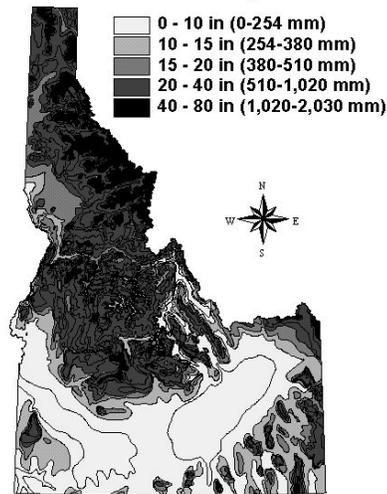
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Sod-former.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season and tufted. Culms are hollow. Base is bulb-like. Roots are shallow and fibrous reaching a minimum depth of 10 in (25 cm). Grows up to 40 in (101 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 18 in (460 mm) or more.

Elevation zone. Up to 10,000 ft (3,050 m).

Habitat & Climate requirements. Adapted to cool, moist, growing conditions. Withstands temperatures to -40 F (-40 C).

Soil type. Shallow, well-drained, clay loam-to-sandy loam alluvial soils of limestone origin with neutral pH. Shallow, nonplowable, rocky areas.

APPLICATIONS:

Roadside suitability. Aggressive competitor. Used for lawns, parks, cemeteries, turf, golf courses, and land reclamation. Considered a weedy species in agriculture. Moderately sensitive to saline conditions. Tolerates long summer dry periods and moderate shade.

Establishment. Seeds remain viable for 5 years, easy to germinate, slow to moderate seedling growth. Moderate fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall or spring at a depth of 0.25 in (0.6 cm) or less. Seed 2-3 lb PLS per acre (1.1-3.4 kg/ha). There are 2,177,000 seeds per lb (4,789,400 seeds per kg).

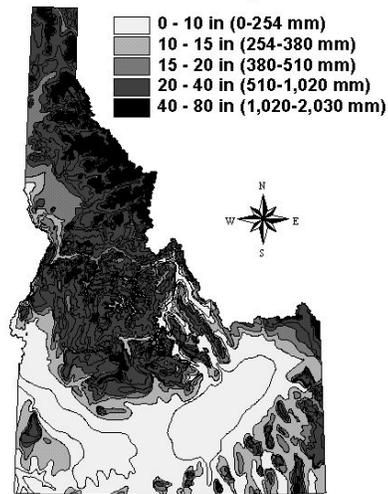
Sandberg Bluegrass

Poa sandbergii



Richard W. Scott (1995)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 8 in (200 mm).

Elevation zone. Ranges from 1,000-12,000 ft (305-3,660 m).

Habitat & Climate requirements. Adapted to the climatic conditions of semi-desert areas. Plains, dry woods and rocky slopes.

Soil type. Moderately coarse- to moderately fine-textured clay loam soils with a neutral pH.

APPLICATIONS:

Roadside suitability. Low growing. Starts growth early in the spring with adequate moisture and stays green late into the summer. Tolerates drought.

Establishment. Low seed viability.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth less than 1 in (3 cm). Seed 2-4 lb PLS per area (2.2-4.5 kg/ha). There are 925,000 seeds per lb (2,035,000 seeds per kg).

LIFE SPAN: Perennial, long-lived.

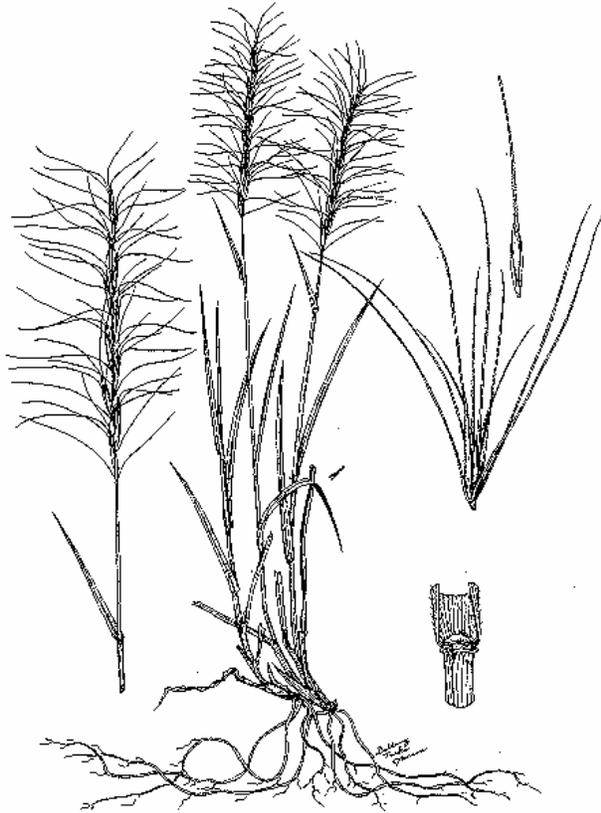
GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are mostly basal, narrow, and curly at maturity. Inflorescence are narrow and compact. Roots are fibrous and reach a minimum depth of 10 in (25 cm). Grows 1-12 in (3-30 cm) tall.

Bottlebrush Squirreltail

Sitanion hystrix



James Stubbendieck et al. (1997)

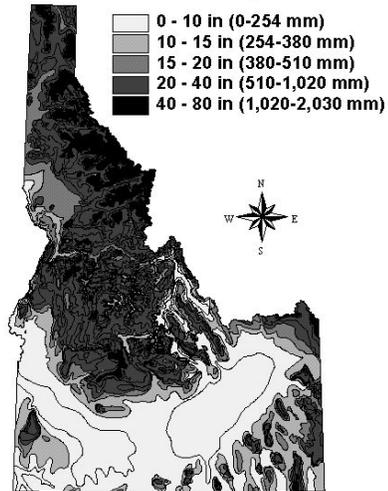
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season, tufted, with bristly inflorescence. Leaves are glabrous to densely white pubescent. Grows 4-20 in (10-50 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-16 in (150-410 mm).

Elevation zone. Middle to high elevations.

Habitat & Climate requirements. Adapted to the climatic conditions of dry hills, plains, open woods, and rocky slopes.

Soil type. Dry, gravelly, shallow to deep soils.

APPLICATIONS:

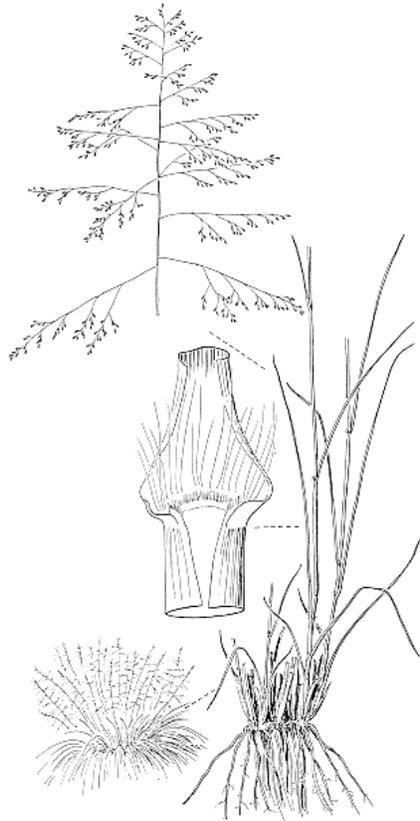
Roadside suitability. Seed availability is limited. Short to medium sized, used for revegetation of disturbed lands. Tolerates drought and alkaline conditions.

Establishment. 40-60 % germination in the first year.

SEEDING RECOMMENDATIONS: Plant in fall. Seed 8-10 lb PLS acre (9-11.2 kg/ha). There are 192,000 seeds per lb (422,400 seeds per kg).

Alkali Sacaton

Sporobolus airoides



R.H. Mohlenbrock (1972)

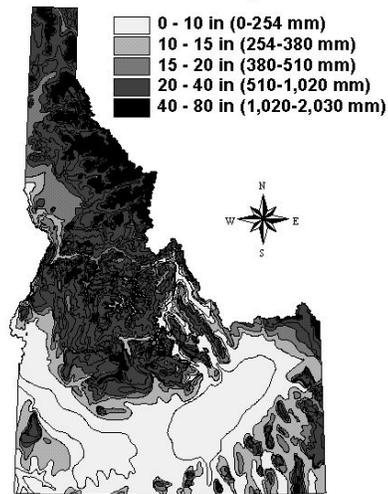
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Warm-season, erect to spreading, robust, and densely tufted. Leaves are elongated and flat. Roots are fibrous with short rhizomes and can reach a minimum depth of 16 in (41 cm). Grows 20-40 in (50-100 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-10 in (150-250 mm).

Elevation zone. Ranges from 3,500-8,000 ft (1,000-2,300 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions in low, slightly moist, alkaline flats, desert drainages, semi-desert areas, open plains, valleys, and bottom lands.

Soil type. Poorly-drained, fine-textured clayey soils that are alkali or saline-alkali.

APPLICATIONS:

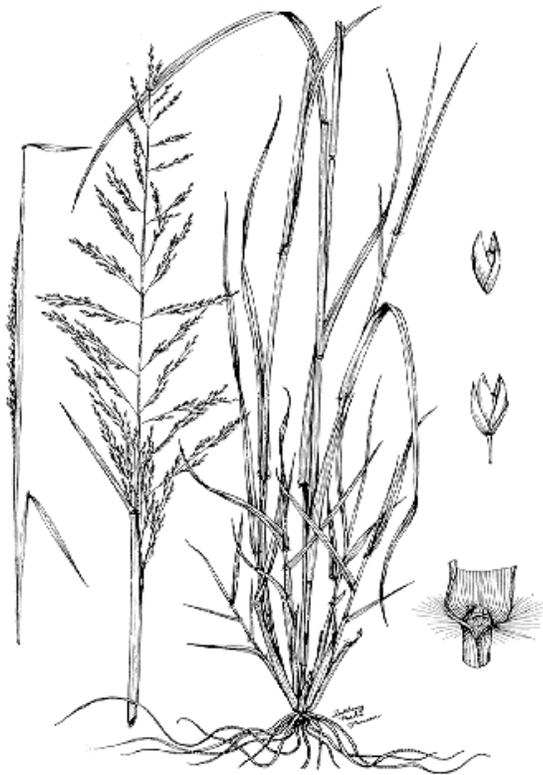
Roadside suitability. Minimal maintenance required. Used to reseed lowlands and reduce erosion. Tolerates drought, cold, alkaline, and saline conditions.

Establishment. Seeds must undergo an afterripening period of several months for good germination results.

SEEDING RECOMMENDATIONS: Plant in early spring or fall. Seed 2-3 lb PLS per acre (2.2-3.4 kg/ha). There are 1,750,000 seeds per lb (3,850,000 seeds per kg).

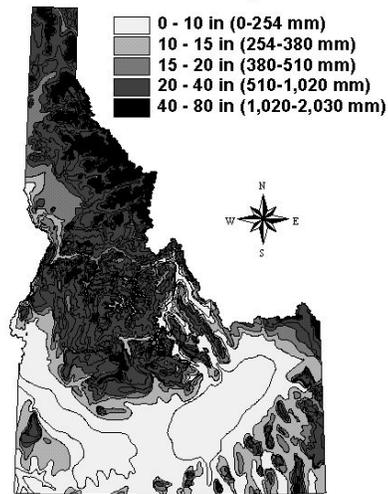
Sand Dropseed

Sporobolus cryptandrus



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-40 in (260-1,020 mm).

Elevation zone. Up to 8,000 ft (2,440 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions, especially suited to open areas and disturbed sites.

Soil type. Dry, coarse, shallow, sandy, and calcareous sites.

APPLICATIONS:

Roadside suitability. Used for erosion control. Tolerates alkaline conditions and drought. Intolerant of shade.

Establishment. Medium germination rate, prolific seeder, established easily, and seeds are long-lived.

SEEDING RECOMMENDATIONS: Plant in spring at a depth of 0.25-0.5 in (0.6-1.3 cm). Seed 1 lb PLS per acre (1.1 kg/ha). There are 5,298,000 seeds per lb (11,655,600 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Warm-season and tufted. Leaves are involute. Stems are leafy and spreading. Roots are fibrous and reach a minimum depth of 18 in (46 cm). Grows 12-40 in (30-100 cm) tall.

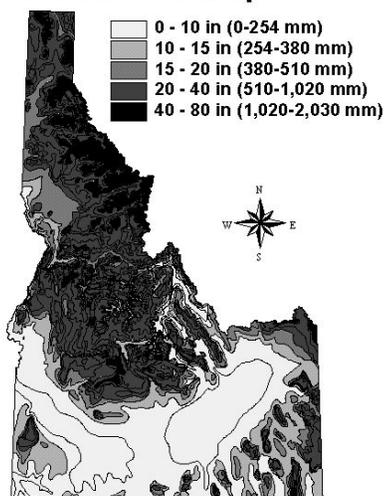
Needle and Thread

Stipa comata



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. 9 in (229 mm) or less

Elevation zone. Ranges from 300-5,000 ft (92-2,593 m).

Habitat & Climate requirements. Adapted to the dry climatic conditions of the Intermountain Pacific Northwest.

Soil type. Shallow, calcareous, well-drained, sandy and gravelly soils with a neutral pH.

APPLICATIONS:

Roadside suitability. Long awns cause problems with seed collection and application. Tolerates drought.

Establishment. Medium germination rate. Low fertility requirement.

SEEDING RECOMMENDATIONS: Plant in fall. Seed 8 lb PLS per acre (9 kg/ha). There are 115,000 seeds per lb (253,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season, erect, densely tufted, and very leafy. Inflorescence is a narrow panicle. Awns are long, twisted, and tapering. Roots are fibrous and extend 3-5 ft (0.9-2 m). Grows 12-24 in (30-60 cm) tall.

Western Needlegrass

Stipa occidentalis



Richard W. Scott (1995)

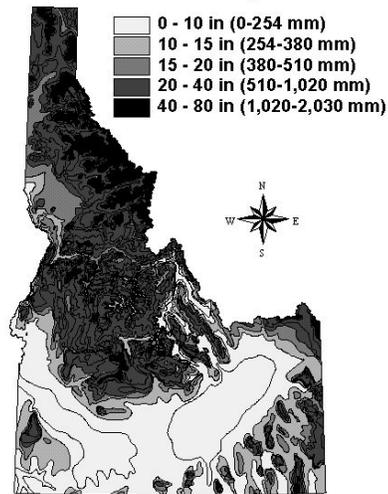
LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Stems are slender. Leaf blades are 4-12 in (10-20 cm) long, usually involute and ascending. Roots are spreading, deep, and penetrating and reach a minimum depth of 16 in (41 cm). Grows 12-30 in (31-76 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-20 in (250-510 mm).

Elevation zone. Ranges from 4,500-10,000 ft (2,013-3,050 m).

Habitat & Climate requirements. Adapted to the climatic conditions of plains, ridges, and open timber extending from upper foothills into higher mountains.

Soil type. Dry, well-drained soils.

APPLICATIONS:

Roadside suitability. Soil stabilizer, tolerates drought. Well suited to disturbed areas.

Establishment. Seeds are large with awns that must be removed before planting. Starts growth early, but establishes and matures slowly.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 3-5 lb PLS per (3.4-5.6 kg/ha) if planted alone. In a mixture seed 1 lb (1.1 kg/ha). There are 311,000 seeds per lb (684,200 seeds per kg).

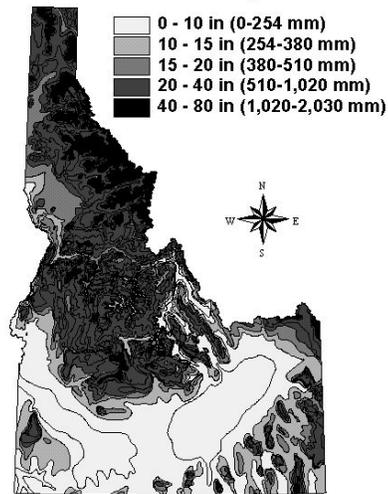
Thurber's Needlegrass

Stipa thurberiana



R.H. Mohlenbrock (1972)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-15 in (200-390 mm).

Elevation zone. Ranges from 6,500-9,000 ft (1,983-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions.

Soil type. Rocky, shallow soils.

APPLICATIONS:

Roadside suitability. Good soil stabilize and medium statured. Tolerates drought.

Establishment. Low seedling vigor and germination rates. Awns may interfere with seeding.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 7 lb PLS per acre (7.8 kg/ha). There are 150,000 seeds per lb (330,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Bunchgrass.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are very fine with ascending branches. Inflorescence is a long and narrow panicle. Roots can reach a minimum depth of 10 in (25 cm). Grows 12-20 in (30-50 cm) tall.

Spring Wheat

Triticum aestivum



A.S. Hitchcock (1971)

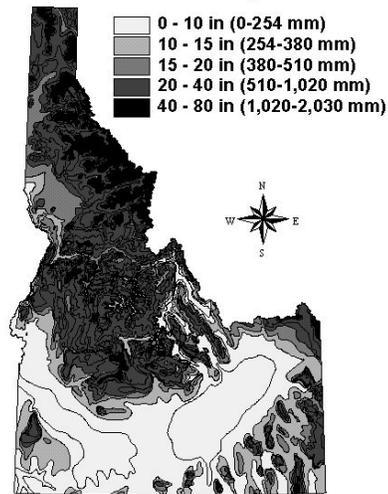
LIFE SPAN: Annual.

GROWTH HABIT: Bunchgrass.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season, erect, and tufted. Roots can reach a minimum depth of 18 in (46 cm). Grows 13-25 in (33-64 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12 in (300 mm).

Elevation zone. Ranges from 0-10,000 ft (0-3,050 m).

Habitat & Climate requirements. Temperate zones.

Soil type. Medium-textured soil with a neutral pH.

APPLICATIONS:

Roadside suitability. Used as a cover, nurse, or temporary erosion control crop. May compete with establishing perennials. Tolerates drought.

Establishment. Slow seed spread rate, but seedling vigor is high.

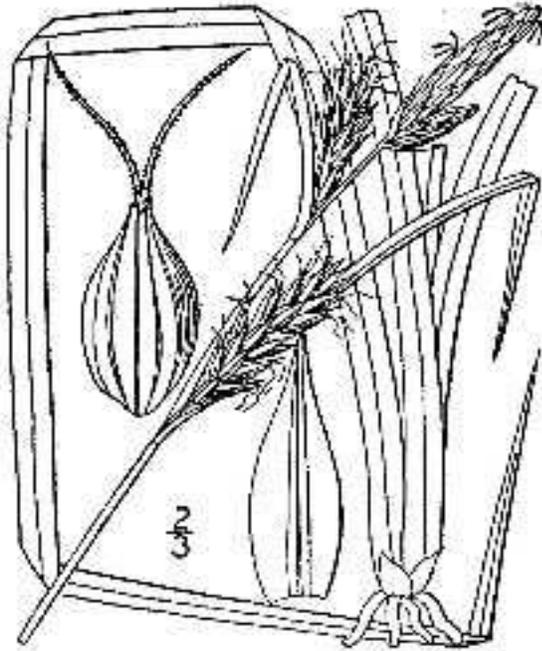
SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 10-14 lb PLS per acre (11.2-15.7 kg/ha). There are 11,000 seeds per lb (24,200 seeds per kg).

Grasslikes



Nebraska Sedge

Carex nebrascensis



Britton, N.L. and A. Brown (1913)

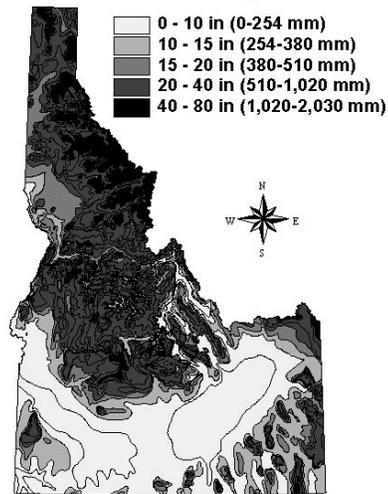
LIFE SPAN: Perennial.

GROWTH HABIT: Sedge, sod-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are light green. Stems are triangular. Base is reddish. Roots are rhizomatous and can reach a minimum depth of 10 in (25 cm). Grows 8-47 in (20-120 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Not a limiting factor for reproduction.

Elevation zone. Up to 9,000 ft (2,745 m).

Habitat & Climate requirements. Wet meadows, swamps, streams, marshes, edges of lakes or ponds, and ditches.

Soil type. Wet, alkaline, moderately fine-textured, loamy soils.

APPLICATIONS:

Roadside suitability. Excellent soil stabilizer. Used for riparian area reclamation.

Establishment. Establishes on dry sites if the roots stay wet.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 5 lb PLS per acre (5.6 kg/ha). There are 534,100 seeds per lb (1,175,020 seeds per kg).

Baltic Rush

Juncus balticus



James Stubbendieck et al. (1997)

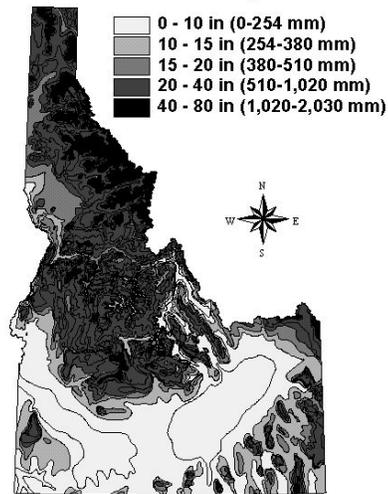
LIFE SPAN: Perennial.

GROWTH HABIT: Sod-forming rush.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Erect. Leaves are wiry and round. Roots are deep and rhizomatous and can reach a minimum depth of 20 in (51 cm). Grows up to 43 in (110 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Requires persistent wet conditions.

Elevation zone. Up to 10,000 ft (3,050 m).

Habitat & Climate requirements. Adapted to the climatic conditions of wetlands and riparian areas.

Soil type. Sometimes associated with alkaline sites. Persists in moist or wet, deep, organic soils or in shallow, gravelly soils if the moisture is ample.

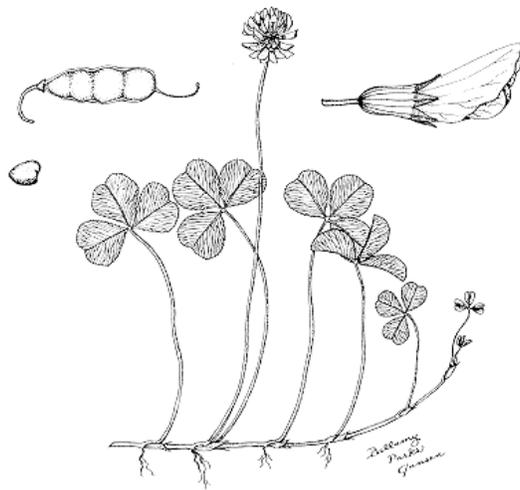
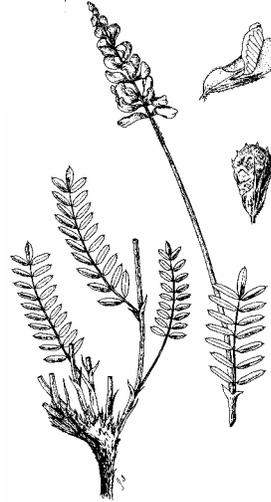
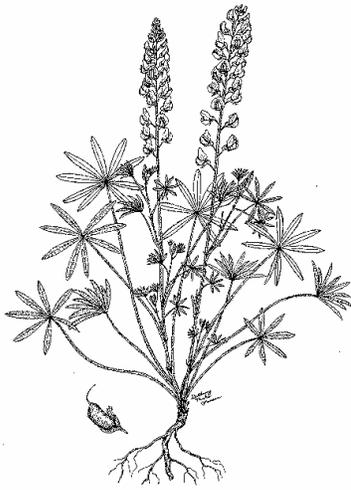
APPLICATIONS:

Roadside suitability. Excellent for rehabilitating wetland and riparian areas.

Establishment. Medium germination rate with slow seedling development.

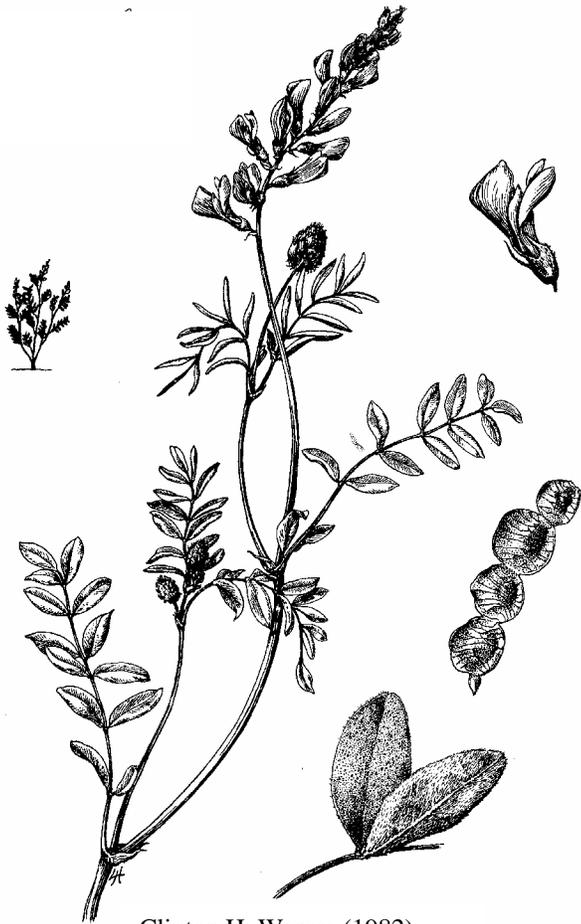
SEEDING RECOMMENDATIONS: Plant in the fall or spring. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 109,301,000 seeds per lb (240,462,200 seeds per kg).

Legumes



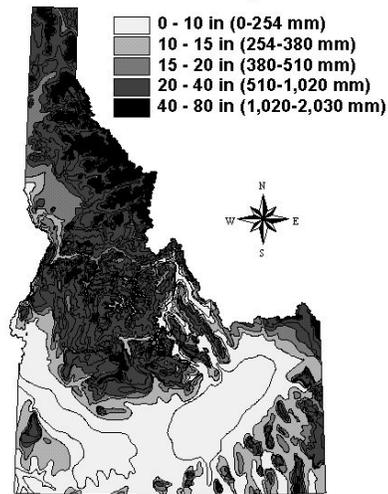
Northern Sweetvetch

Hedysarum boreale



Clinton H. Wasser (1982)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 10 in (250 mm).

Elevation zone. Approximately 8,500 ft (2,593 m).

Habitat & Climate requirements. Adapted to open, exposed, rocky hillsides, and canyons.

Soil type. Well-drained, medium-textured, sandy or clay soils.

APPLICATIONS:

Roadside suitability. Provides good soil stability. Tolerates drought.

Establishment. Good to excellent seedling vigor. Establishes well by the second year. Fair compatibility with other species. Moderately competitive to a native species.

SEEDING RECOMMENDATIONS: Plant in the spring. Seed 15 lb PL per acre (16.8 kg/ha). There are 33,600 seeds per lb (73,920 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Herbaceous legume.

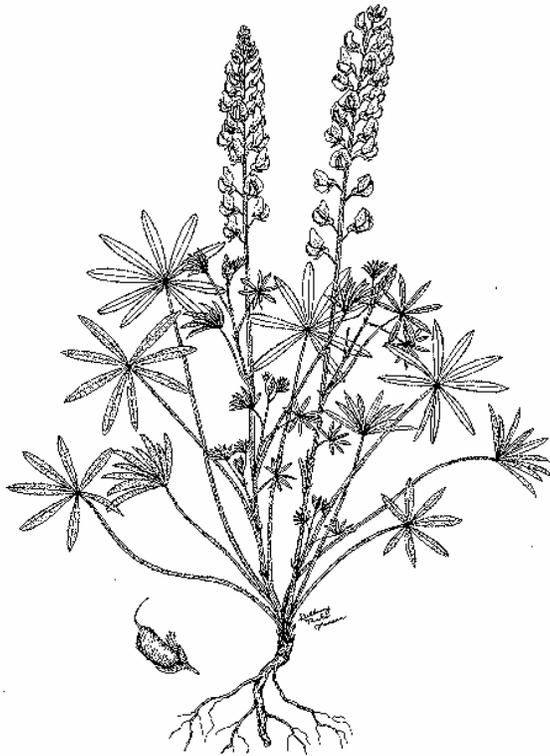
ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Flowers are pink-purple, pea-type, and in spike-like clusters. Leaves are oblong and pinnately compound. Stems are square and reddish. Roots can reach a minimum depth of 18 in (46 cm). Grows 10-24 in (25.4-61 cm) tall.

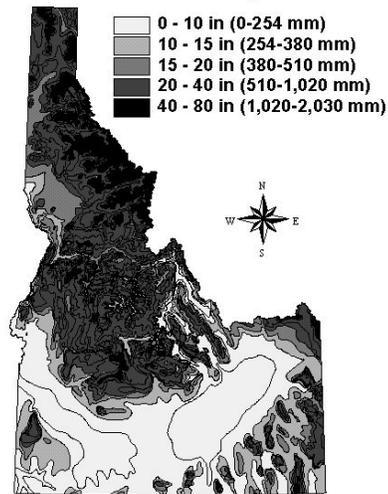
Tailcup Lupine

Lupinus caudatus



James Stubbendeck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Wide range.

Elevation zone. Up to 10,500 ft (3,203 m).

Habitat & Climate requirements. Adapted to a wide range of conditions on open sites.

Soil type. Course or fine well-drained, dry-to-moist, calcareous soils.

APPLICATIONS:

Roadside suitability. Well suited to disturbed sites. Susceptible to fire. Partially tolerates shade and alkaline conditions.

Establishment. Propagate by plant divisions, shoot cuttings, or seeds. Fairly easy to establish.

SEEDING RECOMMENDATIONS: Plant in the spring. Seed 11-35 lb PLS per acre (12.3-39.2 kg/ha). There are 21,000-135,000 seeds per lb (46,200-297,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Herbaceous legume.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Flowers are in dense racemes, attractive, and blue. Taprooted with some fibrous roots that can reach a minimum depth of 6 in (15 cm). Grows 12-24 in (30-61 cm) tall.

Alfalfa

Medicago sativa



James Stubbendieck et al. (1997)

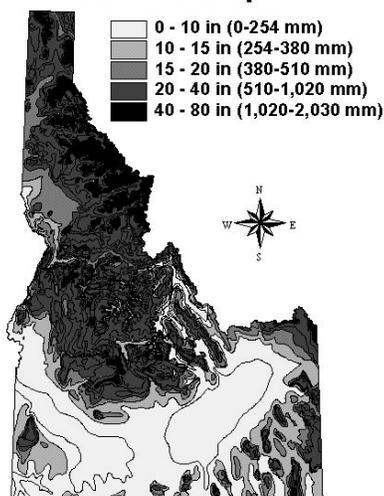
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Herbaceous legume.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Leaves are alternate and pinnately trifoliate. Stems are erect and grow from a woody crown. Flowers are violet-blue. Taproot that can reach minimum depths of 24 in (61 cm). Grows less than 24 in (61 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-18 in (307-460 mm).

Elevation zone. Below 7,500 ft (2,270 m).

Habitat & Climate requirements. Adapted to semi-arid climatic conditions.

Soil type. Deep, well-drained soils of all textures with a pH of 6.5 or above.

APPLICATIONS:

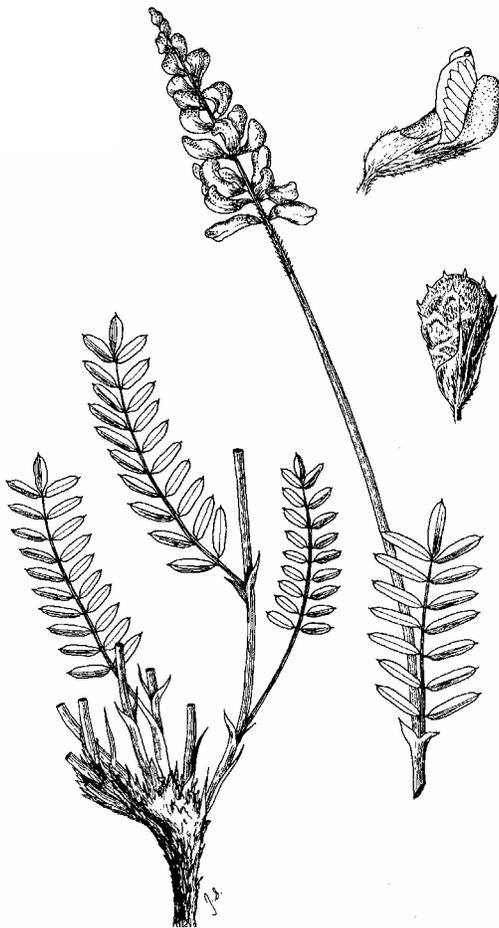
Roadside suitability. Used for windbreaks and cover crops. Winter-hardy. Tolerates drought and full sunlight.

Establishment. Easily established and persistent on disturbed sites or areas of construction.

SEEDING RECOMMENDATIONS: Plant in early spring or fall at a depth of 0.25 in (0.65 cm). Seed 8-15 lb PLS per acre (5.6-16.8 kg/ha). There are 210,000 seeds per lb (462,000 seeds per kg).

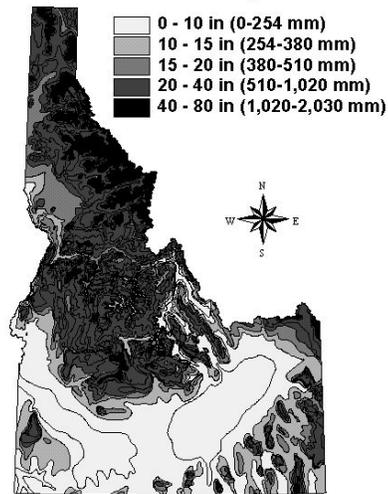
Sanfoin

Onobrychis viciaefolia



Clinton H. Wasser (1982)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-18 in (380-460 mm).

Elevation zone. Above 4,000 ft (1,220 m).

Habitat & Climate requirements. Adapted to the Northern Great Plains and Intermountain regions.

Soil type. Well-drained, medium-textured, sandy-to-loamy soils.

APPLICATIONS:

Roadside suitability. Moderately tall in stature. Tolerates drought, frost and alkaline conditions. Deep tap root.

Establishment. Easy to establish, a good seed producer, and long-lived once established.

SEEDING RECOMMENDATIONS: Plant in spring at a depth of 0.25-0.75 in (0.6-1.9 cm). Seed 20 lb PLS per acre (22.4 kg/ha).

LIFE SPAN: Perennial, long-lived.

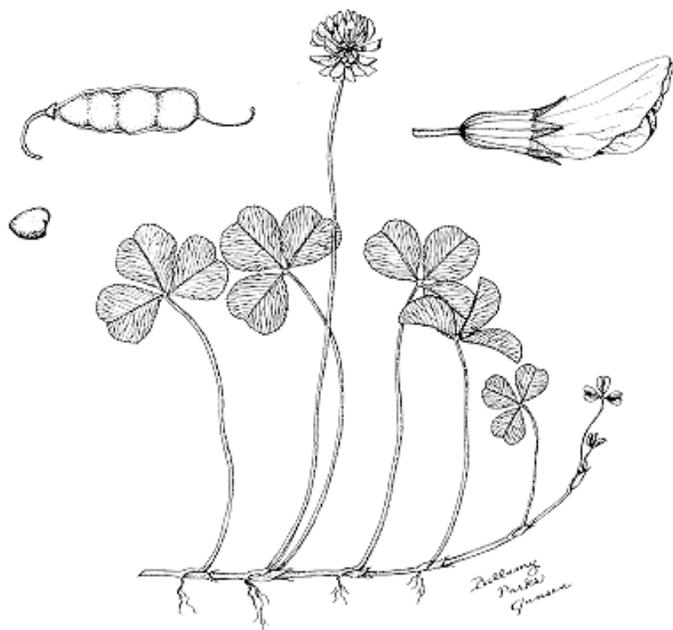
GROWTH HABIT: Herbaceous legume.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Cool-season. Upright and leafy. Flowers are pink. Roots can reach a minimum depth of 14 in (36 cm). Grows 25 in (64 cm) or taller.

White Dutch Clover

Trifolium repens



James Stubbendieck et al. (1997)

LIFE SPAN: Perennial, long-lived.

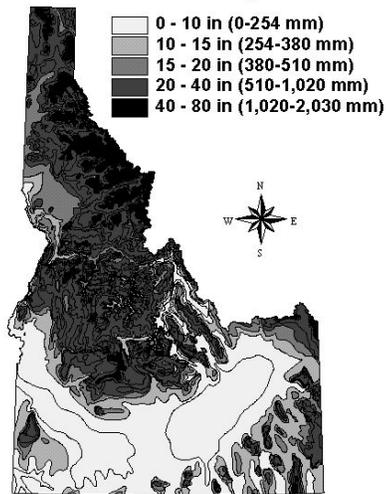
GROWTH HABIT: Herbaceous legume.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS:

Branches are creeping. Flowers are white to pink born on long stalks. Roots are up to 24 in (61 cm) deep. Grows less than 12 in (61 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Over 20 in (520 mm).

Elevation zone. Ranges from 0-14,000 ft (0-4,270 m).

Habitat & Climate requirements. Adapted to a cool, moist, humid climatic conditions.

Soil type. Clay and silt loams of medium-to-high fertility or shallow, sandy soils with a high water table.

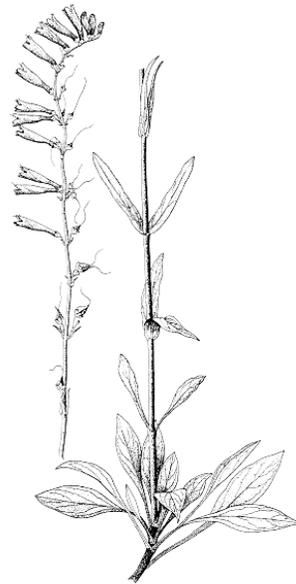
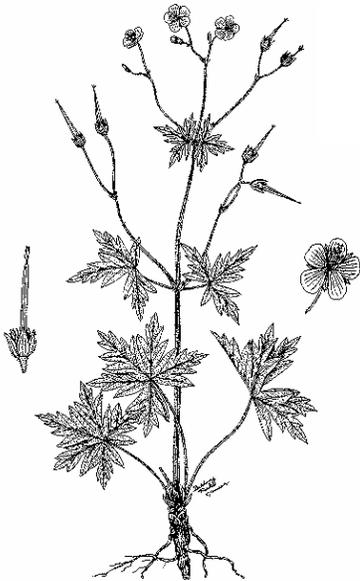
APPLICATIONS:

Roadside suitability. Short and creeping. Used for erosion control on streambanks and roadsides. Cold-hardy. Tolerates poor drainage and shade. Intolerant of strongly acidic or alkaline conditions. Also a weak sod-former.

Establishment. Easy to establish, good seed producer, and long-lived once established.

SEEDING RECOMMENDATIONS: Plant in spring or fall. Seed 2-6 lb PLS per acre. (2.2-6.7 kg/ha). There are 850,000 seeds per lb (1,870,000 seeds per kg).

Forbs



Western Yarrow

Achillea millefolium



James Stubbendieck et al. (1997).

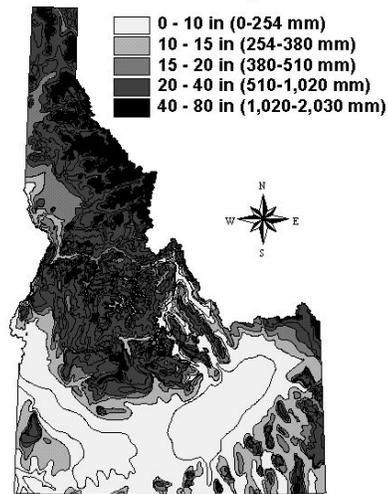
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are basal and fern-like with dense silky hairs. Flowers are white, rounded, and clustered in a terminal corymb. Roots are fibrous with well-developed rhizomes that can reach a minimum depth of 8 in (20 cm). Grows 12-36 in (30-91 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 20 in (510 mm).

Elevation zone. Ranges from 200-9,000 ft (61-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions. Requires 120 frost-free days and can withstand temperatures as low as -38 F (-53 C).

Soil type. Commonly found on sandy and gravelly loams that are weakly basic to weakly acidic.

APPLICATIONS:

Roadside suitability. Turf-forming. Good stabilization value. Found on disturbed sites and roadsides. Resistant to drought and fire.

Establishment. Reproduces by seeds and root stalks and is easily established.

SEEDING RECOMMENDATIONS: Drill or broadcast in fall or early spring. Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 2,770,000 seeds per lb (6,094,000 seeds per kg).

Rosy Pussytoes

Antennaria microphylla



John J. Craighread et al. (1963)

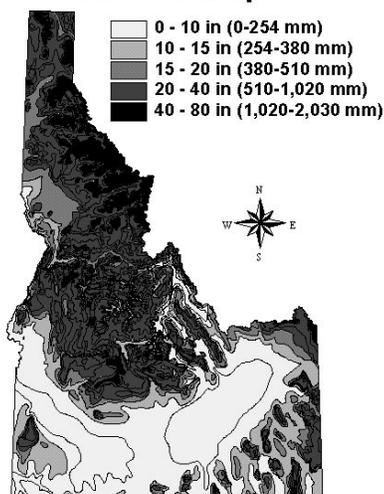
LIFE SPAN: Perennial.

GROWTH HABIT: Forb, mat-former.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Woody rosette. Leaves are alternate. Flowers are densely clustered, white to pink, with male and females on separate plants. Roots are fibrous with stolons, reaching minimum rooting depths of 12 in (31 cm). Grows 6 in (15 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-20 in (380-510 mm).

Elevation zone. Ranges from 6,000-9,000 ft (1,830-2,745 m).

Habitat & Climate requirements. Adapted to meadows and open hillsides in the northern temperate zone. Requires 90 frost-free days and can withstand temperatures to -38 F (-53 C).

Soil type. Dry-to-moist soil conditions.

APPLICATIONS:

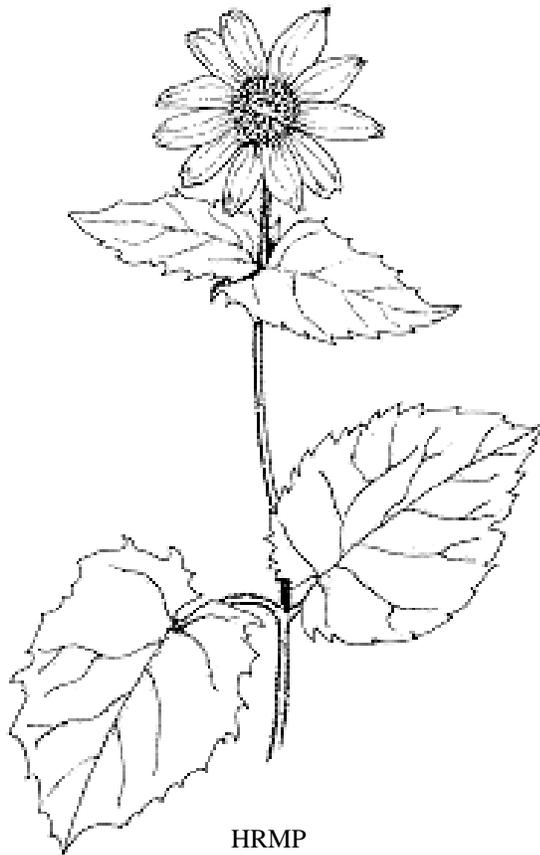
Roadside suitability. Good potential for soil stabilization. Well adapted to disturbed sites and construction areas.

Establishment. Produces seed without aid of fertilization. Limited seed availability, but easy to establish from seeding.

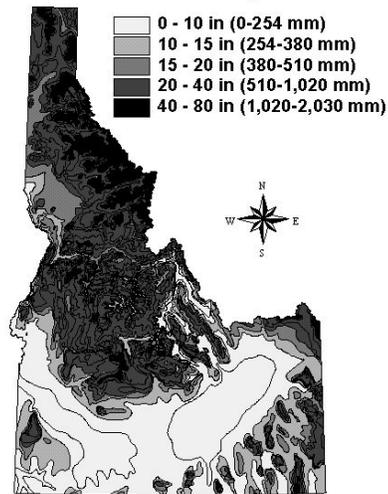
SEEDING RECOMMENDATIONS: Direct broadcast 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 8,000,000 seeds per lb (17,600,000 seeds per kg).

Heartleaf Arnica

Arnica cordifolia



Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-35 in (25-89 cm).

Elevation zone. Ranges from 1,000-11,000 ft (305-3,355 m).

Habitat & Climate requirements. Warm, moist forests at mid-elevations in the Pacific Northwest. Requires 130 frost-free days and can withstand temperatures as low as -28 F (-48 C).

Soil type. Fine-, medium-, and coarse-textured soils, with high moisture content.

APPLICATIONS:

Roadside suitability. Moderate soil stabilization limited to open forest understory. Attractive low growing plant that provides good cover for soil protection. Shade and fire tolerant.

Establishment. Seedling vigor is high and seed and vegetative spread rates are rapid, but cold stratification is required. Can also be propagated by corms, cuttings, and sprigs.

SEEDING RECOMMENDATIONS: Plant in early spring. Plant between 1200-4800 per acre. There are 220,000 seeds per lb (484,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are basal and heart-shaped. Flowers are large, yellow, and born in a loose cyme. Roots are fibrous with rhizomes and reach a minimum depth of 6 in (15 cm). Grows 6-24 in (15-61 cm) tall.

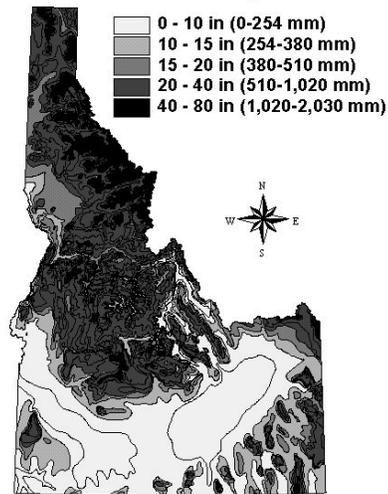
Gray Aster

Aster glaucodes



Richard W. Scott (1995)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 14-30 in (359-769 mm).

Elevation zone. Ranges from 4,000-10,000 ft (1,220-3,050 m).

Habitat & Climate requirements. Adapted to the western United States on dry, exposed, disturbed, and depleted lands. Requires 130 frost-free days and can withstand temps to -43 F (-56 C).

Soil type. Medium- to moderately-coarse-textured soils.

APPLICATIONS:

Roadside suitability. High stabilization value. Useful plant in erosive areas. Tolerates drought and fire.

Establishment. Moderate moisture requirement.

SEEDING RECOMMENDATIONS: Direct seed or transplant in the fall at a depth of 0.5 in (1.3 cm). Seed 5 lb PLS per acre (5.6 kg/ha). There are 540,000 seeds per lb (1,188,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Flowers are white-lavendar. Roots are fibrous with rhizomes and reach a minimum depth of 10 in (25 cm). Grows 24-60 in (61-152 cm) tall.

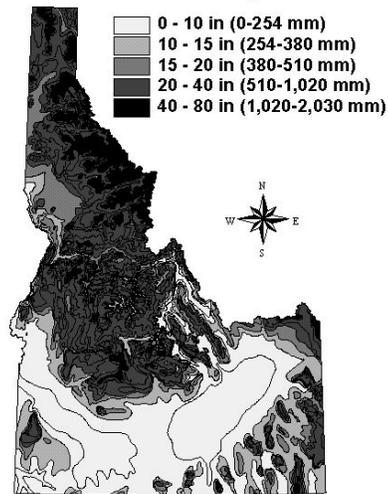
Arrowleaf Balsamroot

Balsamorhiza sagittata



Patricia A. Patterson et al. (1985)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-14 in (200-360 mm).

Elevation zone. Ranges from 4,300-8,300 ft (1,312-2,532 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the Great Basin, Rocky Mountains, and along the foothills up to the aspen zone.

Soil type. Well-drained, deep, sandy, silty, loamy to extremely stony soils. Occasionally found on acidic soils with duripans or hardpans.

APPLICATIONS:

Roadside suitability. Highly productive. Winter-hardy and persists in full sunlight. Tolerates drought.

Establishment. Establishment is slow and seedling vigor is low.

SEEDING RECOMMENDATIONS: Seed in the spring. Broadcast or drill at a depth of 0.33 in (0.84 cm). Plant 16 lb PLS per acre (18 kg/ha). There are 27,000 seeds per lb (59,400 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Tufted. Leaves are broad and arrowhead-shaped. Flowers are showy and yellow. Taproots are deep, reaching a minimum depth of 14 in (36 cm), thick, and woody. Grows 16-30 in (41-76 cm) tall.

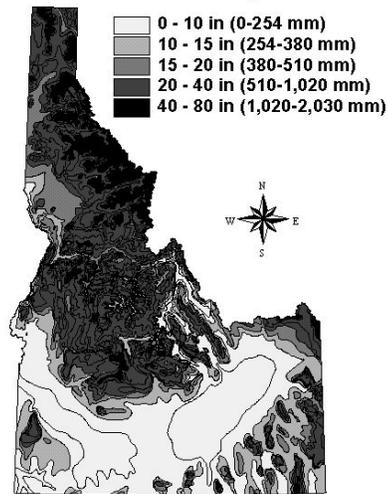
Tapertip Hawksbeard

Crepis acuminata



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-20 in (20-51 cm).

Elevation zone. Up to 8,000 ft (2,440 m).

Habitat & Climate requirements. Adapted to climatic conditions of dry, mountain, prairie, hillsides, broken slopes, and open areas. Requires 110 frost-free days and can withstand temperatures to -38 F (-53 C).

Soil type. Well-drained, shallow, stony soils.

APPLICATIONS:

Roadside suitability. Found on roadsides. Drought tolerant and moderately shade tolerant. Also tolerates moderate amounts of limestone in the soil.

Establishment. Seed spread rate is slow and seedling vigor is low.

SEEDING RECOMMENDATIONS: Plant in early spring. There are 800,000 seeds per lb (1,760,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are grayish, mostly basal, lance-shaped, and dissected into narrow divisions. Flowers are yellow and form cylindrical heads. Taproots can reach a minimum rooting depth of 10 in (25 cm). Grows 8-20 in (20-70 cm) tall.

Yellow Buckwheat

Eriogonum flavum



Charles Grier Johnson (1993)

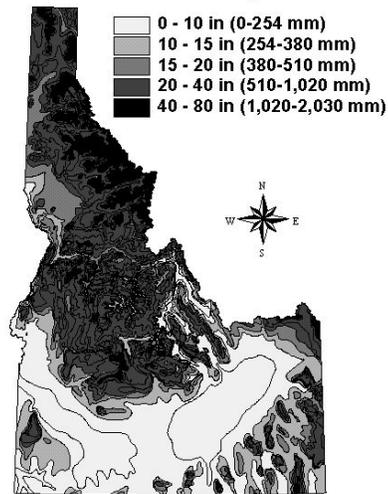
LIFE SPAN: Perennial.

GROWTH HABIT: Forb/small shrub.

ORIGIN: Native

VEGETATIVE CHARACTERISTICS: Leaves in dense clusters that are green above and gray and hairy beneath. Stems are tangled and have wooly hair on surface. Branches are woody. Flowers are simple umbels, small, and yellow. Taproots can reach a minimum depth of 10 in (25 cm). Grows 4-16 in (10-41 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges between 14-20 inches (360-510 mm).

Elevation zone. Adapted to 9,000 ft (2,745 m).

Habitat & Climate requirements. Adapted to arid climatic conditions. On open, dry ridges in grasslands to alpine ridges.

Soil type. Medium-course- to medium-textured soil with neutral pH.

APPLICATIONS:

Roadside suitability. Persistent and compatible with other plants. Branches mat over the ground and provide rapid soil stabilization. Persists in full sunlight to partial shade. Stout, woody taproot.

Establishment. Medium germination and growth rates.

SEEDING RECOMMENDATIONS: Plant in fall or spring. Seed 8-10 lb PLS per acre (9-11.2 kg/ha). There are up to 209,000 seeds per lb (459,800 seeds per kg).

Blanketflower

Gaillardia aristata



F.J. Hermann (1966)

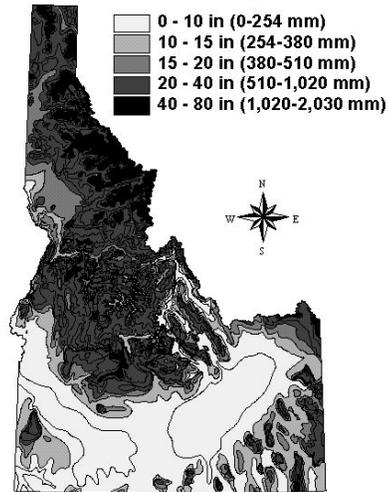
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are narrow, pointed, alternate, and hairy. Stems are round, rigid, and hairy. Flowers are yellow or red and daisy-like. Roots can reach a minimum depth of 16 in (41 cm). Grows 18-24 in (46-61 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 16-25 in (410-641 mm).

Elevation zone. Up to 8,000 ft (2,440 m).

Habitat & Climate requirements. Adapted to very dry, open areas, gravelly roadsides and waste areas.

Soil type. Well-drained, moderately to medium-course textured soil with neutral pH.

APPLICATIONS:

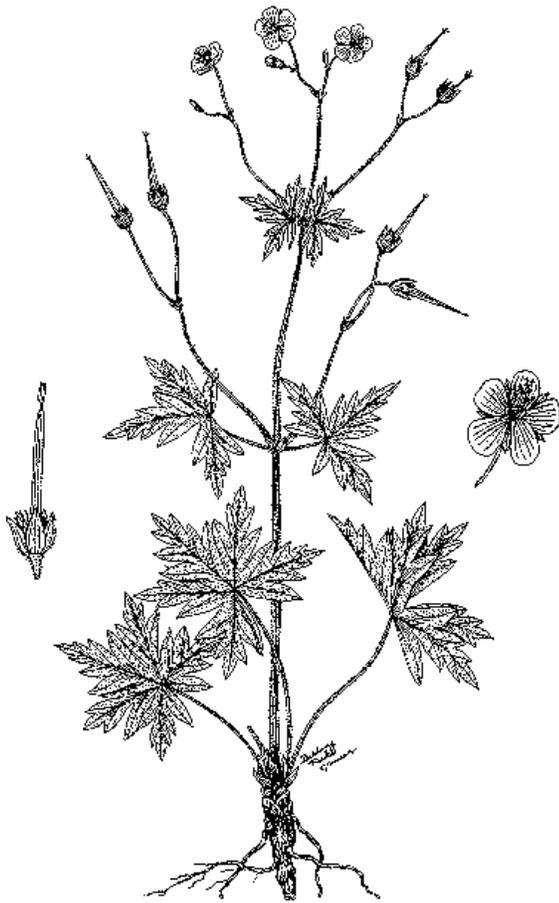
Roadside suitability. Found on roadsides. Used for erosion control and beautification. Persists in full sun to partial shade. Tolerates drought.

Establishment. Pioneer species with a low moisture requirement.

SEEDING RECOMMENDATIONS: Plant in early spring. Seed 10 lb PLS per acre (11.2 kg/ha). There are 132,000 seeds per lb (290,400 seeds per g).

Sticky Purple Geranium

Geranium viscosissimum



James Stubbendieck et al. (1997)

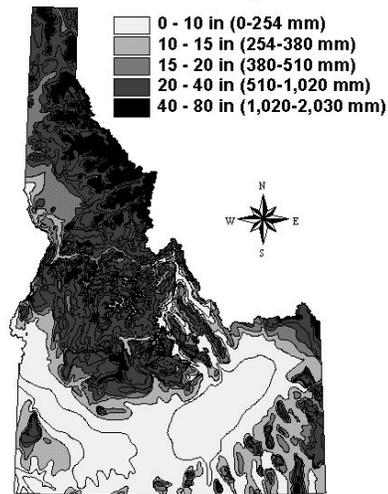
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Stems are leafy and branched. Flowers are pale lavender to pink with sticky hairs. Root crown is stout and woody. Taprooted with some rhizomes, reaching a minimum depth of 6 in (15 cm). Grows 4-36 in (10-91 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 20 in (510 mm).

Elevation zone. Ranges from 750-10,000 ft (229-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout temperate North America.

Soil type. Fertile, fairly moist, coarse- to medium-fine-textured soils.

APPLICATIONS:

Roadside suitability. Moderate soil stabilization value. Found on roadsides and is highly susceptible to application of pesticides. Persists in diffuse sunlight.

Establishment. Propagated by sowing seed during the later part of the summer. Low to moderate moisture requirement.

SEEDING RECOMMENDATIONS: Drill or broadcast in the fall. Seed 9 lb PLS per acre (10.1 kg/ha). There are 52,000 seeds per lb (114,400 seeds per kg).

Common Cowparsnip

Heracleum maximum



Richard W. Scott (1995)

LIFE SPAN: Perennial.

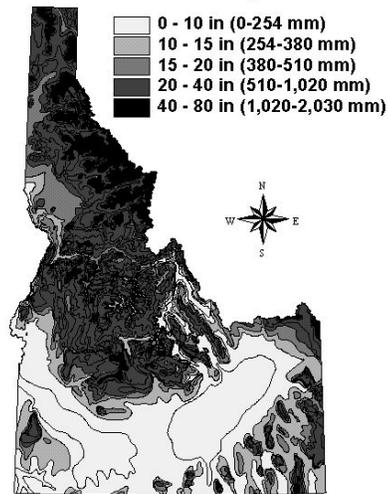
GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Woody, leaves are large and pale green with thick stalks that come off the main stem. Stems are stout and erect. Flowers are white to pinkish. Roots are fibrous and taprooted and aromatic, reaching a minimum depth 12 in (31 cm). Grows 36-108 in (91-274 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-40+ in (380-1,024+ mm)..

Elevation zone. Ranges from 0-10,000 ft (0-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout temperate North America.

Soil type. Rich, loamy soils.

APPLICATIONS:

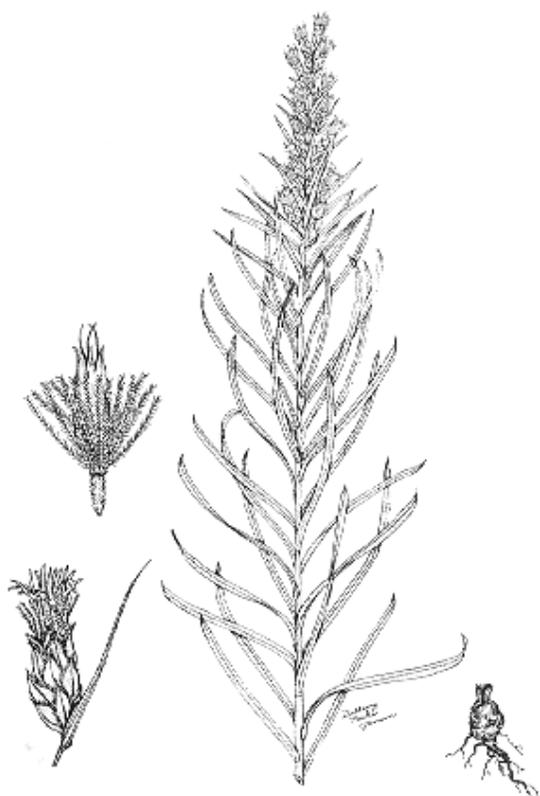
Roadside suitability. Good compatibility with other plants and soil stability.

Establishment. Good germination, slow to establish, good final establishment, and good reseeder.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 0.25-0.5 lb PLS per acre (0.28-0.56 kg/ha). There are 44,850 seeds per lb (986,700 seeds per kg).

Dotted Blazing Star

Liatris punctata



James Stubbendieck et al. (1997)

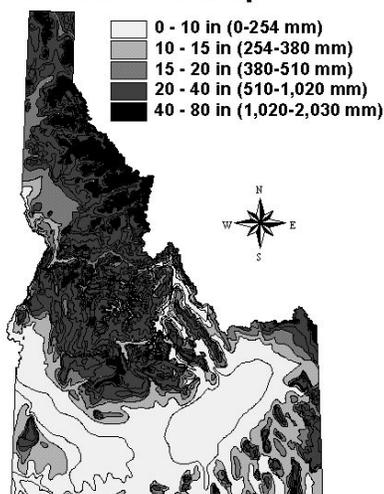
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are alternate and simple. Flowers are purple. Tuberous taproot that reaches a minimum depth of 14 in (36 cm). Grows 4-32 in (10-80 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 18-26 in (460-660 mm).

Elevation zone. Ranges from 2,000-8,000 ft (853-2,438 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout dry plains, hills, and uplands. Requires 120 frost-free days and can withstand temperatures to -43 F (-56 C).

Soil type. Well-drained, dry soil of open sandy and rocky areas.

APPLICATIONS:

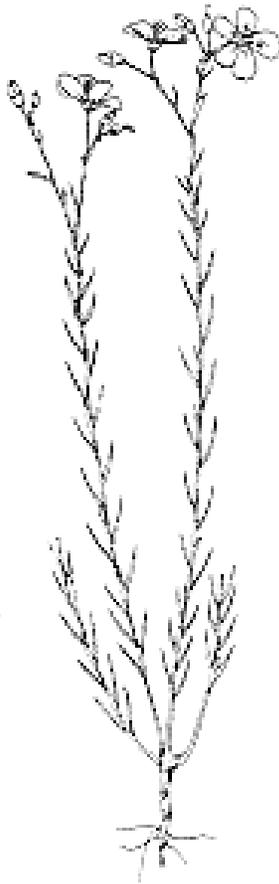
Roadside suitability. Used on severely eroded, steep slopes, and on mine spoils. Resists drought and fire.

Establishment. Propagate by seed sown in the fall or by division of the tuberous root. Seed spread rate is slow, but seedling vigor is fairly good.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 12 lb PLS per acre (13.5 kg/ha). There are 63,000 seeds per lb (138,600 seeds per kg).

Prairie Flax

Linum lewisii



PKCRMA

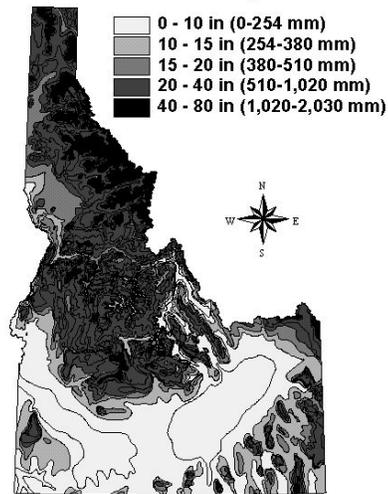
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are gray-green, alternate, narrow and linear. Stems are slender. Flowers are sky-blue and saucer-shaped in loose terminal clusters. Taproots can reach a minimum depth of 15 in (38 cm). Grows 1-3 ft (30-90 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-16 in (300-410 mm).

Elevation zone. Ranges from 4,000-11,000 ft (1,220-3,355 m).

Habitat & Climate requirements. Adapted to dry, subtropic climatic conditions of northern temperate zones. Requires 90 frost-free days and can withstand temperatures to -43 F (-56 C).

Soil type. Moderately coarse-to-medium-textured soils with a neutral pH. Also tolerates limestone soils.

APPLICATIONS:

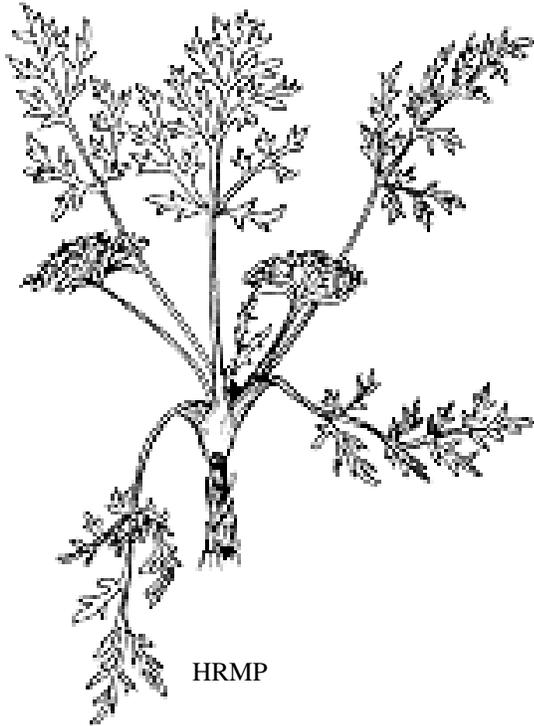
Roadside suitability. Aesthetic, persistent, and compatible with other plants. Fair soil stabilizer. Widely used for reclamation and beautification seedings. Persists in full sunlight.

Establishment. Establishes by seeds and plant divisions. Very good germination rate and initial establishment.

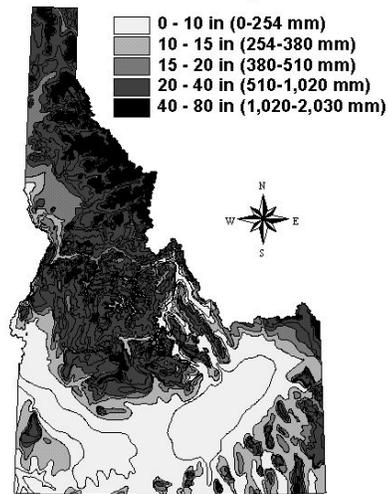
SEEDING RECOMMENDATIONS: Plant in the spring at a depth of 0.13 in (0.3 cm). Seed 8 lb PLS per acre (9 kg/ha). There are 293,000 seeds per lb (644,600 seeds per kg).

Fernleaf Biscuitroot

Lomatium dissectum



Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 14-100 in (360-1000 mm).

Elevation zone. Ranges from 0-10,000 ft (0-3,050 m).

Habitat & Climate requirements. Adapted to full sunlight on scablands, Rocky Mountain slopes, open slopes, and exposed ridges. Requires 240 frost-free days and can withstand temperatures to 7 F (-28 C).

Soil type. Prefers well-drained, rocky soils. Can also tolerate limestone soils.

APPLICATIONS:

Roadside suitability. Good to excellent for roadside plantings.

Establishment. Limited seed source. Plant dissections are sometimes available. Cold stratification is required.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 2-4 lb PLS per acre (2.2-4.8 kg/ha). There are 134,240 seeds per lb (295,328 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Flowers are aromatic, yellow, white, or purple. Propagates vegetatively by tubers. Taproot can reach a minimum depth of 12 in (31 cm). Stands 4-12 in (10-31 cm) tall.

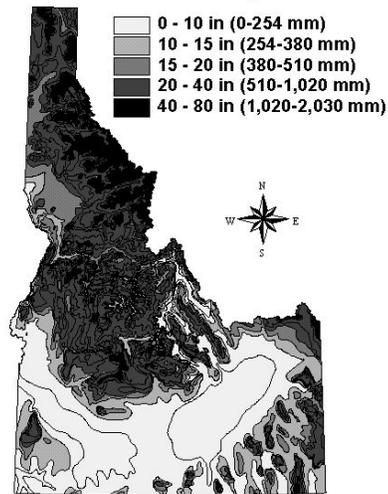
Desert Primrose

Oenothera caespitosa



R. Currah et al. (1983)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-40 in (380-1000 mm).

Elevation zone. Ranges from 3,000-6,607 ft (900-2,015 m).

Habitat & Climate requirements. Adapted to dry open sites, often found on clay flats and along roadsides. Requires 140 frost-free days and can withstand temperatures to -13 F (-39 C).

Soil type. Adapted to a wide range of soil conditions, from sandy rocky soils to clay flats.

APPLICATIONS:

Roadside suitability. Low-growing, fairly easy to establish on altered sites. Drought tolerant.

Establishment. Fair germination with good initial establishment. Cold stratification is required.

SEEDING RECOMMENDATIONS: Plant in the spring. There are 1,000,000 seeds per lb (2,200,000 seeds per kg).

LIFE SPAN: Perennial.

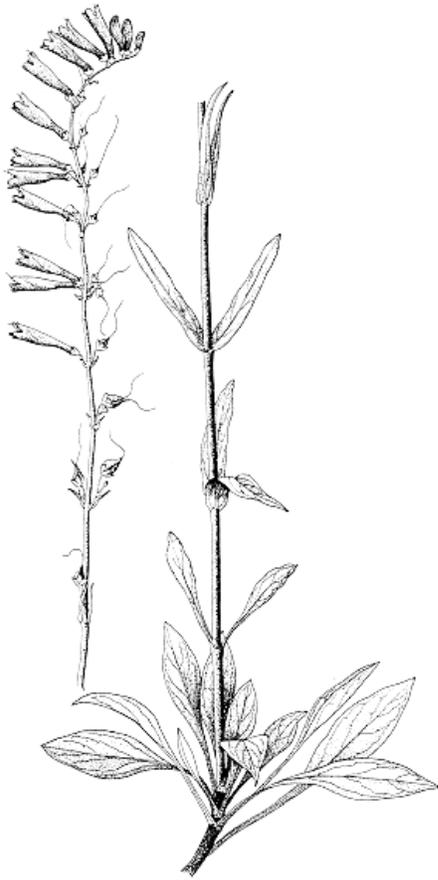
GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are clustered around the root crown. Flowers open at night, are white when young, and red at maturity. Roots are thick and woody and can reach a minimum depth of 6 in (15 cm). Stands up to 8 in (20 cm) tall.

Firecracker Penstemon

Penstemon eatonii



Arthur Cronquist et al. (1994)

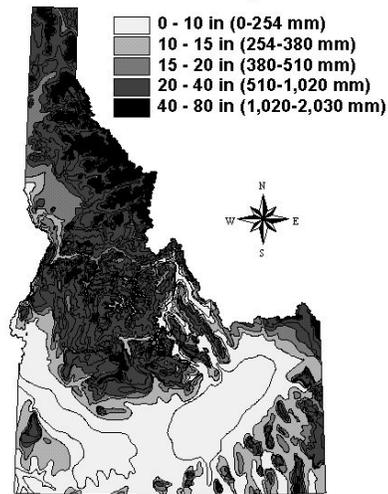
LIFE SPAN: Perennial.

GROWTH HABIT: Forb/subshrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season and erect. Leaves are opposite and large. Flowers are tubular and bright red. Somewhat rhizomatous with a taproot that can reach a minimum depth of 12 in (31 cm). Stands 12-40 in (30-102 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-16 in (250-410 mm).

Elevation zone. Ranges from 3,300-8,000 ft (1,007-2,440 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions under full sunlight. Requires 165 frost-free days and can withstand temperatures to -18 F (-42 C).

Soil type. Well- to-moderately well-drained soils of moderately coarse texture. Does not do well in poorly-drained areas.

APPLICATIONS:

Roadside suitability. Potential erosion control species. Survives cold, harsh winters. Natural spreader and tolerates drought.

Establishment. Low moisture requirement. Easy to plant with good germination, seedling vigor, and final establishment. Cold stratification is required.

SEEDING RECOMMENDATIONS: Plant in early spring or late fall at a depth of 0.25 in (0.6 cm). Seed 1.5-3 lb PLS per acre (1.7-3.4 kg/ha). There are 351,050 seeds per lb (772,310 seeds per kg).

Palmer Penstemon

Penstemon palmeri



Arthur Cronquist et al. (1994)

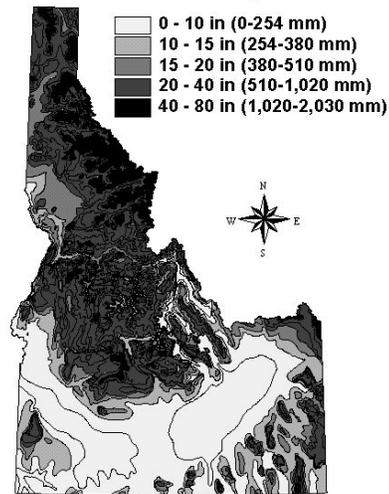
LIFE SPAN: Perennial, short-lived.

GROWTH HABIT: Forb.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Foliage is glaucous. Leaves are basal, opposite, and green throughout the winter. Flowers are tubular and white to pink. Roots are fibrous and can reach a minimum depth of 14 in (36 cm). Stands 48 in (122 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-16 in (250-410 mm).

Elevation zone. Ranges from 3,500-6,500 ft (1,068-1,983 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions. Requires 140 frost-free days and can withstand temperatures to -8 F (-36 C).

Soil type. Well-drained, rocky, gravelly-to-clayey soils that are basic to slightly acidic.

APPLICATIONS:

Roadside suitability. Thrives on disturbed, depleted, and exposed sites on washes and along roadsides. Moderate soil stabilizer. Used for erosion control, diversity, and beautification. Natural spreader and persists in full sunlight.

Establishment. Easy to plant. Good initial establishment and moderate final establishment.

SEEDING RECOMMENDATIONS:

Broadcast or drill in early spring or late fall at a depth less than 0.13 in (0.32 cm). Seed 3 lb PLS per acre (3.4 kg/ha). There are 610,000 seeds per lb (1,342,000 seeds per kg).

Rocky Mountain Penstemon

Penstemon strictus



Arthur Cronquist et al. (1994)

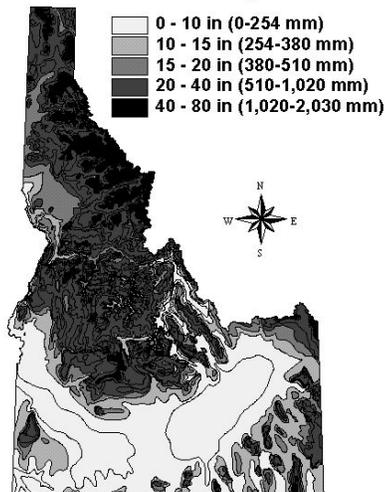
LIFE SPAN: Perennial, long-lived.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are opposite, green, long, smooth, and curled or reflexed. Flowers are solitary and bluish purple. Underground stems are large. Roots are fine and can reach a minimum depth of 14 in (36 cm). Stands 12-36 in (30-91 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-20 in (380-510 mm).

Elevation zone. Found up to 11,000 ft (3,355 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the mountains of the western United States. Requires 120 frost-free days and can withstand temperatures to -33 F (-50 C).

Soil type. Well-drained, medium-textured, rocky and sandy loam soils that range from weakly acidic to weakly alkaline.

APPLICATIONS:

Roadside suitability. Used in reclamation and wildflower mixes. Persists in full sunlight.

Establishment. Easy to establish and good seed producer.

SEEDING RECOMMENDATIONS:

Broadcast or drill seed early in spring or late fall at a depth of 0.13 in (0.33 cm). Seed 4 lb PLS per acre (4.5 kg/ha). There are 592,000 seeds per lb (1,302,400 seeds per kg).

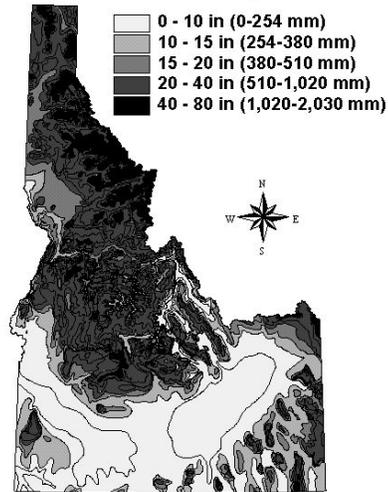
Alpine Penstemon

Penstemon venustus



Charles Grier Johnson (1993)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 20-35 in (510-897 mm).

Elevation zone. Ranges from 1,000-6,000 ft (305-1,830 m).

Habitat & Climate requirements. Adapted to the climatic conditions of full sunlight on open slopes of mountain valleys and foothills. Requires 170 frost-free days and can withstand temperatures to -18 F (42 C).

Soil type. Well- to moderately drained soils.

APPLICATIONS:

Roadside suitability. Used for beautification and erosion control. Tolerates drought, cold, and weakly acidic conditions. Intolerant of poorly-drained soils.

Establishment. Good seedling vigor, rapid seed spread rate and fairly easy to establish.

SEEDING RECOMMENDATIONS: Plant in early spring or late fall at a depth of 0.25 in (0.6 cm). Seed 1.5-3 lb PLS per acre (1.7-3.4 kg/ha). There are 280,000 seeds per lb (616,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb/half shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool-season. Leaves are toothed or entire and opposite. Base is woody. Flowers are several stalked and bright lavender to purple. Taproot is strong and can reach a minimum depth of 6 in (15 cm). Stands 12-24 in (30-61 in) tall.

Spreading Phlox

Phlox diffusa



Arthur Cronquist et al. (1994)

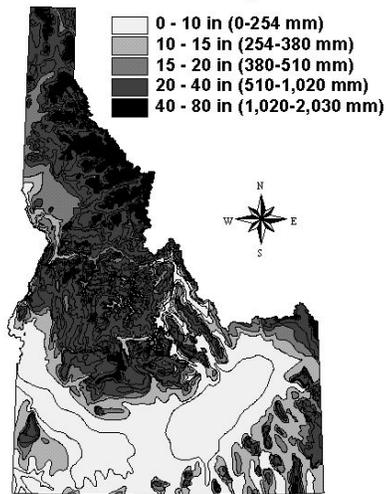
LIFE SPAN: Perennial.

GROWTH HABIT: Forb, cushion plant.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are narrow and rigid. Branches are numerous and erect. Flowers are showy, brightly colored, with long tubular bases and perpendicular pedal shoots. Roots can reach a minimum depth of 15 in (38 cm).

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. 14 in (350 mm) and above.

Elevation zone. Ranges from 4,000-8,000 ft (1,200-2,440 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the Pacific Northwest. Requires 120 frost-free days and can withstand temperatures to -13 F (-39 C).

Soil type. Well-drained, sandy, rocky, or gravelly soils.

APPLICATIONS:

Roadside suitability. Low-growing. Persists on rocky slopes and roadsides. Drought and shade tolerant.

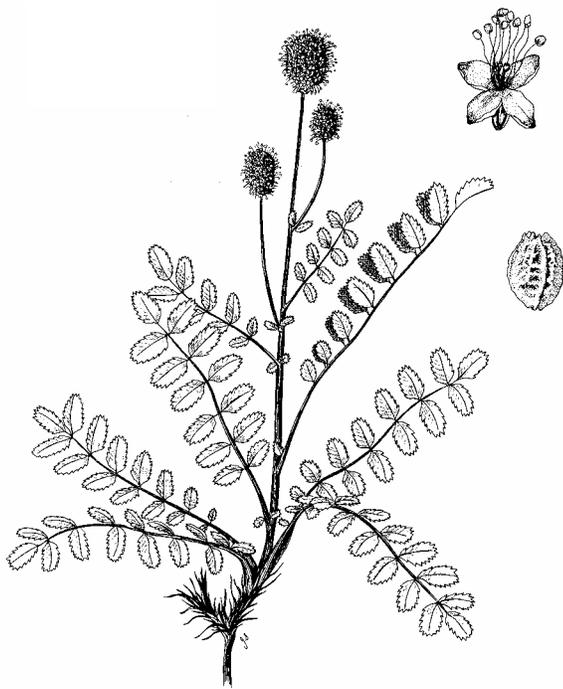
Establishment. Established by root divisions or cuttings with good results. Establishment from seed has mixed results ranging from moderate to poor.

SEEDING RECOMMENDATIONS:

Broadcast in late fall or winter. Seed 1-3 lbs per acre (1.1-3.4 kg/ha). There are 907,000 seeds per lb (1,997,000 seeds per kg).

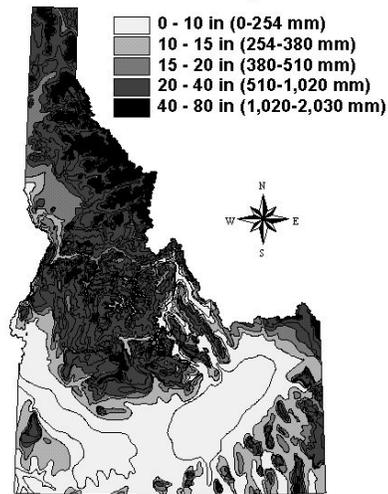
Small Burnet

Sanguisorba minor



Clinton H. Wasser (1982)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-25 in (310-640 mm).

Elevation zone. Ranges from 1,000-6,000 ft (305-1,830 m).

Habitat & Climate requirements. Well adapted to the climatic conditions of Intermountain regions. Requires 90 frost-free days and can withstand temperatures to -33 F (-50 C).

Soil type. Well-drained, droughty, moderately wet, acidic, and alkaline-to-weakly saline soils with low fertility.

APPLICATIONS:

Roadside suitability. Moderate soil stabilization value. Used for erosion control and beautification. Winter-hardy and persists in full sunlight.

Establishment. Easy to germinate, excellent seedling vigor, seed production, and growth rate.

SEEDING RECOMMENDATIONS: Plant in late fall or early spring at a depth less than 0.25-0.75 in (0.6-1.9 cm). Seed 2-5 lb PLS per acre (2.2-2.6 kg/ha) PLS. There are 55,000 seeds per lb (121,000 seeds per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS:

Branched with a thick base of stems. Leaves are alternate and pinnately compound. Flowers are pinkish white and sessile. Prominent taproot with weak rhizomes that can reach a minimum depth of 12 in (31 cm). Stands 20-25 in (51-64 cm) tall.

Western Groundsel

Senecio integerrimus



Charles Grier Joahnsen (1993)

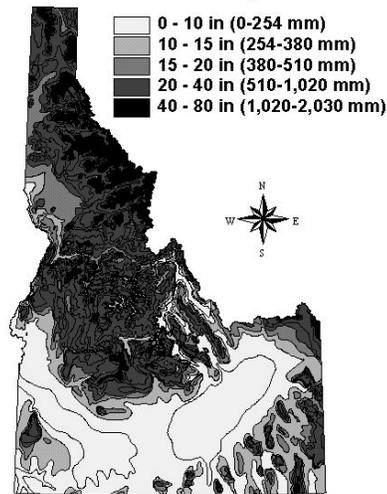
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are alternate, lance-shaped and petiolate at base, cauline leaves becoming sessile. Flowers are in heads, approximately 0.5 in (1.25 cm) in diameter. Roots are fibrous and can reach a minimum depth of 14 in (36 cm). Stands 12-40 in (30-102 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 12 in (300 mm).

Elevation zone. Ranges from 0-14,000 ft (0-4,270 m).

Habitat & Climate requirements. Adapted to the climatic conditions of moist-to-dry open meadows in sagebrush and ponderosa pine belts.

Soil type. Adapted to a wide rang of soil conditions and types.

APPLICATIONS:

Roadside suitability. Good erosion control species. Survives cold, harsh winters. Drought and fire tolerant and rapid spread.

Establishment. Low moisture requirement with good germination, seedling vigor and final establishment.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 900,000 seeds per lb (1,900,000 seeds per kg).

Scarlet Globemallow

Sphaeralcea coccinea



Britton, N.L. and A. Brown (1913)

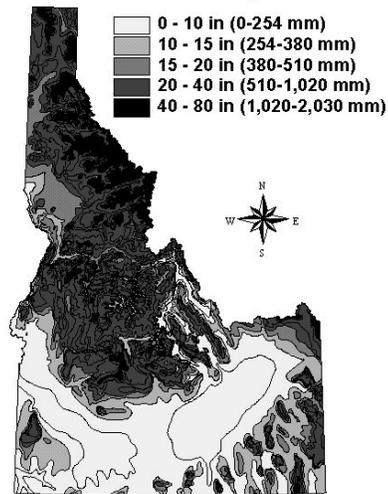
LIFE SPAN: Perennial.

GROWTH HABIT: Forb.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Stems are single or clustered and branched. Flowers are reddish-orange with tiny star-shaped hairs. Woody taproot with creeping root stalk that can reach a minimum depth of 6 in (15 cm). Stands 3-12 in (8-30 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-12 in (200-300 mm).

Elevation zone. Ranges from 3,000-7,000 ft (915-2,135 m).

Habitat & Climate requirements. Adapted to dry climatic conditions. Requires 115 frost-free days and can withstand temperatures to -23 F (-45 C).

Soil type. Rocky, sandy, or fine-textured soils.

APPLICATIONS:

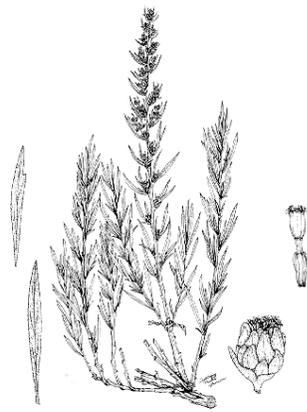
Roadside suitability. Persistent and compatible with other plants. Good soil stabilizer. Known to colonize roadsides. Persists in full sunlight and tolerates drought.

Establishment. Requires seed scarification as hard seed coat prevents prolific seed germination.

SEEDING RECOMMENDATIONS:

Broadcast or drill in fall or winter. Seed 4 lb PLS per acre (4.5 kg/ha). There are 500,000 seeds per lb (1,110,000 seeds per kg).

Shrubs



Rocky Mountain Maple

Acer glabrum



Britton, N.L. and A. Brown (1913)

LIFE SPAN: Long-lived.

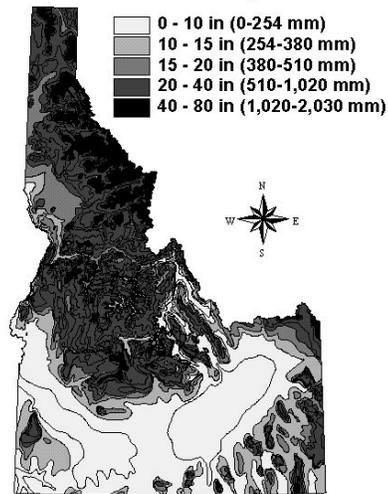
GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Dwarf.

Leaves are three-lobed, simple, and sharply serrate. Crown is narrow with small branches. Bark is thin, smooth, and dark reddish-brown. Roots can reach a minimum depth of 24 in (61 cm). Grows 5-25 ft (1.5-7.6 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12-25 in (300-635 mm).

Elevation zone. Ranges from 1,100-10,000 ft (336-3,050 m).

Habitat & Climate requirements. Adapted to the climatic conditions of foothills and cold deserts on fairly dry slopes. Can withstand temperatures to -43 F (-42 C).

Soil type. Well-drained rocky, gravelly, and limestone soils.

APPLICATIONS:

Roadside suitability. Aesthetic and tolerates some shade. Deep roots provide good slope stabilization.

Establishment. Erratic germination. Seedlings develop slowly. Very persistent once established. Cold stratification is required.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 3-4 lb PLS per acre (3.4-4.5 kg/ha). There are 20,000 seeds per lb (44,000 seeds per kg).

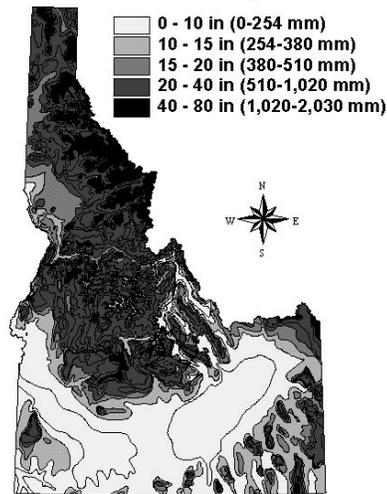
Serviceberry

Amerlanchier alnifolia



Patricia A. Patterson et al. (1985)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12-30 in (300-762 mm).

Elevation zone. Up to 9,000 ft (2,745 m).

Habitat & Climate requirements. Adapted to the climatic conditions associated with open forest and canyon slopes throughout much of the Pacific Northwest. Can withstand temperatures to -38 F (-39 C).

Soil type. Well-drained, moderately-course- to fine-textured soils with neutral to weakly acid pH (5.6-8.4).

APPLICATIONS:

Roadside suitability. Thicket forming. Cold-hardy and resistant to drought. Deep roots provide good slope stabilization.

Establishment. Seed quality is often low. Seed germination is erratic. Seedlings develop at a moderate rate. Once established, very persistent. Cold stratification is required.

SEEDING RECOMMENDATIONS: Plant in fall or early spring at a depth of 0.25 in (0.6 cm). Seed 1 lb PLS per acre (1.1 kg/ha). There are 25,000 seeds per lb (55,000 seeds per kg).

LIFE SPAN: Long-lived.

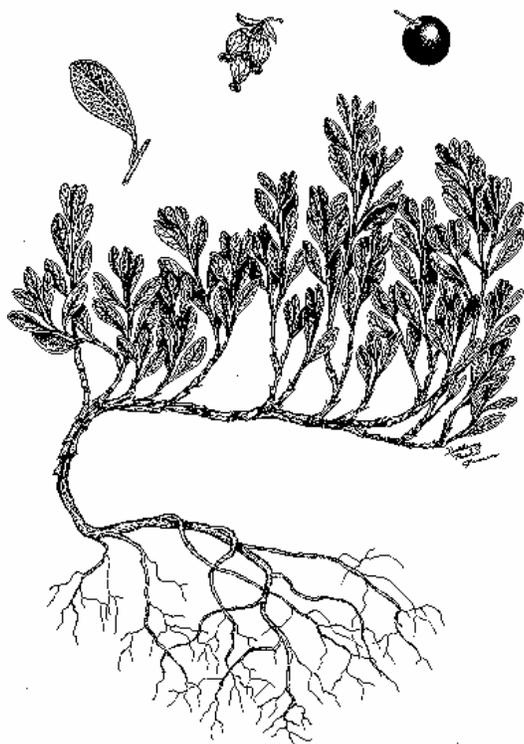
GROWTH HABIT: Deciduous shrub or tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Cool season, erect, and multi-stemmed. Leaves are dark green. Twigs are dark greyish. Flowers are white-to-pinkish. Fruits are cherry-like, fleshy, and purple. Roots can reach a minimum depth of 24 in (61 cm). Grows 3-15 ft (1-4.6 m) tall.

Kinnikinnick

Arctostaphylos uva-ursi



James Stubbendieck et al. (1997)

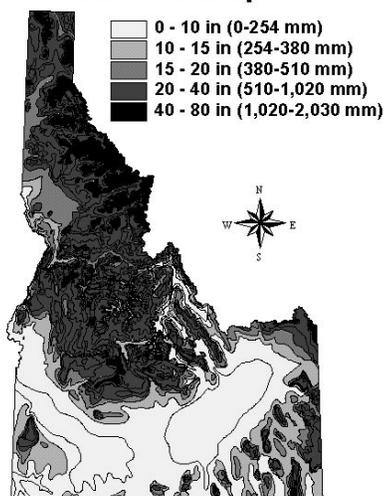
LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are small, round, and thick. Bark is red and exfoliating. Flowers are white or pinkish and urn-shaped. Fruits are red and roundish. Roots can reach a minimum depth of 10 in (25 cm). Grows up to 12 in (.3 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 14-45 in (350-1140 mm).

Elevation zone. Ranges from 7,020-11,510 ft (2,141-3,511 m).

Habitat & Climate requirements. Adapted to wide range of climatic conditions. In open forests throughout the Rocky Mountain region, withstands temperatures from -50 to 0 F (-45 to -18 C).

Soil type. Adapted to well-drained, moderately coarse, sandy, acidic soils (pH 5.5-8.0).

APPLICATIONS:

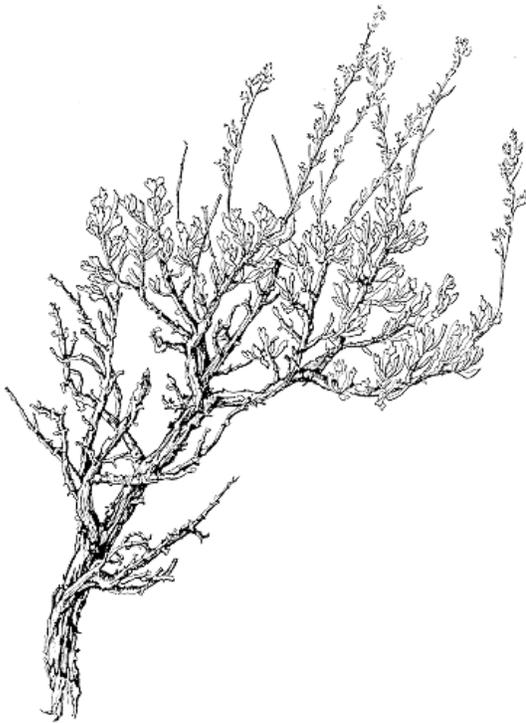
Roadside suitability. Low and trailing. Used for landscape, watershed, and erosion control plantings. Excellent soil stabilizer.

Establishment. Slow to establish without top soil. Propagate from seeds, stems, or root cuttings.

SEEDING RECOMMENDATIONS: Plant in spring. Seed at 2-3 lbs (metric) PLS per acre (2.2-3.4 kg/ha). There are 37,900 seeds per lb (83,380 seeds per kg).

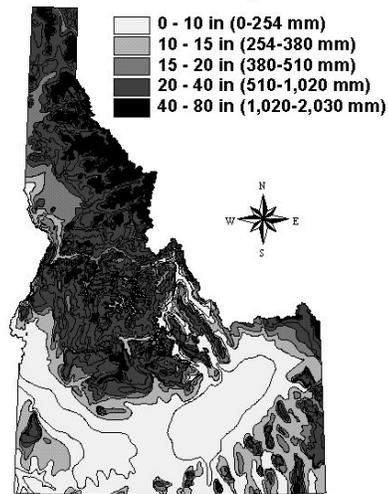
Low Sagebrush

Artemisia arbuscula



Hugh Mozingo (1987)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-20 in (200-510 mm).

Elevation zone. Ranges from 7,000-8,000 ft (2,135-2,440 m).

Habitat & Climate requirements. Adapted to dry, rocky slopes and ridges throughout much of the Rocky Mountain region. Can withstand temperatures to -43 F (-42 C).

Soil type. Well-drained, shallow, stony soils as well as soils with heavy clay subsurface horizons (pH 5.5-8.6).

APPLICATIONS:

Roadside suitability. Plant in a mix with native grasses. Relatively easy to establish, low growing with good root penetration for slope stabilization.

Establishment. Germinates easily. Develops rapidly.

SEEDING RECOMMENDATIONS: Plant in fall, winter, or spring at a depth of 0.25 in (0.6 cm). Seed 1 lb PLS per acre (1.1 kg/ha). There are 972,000 seeds per lb (2,138,400 per kg).

LIFE SPAN: Perennial.

GROWTH HABIT: Dwarfed shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Small, stiff, shaggy, and very branched. Leaves are greyish white, and three toothed. Inflouescence are narrow. Roots are fibrous with a taproot and reach a minimum depth of 10 in (25 cm). Grows 4-159 in (10-400 cm) tall.

Silver Sagebrush

Artemisia cana



James Stubbendieck et al. (1997)

LIFE SPAN: Long-lived.

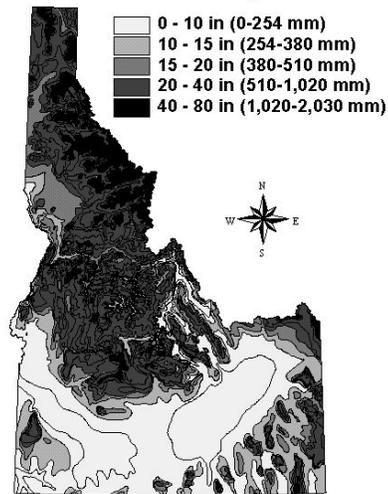
GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Densely branched. Leaves are small and silvery and linear. Flowers are inconspicuous and yellow. Roots can reach a minimum depth of 20 in (51 cm). Grows 5 ft (1.5 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 8-40 in (200-1,010 mm).

Elevation zone. Ranges from 6,000-10,600 ft (1,830-3,233 m).

Habitat & Climate requirements. Adapted to the climatic conditions of moist river valleys, prairies, terraces, and uplands.

Soil type. Moist-to-moderately dry, deep loam-to-sand, moderately fine-textured, shallow soils (pH 5.1-9).

APPLICATIONS:

Roadside suitability. Spreads by rhizomes under favorable conditions. Resprouts after a disturbance. Used for erosion control. Tolerates fire and alkalinity.

Establishment. Fairly easy to establish. Once established, spreads readily.

SEEDING RECOMMENDATIONS: Plant in fall or early spring. Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 850,000 seeds per lb (1,870,000 seeds per kg).

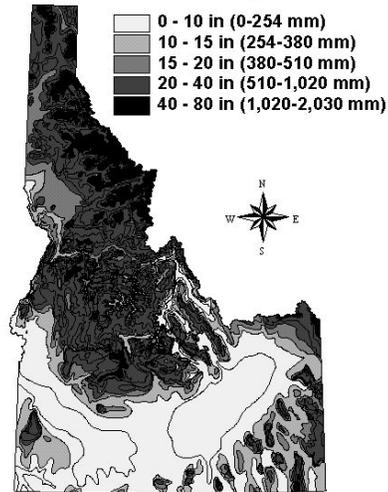
Black Sagebrush

Artemisia nova



James Stubbendieck et al (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-20 in (152-510 mm).

Elevation zone. Ranges from 4,000-8,000 ft (1,220-2,440 m).

Habitat & Climate requirements. Especially adapted to dry rocky ridges, foothills, and cold deserts primarily in the Intermountain West. Can withstand temperatures to -33 F (-36 C).

Soil type. Favors shallow, dry, stony, calcareous soils (pH 7-8.5).

APPLICATIONS:

Roadside suitability. Low growing with deep taproot. Aggressive natural spreader once established. Potential species for disturbed land plantings.

Establishment. Fairly easy to establish with low moisture requirement.

SEEDING RECOMMENDATIONS:

Broadcast in late fall or winter. Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 907,200 seeds per lb (1,995,840 seeds per kg).

LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Small, spreading, dullish gray, and aromatic. Flowers are inconspicuous. Leaves are alternate, simple, spatulate, 3-lobed at tip, constricted just below the lobes, glands present. Roots can reach a minimum depth of 10 in (25 cm). Grows less than 24 in (61 cm) tall.

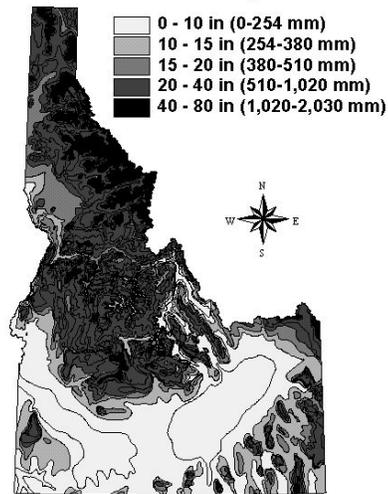
Basin Big Sagebrush

Artemisia tridentata var. *tridentata*



Arthur Cronquist et al. (1994)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-35 in (152-890 mm).

Elevation zone. Ranges from 1,475-8,033 ft (450-2,450 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the semi-desert regions in the Pacific Northwest east of the Cascades. Can withstand temperatures to -13 F (-25 C).

Soil type. Moderately shallow to deep, well-drained, alluvial clay loams. Neutral to slightly alkaline soil conditions (pH 6.5-8.5).

APPLICATIONS:

Roadside suitability. Useful for stabilizing backslope washes, gullies, roadcuts, and other raw exposed sites. Tolerates drought.

Establishment. Establishes rapidly from transplanting and direct seeding. Good seed producer. Low moisture requirement.

SEEDING RECOMMENDATIONS: Plant in late fall or winter. Seed 1-3 lb PLS per acre (.5-1.4 kg/ha). There are 2,500,000 seeds per lb (5,507,000 seeds per kg).

LIFE SPAN: Long-lived.

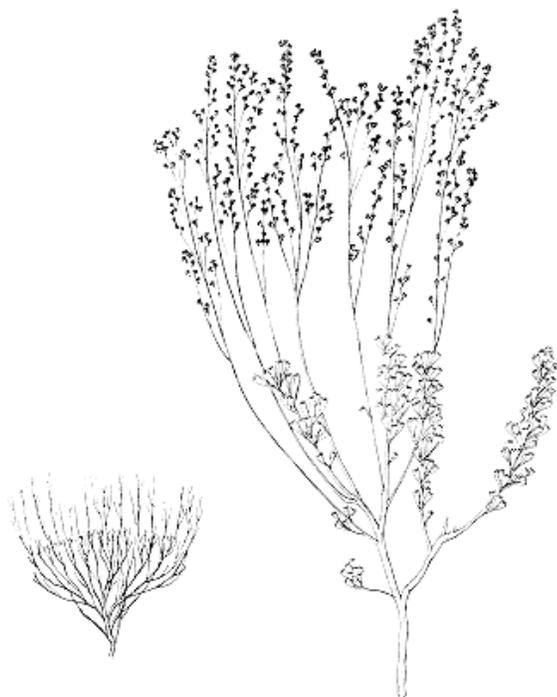
GROWTH HABIT: Shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Tall, erect, rounded, and strongly aromatic. Trunk is short, branched and woody. Leaves are wedge-to fan-shaped and usually three lobed at the tips. Flowers are yellow and inconspicuous. Roots can reach a minimum depth of 16 in (41 cm). Grows 1.5-15 ft (.5-5 m) tall.

Mountain Big Sagebrush

Artemisia tridentata var. *vaseyana*



Arthur Cronquist et al. (1994)

LIFE SPAN: Long-lived.

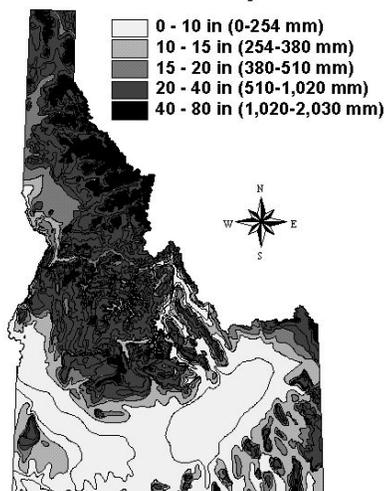
GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Rounded with short branches and a woody trunk. Leaves are wedge- to fan-shaped at the tips. Flowers are inconspicuous and yellow. Roots can reach a minimum depth of 16 in (41 cm). Grows 20-50 in (51-127 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-14 in (250-360 mm).

Elevation zone. Ranges from 4,000-10,000 ft (1,220-3,050 m).

Habitat & Climate requirements. Widespread in the central Rocky Mountains and Pacific Northwest at higher montane elevations east of the Cascades. Well adapted to dry regions of upper foothills and aspen zones. Can withstand temperatures to -33 F (-36 C).

Soil type. Well-drained, moderately shallow to deep, sandy to silty loam soils, with a special affinity to granitic substrates (pH 6-8.5).

APPLICATIONS:

Roadside suitability. Low growing shrub that is well suited for roadside revegetation. Deep rooted. Used for the outer rows of multi-row wind breaks. Tolerates drought fairly well.

Establishment. Easy to germinate. Medium moisture requirement.

SEEDING RECOMMENDATIONS: Plant in fall on a compact seedbed. Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 2,500,000 seeds per lb (5,500,000 seeds per kg).

Fourwing Saltbush

Atriplex canescens



James Stubbendieck et al. (1997)

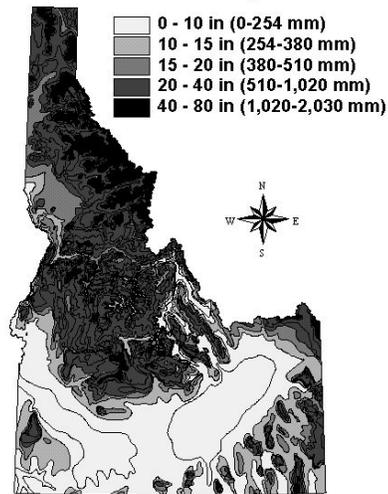
LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Upright and branched freely with male and female plants. Leaves are greyish white and alternate. Flowers are inconspicuous. Fruits are four-winged. Roots are fibrous with a taproot that can exceed 20 ft (6 m) deep. Grows 1.6-6.6 ft (.5-2 m) tall .

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 6-15 in (150-380 mm).

Elevation zone. Up to 7,000 ft (2,135 m).

Habitat & Climate requirements. Adapted to a wide range of conditions throughout the western United States from the desert to the pine forest.

Soil type. Suited to well-drained, sandy soils. Tolerates salinity, gravelly washes, heavy clays, and alkaline soils (pH 6.6-9).

APPLICATIONS:

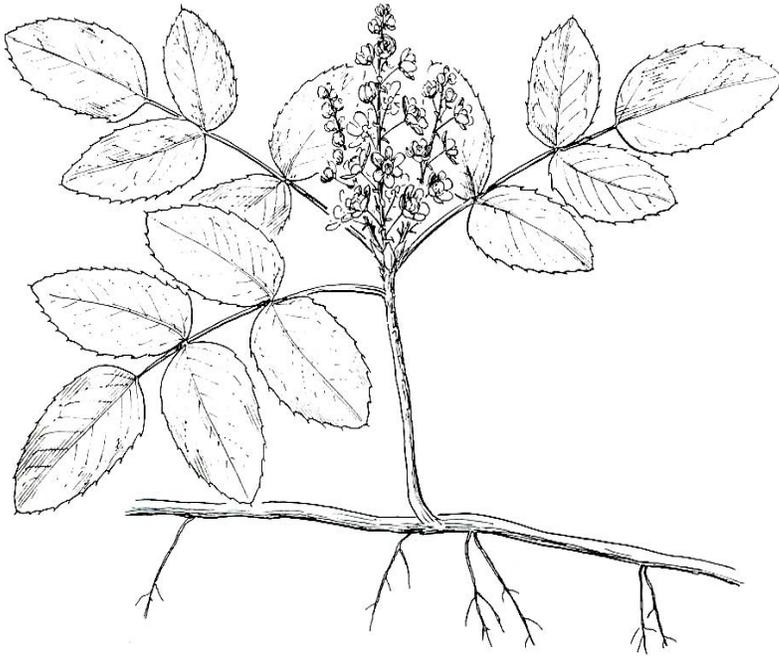
Roadside suitability. Used for rangeland rehabilitation and soil stabilization. Cold- and drought-hardy. Stays green through the summer. Very deep taproot for slope stabilization.

Establishment. Grows rapidly. Plant by direct seeding, bare root, or container transplants. Grows well from seed.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 6-8 lb PLS per acre (6.7-9 kg/ha). There are 52,000 seeds per lb (114,400 seeds per kg).

Oregon Grape

Beberis repens



Charles Greir Johnson (1999)

LIFE SPAN: Long-lived

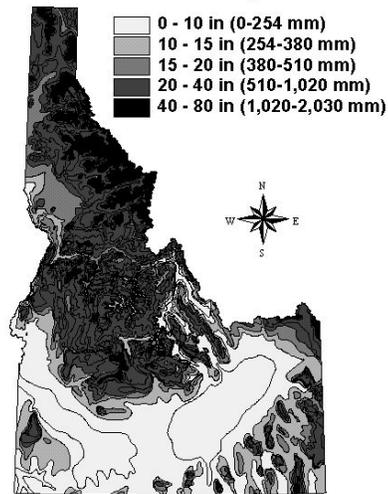
GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Attractive. Leaves are shiny-green. Flowers are bright yellow. Fruits are dark, waxy-blue berries. Roots are deep and creeping with rhizomes and stolons and can reach a minimum depth of 10 in (25 cm). Grows 1-3 ft (0.3-1 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 18 in (460 mm).

Elevation zone. Ranges from 1,000-10,000 ft (305-3,050 m).

Habitat & Climate requirements. Adapted to rocky slopes and canyon bottoms in the shade or in dry exposed sites. Often found in open, dry coniferous forest settings. Can withstand temperatures to -23 F (-45 C).

Soil type. Well-drained loams and deep, moist soils rich in humus. Tolerates dry, stony, thin soils (pH 5.5-7.5).

APPLICATIONS:

Roadside suitability. Low growing and evergreen. Excellent ground cover and good potential for slope stabilization and erosion control. Very extensive and deep rooting system. Very attractive plant in all seasons.

Establishment. Medium growth rate. Moderate establishment from seed, excellent establishment from transplants.

SEEDING RECOMMENDATIONS: Plant at a depth of 0.25-0.5 in (0.63-1.3 cm). Seed 0.25-1 lb PLS per acre (0.28-0.56 kg/ha). There are 45,000 seeds per lb (99,000 seeds per kg).

Redstem Ceanothus

Ceanothus sanguineus



Charles Greir Johnson (1993)

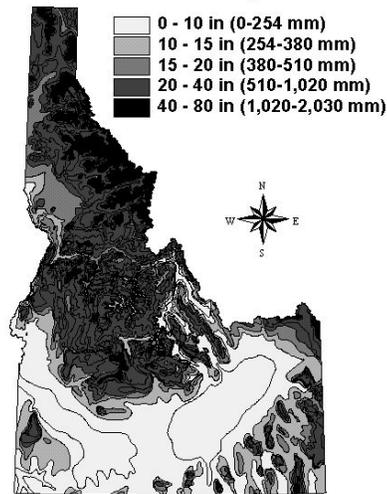
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are shiny green, egg-shaped, three-ribbed, alternate, and simple. Twigs are reddish and flexible. Flowers are many, small, and white. Roots can reach a minimum depth of 12 in (31 cm). Grows 3-10 ft (1-3 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 14 in (360 mm).

Elevation zone. To 5,000 ft (1520 m).

Habitat & Climate requirements. Adapted to a wide range of open conditions, generally as a result of fire. Can withstand temperatures to -13 F (-25 C).

Soil type. Well-drained medium-textured with a neutral pH (6.5-8.0).

APPLICATIONS:

Roadside suitability. Provides ground cover and soil stabilization on areas where slumping and surface erosion are common. Used to seed abandoned roadway and logging disturbances. Low shade tolerance. Sprouts after a disturbance, especially fire.

Establishment. Medium germination rate. Good seedling establishment.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 0.25 lb PLS per acre (0.28 kg/ha). There are 131,900 seeds per lb (290,180 seeds per kg).

Snowbush

Ceanothus velutinus



James Stubbendieck et al. (1997)

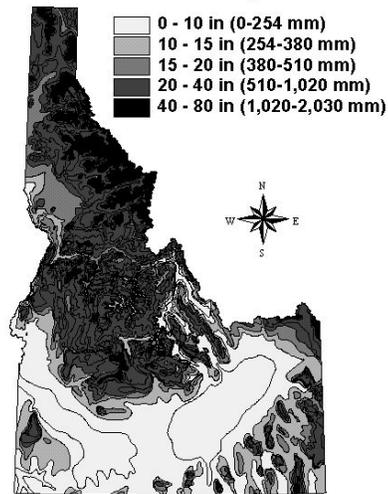
LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are bright, glossy green, three main veins branch from leaf base. Flowers are attractive, white, fluffy masses. Roots are nitrogen-fixing. Roots can reach a minimum depth of 18 in (46 cm). Grows 3-10 ft (1-3 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 14 in (360 mm).

Elevation zone. Ranges from 3,500-10,000 ft (1,068-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of dry climatic conditions. Generally on mesic to moist sites at higher elevations.

Soil type. Well-drained, rocky, and shallow, weakly acidic, basic, and non-saline soils (pH 6.5-8.5).

APPLICATIONS:

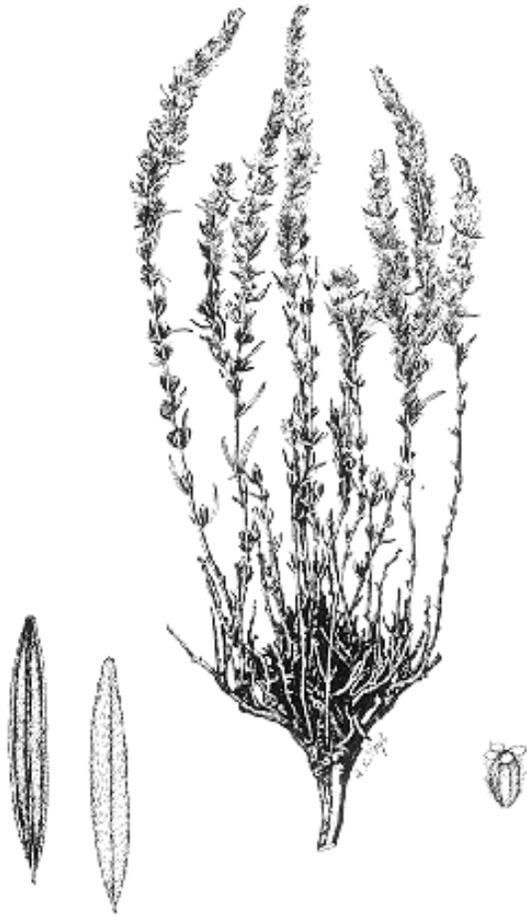
Roadside suitability. Useful for erosion control plantings following fire or other disturbances. Fairly tolerant of shade, drought, and fire. Nitrogen-fixing roots.

Establishment. Seed requires heat and prechill treatments. Good germination. Fairly slow seedling development.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 0.33 in (0.84 cm). Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 124,275 seeds per lb (273,405 seeds per kg).

Winterfat

Ceratoides lanata



James Stubbendieck et al. (1997)

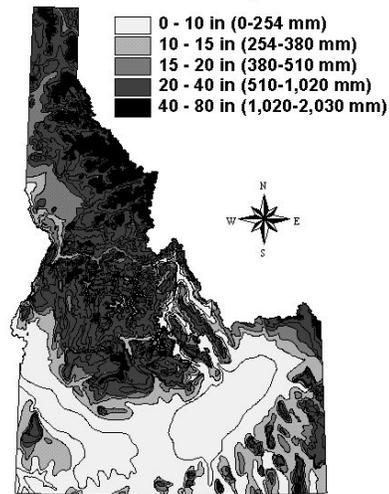
LIFE SPAN: Perennial.

GROWTH HABIT: Half-shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Base is woody and covered with dense, whitish grey, wooly hairs. Stems are herbaceous, erect, and freely branched. Flowers are inconspicuous. Roots are fibrous with a taproot that can reach a minimum depth of 10 in (25 cm). Grows up to 32 in (80 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 5-25 in (130-640 mm).

Elevation zone. Ranges from 2,000-10,000 ft (610-3,050 m).

Habitat & Climate requirements. Adapted to lower foothills, plains, and valleys.

Soil type. Undeveloped, moderately-course- to fine-texture, dry, subalkaline, chalky, and calcareous soils of low fertility.

APPLICATIONS:

Roadside suitability. Low growing half-shrub. Tolerates burning and cold environments. Intolerant of shade.

Establishment. High seedling vigor and seeds require after-ripening for maximum germination. Seedlings are vulnerable to spring frosts.

SEEDING RECOMMENDATIONS: Plant in the fall at a depth of 0.25-0.5 in (0.6-1.3 cm). Hand seed 5-10 PLS per hill at 5 ft (1.5 m) spacing. There are 56,700 seeds per lb (124,740 seeds per kg).

Curleaf Mountain Mahogany

Cercocarpus ledifolius



James Stubbendieck et al. (1997)

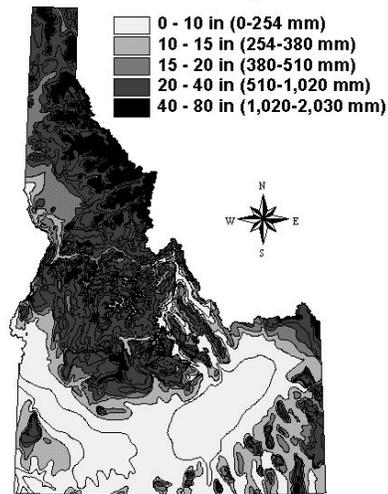
LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub/small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are persistent, alternate, simple, lance-shaped, leathery, and roll in at the margins. Flowers are pale yellow. Roots are fibrous with deep taproots. Roots can reach a minimum depth of 20 in (51 cm). Grows 3-20 ft (1-6 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 8 in (200 mm).

Elevation zone. Ranges from 2,000-9,000 ft (610-2,745 m).

Habitat & Climate requirements. Adapted to warm, dry, rocky ridges and rim outcrops. Can withstand temperatures to -32 F (-36 C).

Soil type. Dry, shallow, limestone soils, on gravelly ridges and sometimes clay or loam soils (pH 6.0-9.0).

APPLICATIONS:

Roadside suitability. Large evergreen shrub is drought resistant and tolerates high temperatures, well adapted to semiarid sites.

Establishment. Ease of establishment is intermediate.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 10 lb PLS per acre (11.2 kg/ha). There are 30,000 seeds per lb (66,000 seeds per kg).

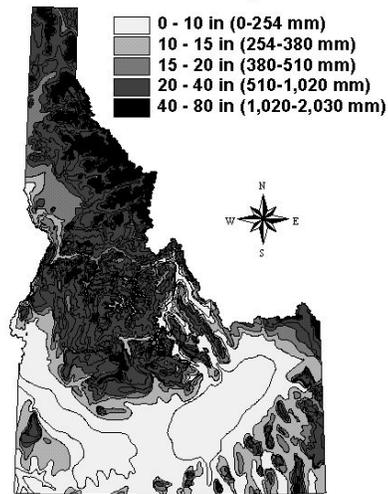
True Mountain Mahogany

Cercocarpus montanus



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 10 in (250 mm).

Elevation zone. Ranges from 4,000 to 10,000 ft (1,220-3,050 m).

Habitat & Climate requirements. Adapted to dry slopes and ridges in rocky, mountain habitats. Can withstand temperatures to -38 F (-39 C).

Soil type. Course, shallow, dry to moist, fertile soils (pH 6.0-8.0).

APPLICATIONS:

Roadside suitability. Tall and spreading. Not competitive with herbs.

Establishment. Can be difficult to establish due to the vulnerability of seedlings to competition.

SEEDING RECOMMENDATIONS: Sow stratified seed in the spring. Seed 10 lb PLS per acre (11.2 kg/ha). There are 59,000 seeds per lb (129,800 seeds per kg).

LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub/small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Bushy. Branches are upright. Leaves are toothed, persistent, alternate, and simple. Flowers are in yellow clusters. Roots are fibrous with a deep taproot. Grows less than 12 ft (3.7 m) tall.

Rubber Rabbitbrush

Chrysothamnus nauseosus



James Stubbendieck et al. (1997)

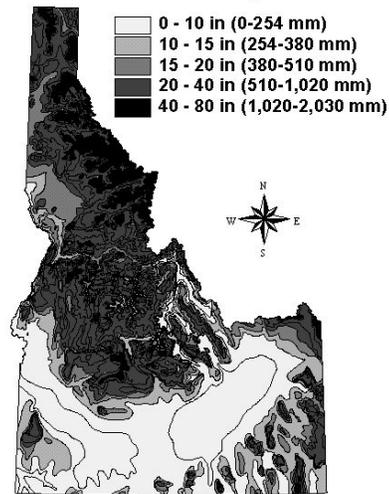
LIFE SPAN: Short-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are grey or white. Twigs are dense and leafy. Base is very stout and woody. Flowers are yellow discs in terminal, round clusters. Grows 12-84 in (30-213 cm) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 8 in (200 mm).

Elevation zone. Ranges from 2,000-9,000 ft (610-2,745 m).

Habitat & Climate requirements. Adapted to plains, hillsides, and dry alluvial slopes and mesas.

Soil type. Found in all soil textures. Favors sandy or clayey soils of decomposed granite. Tolerates slightly to strongly alkaline soils.

APPLICATIONS:

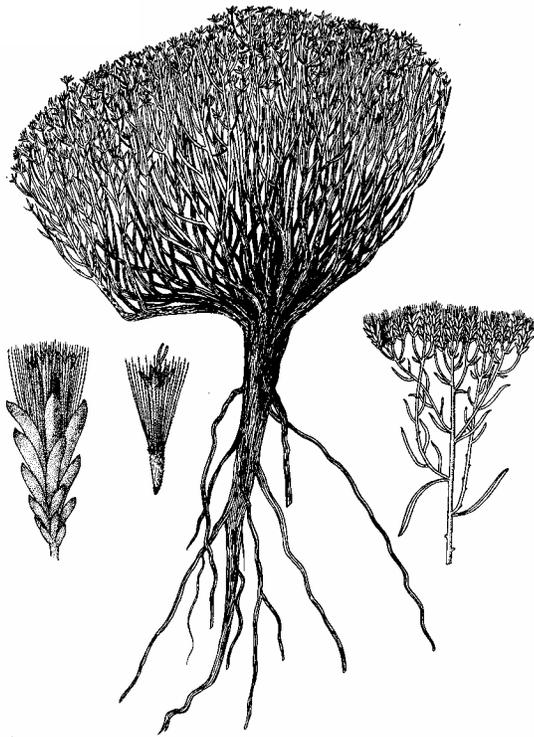
Roadside suitability. Spreads aggressively. Deep rooted with a 8-9 year life span. Found along roadsides and on disturbed sites.

Establishment. Establishes easily by direct seeding and transplanting.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 1 lb PLS per acre (1.1 kg/ha). There are 400,000 seeds per lb (880,000 seeds per kg).

Green Rabbitbrush.

Chrysothamnus viscidiflorus



Clinton H. Wasser (1982)

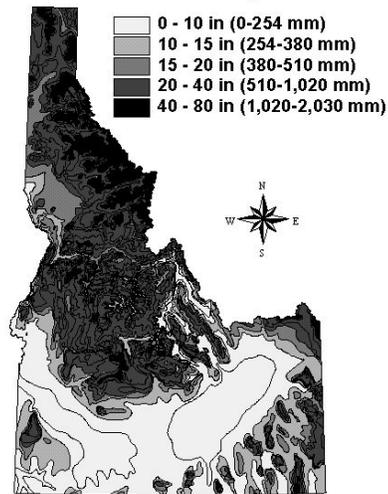
LIFE SPAN: Short-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Stout, woody, and erect. Leaves are twisted, greenish, or white. Bark is semiglossy. Flowers are yellowish, flat topped, terminal cymes. Deep roots reaching a minimum depth of 14 in (36 cm). Grows up to 3.3 ft (1 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum 6 in (150 mm).

Elevation zone. Ranges from 2,000-10,000 ft (610-3,050 m).

Habitat & Climate requirements. Adapted dry open prairies, valleys, hillsides, foothill locations. Extending into forests at lower elevations. Can withstand temperatures to -23 F (-31 C).

Soil type. Moderately coarse- to medium-textured soil with neutral pH (7.0-8.5).

APPLICATIONS:

Roadside suitability. Same as *Chrysothamnus nauseosus*.

Establishment. Medium to high germination rate. Fairly easy to establish through direct seeding on transplants.

SEEDING RECOMMENDATIONS: Plant in late fall or early spring. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 782,000 seeds per lb (1,720,400 seeds per kg).

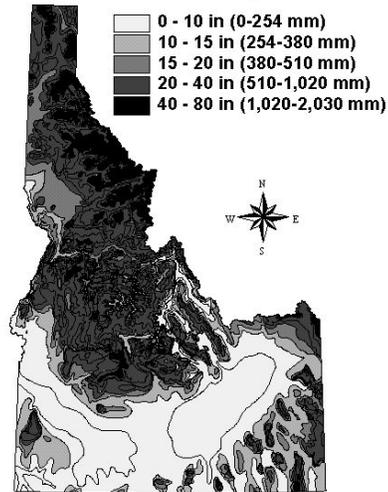
Redosier Dogwood

Cornus stolonifera



Robin Rose et al. (1998)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 18 in (460 mm).

Elevation zone. Ranges from 1,500-9,000 ft (458-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of cool, climatic conditions. Grows along streams mainly in sandy swamps. Can withstand temperatures to -38 F (-39 C).

Soil type. Best in medium- to coarse-textured moist soils. Somewhat poorly-drained, moderately acidic to neutral pH (4.8-7.0).

APPLICATIONS:

Roadside suitability. Thicket forming. Widely used in soil stabilization plantings for riparian areas, streambanks, wildlife habitats, and windbreaks. Tolerates sun and shade.

Establishment. Seed can be used. Readily established from hardwood plantings, container plantings, or bare root stock plantings. Can be seeded, however, germination is unpredictable, and seedling establishment can be slow.

SEEDING RECOMMENDATIONS: Seed in the fall. Seed 1 lb PLS per acre (1.1 kg/ha). There are 173,000 seeds per lb (380,600 seeds per kg).

LIFE SPAN: Moderate.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are dark green and ovate. Stems are attractive and red. Flowers are white, clustered, and inconspicuous. Fruits are white berries. Stoloniferous. Roots can reach a minimum depth of 16 in (41 cm). Grows 3-9 ft (1-3 m) tall.

Oceanspray

Holodiscus discolor



Patricia A. Patterson et al. (1985)

LIFE SPAN: Long-lived.

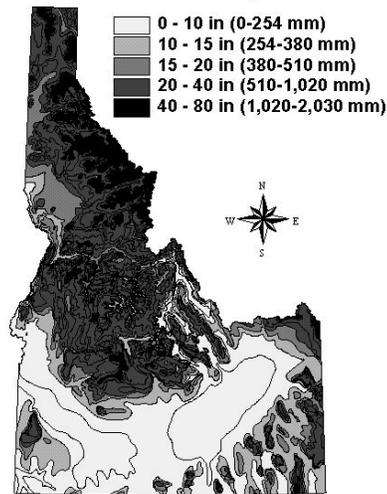
GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Attractive, symmetrical, and bushy. Leaves are single, basal, triangular with truncate base, margins are shallowly lobed with coarse teeth. Pale green above and white hairy below. Branches are spreading. Flowers are small, creamy-white and saucer-shaped. Born in dense large pyramidal panicles. Roots can reach a minimum depth of 12 in (31 cm). Grows 2-5 ft (.8-1.5 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 15 in (381 mm).

Elevation zone. Ranges from 0-7,000 ft (0-2,135 m).

Habitat & Climate requirements. Adapted to a wide range of conditions in the Pacific Northwest. Generally found in open forest stands of warm, dry tree species. Can withstand temperatures to 7 F (-14 C).

Soil type. Well-drained, sandy, gravelly, or rocky soils. Bouldery sites of rocky basalt outcroppings or on granite (pH 6.5-7.5).

APPLICATIONS:

Roadside suitability. Is often used in erosion control plantings. Thicket forming and deep rooted. Resprouts following fire.

Establishment. Moderate growth rate. Propagate by bare root container stock or seed.

SEEDING RECOMMENDATIONS: Plant in fall. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 190,000 seeds per lb (418,000 seeds per kg).

Ninebark

Physocarpus malvaceus



Patricia A. Patterson et al. (1985)

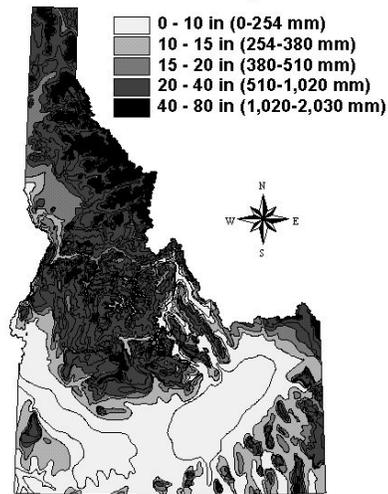
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are alternate, maple-like with three palmate lobes, and abundant. Bark is shreddy. Flowers are white and assembled in umbrella-shaped clusters. Roots are fibrous with a deep taproot that can reach a minimum depth of 24 in (61 cm). Grows 3-7 ft (1-2 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 0-10 in (0-256 mm).

Elevation zone. Ranges from 5,200-10,800 ft (1,560-3,240 m).

Habitat & Climate requirements. Adapted to dry, rocky slopes, cliffs and deep canyons. Beneath dry, warm forest types as well as on non-forested shrubland sites. Can withstand temperatures to -33 F (-36 C).

Soil type. Well-drained, medium-textured, organic soils. Persists on drier, sandy or rocky soils (pH 6.0-7.5).

APPLICATIONS:

Roadside suitability. Forms dense thickets and resprouts from root crown. Potential erosion control species. Used for outer rows of multi-row wind breaks. Adapted to fire.

Establishment. Germinates readily from seed. Can also propagate from root cuttings and bare root plantings.

SEEDING RECOMMENDATIONS:

Broadcast in fall or spring. Seed 1-2 lb PLS per acre (1.1-2.2 kg/ha). There are 756,000 seeds per lb (1,663,200 seeds per kg).

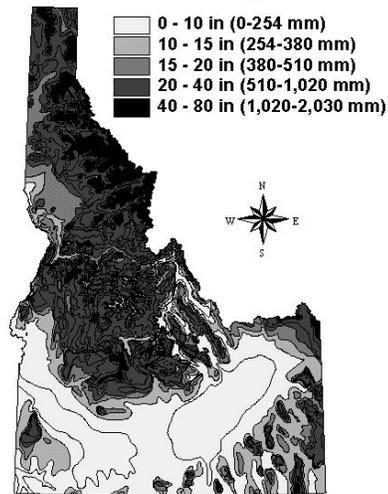
Shrubby Cinquefoil

Potentilla fruticosa



James Stubendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum 16 in (410 mm).

Elevation zone. Ranges from 5,500-11,000 ft (1,670-3,355 m).

Habitat & Climate requirements. Adapted to subalpine meadows, bogs, rocky grounds at higher elevations can tolerate same shading. Can withstand temperatures to -28 F (-33 C).

Soil type. Well-drained, medium-textured, moist soils (pH 5.0-8.0).

APPLICATIONS:

Roadside suitability. Colonizes disturbed sites. Useful soil stabilization species. Used for roadside plantings. Sprouts following a disturbance. Tolerates cold conditions.

Establishment. Difficult to establish from seed.

SEEDING RECOMMENDATIONS: Plant in early spring or late fall. Seed 20-30 PLS per square foot. There are 1,000,000-1,300,000 seeds per lb (2,200,000-2,860,000 seeds per kg).

LIFE SPAN: Short-lived.

GROWTH HABIT: Deciduous low-shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are alternate, pinnately compound leaflets crowded with upper three often confluent at base. Stems are clustered. Flowers are yellow, buttercup-like, and born on ends of branches. Roots can reach a minimum depth of 18 in (46 cm). Grows 12-24 in (30-61 cm) tall.

Chokecherry

Prunus virginiana



James Stubbendeck et al. (1997)

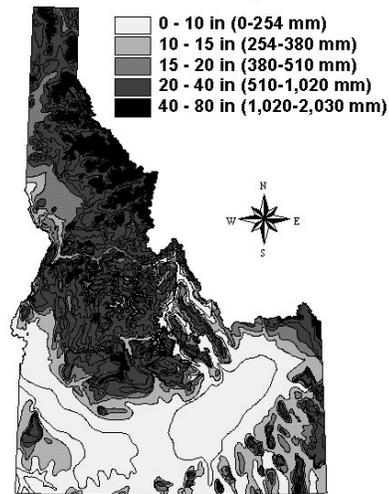
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub/small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Dense and bushy. Leaves are deciduous, alternate, oblong-ovate and finely serrate. Dark green above and pale green below. Flowers are white, showy, and born in large terminal clusters. Fruits are round and dark purple to black when ripe. Roots can reach a minimum depth of 20 in (51 cm). Height varies by variety from 3-19.5 ft (1-6 m).

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 12-30 in (300-760 mm).

Elevation zone. Ranges from 4,500-9,000 ft (1,373-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions on foothills throughout the aspen zone. Can withstand temperatures to -43 F (-42 C).

Soil type. Moderately coarse- to fine-textured silty soils that are moderately acidic, moderately basic, or weakly saline (pH 5.2-8.4).

APPLICATIONS:

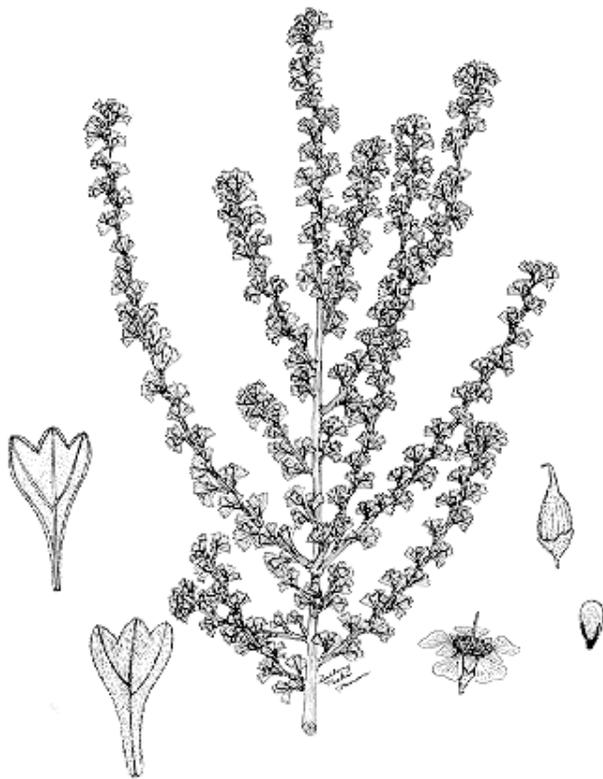
Roadside suitability. Forms thickets and spreads by rhizomes. Potential for disturbed sites as an ornamental, erosion control, or windbreak species. Hardy, and tolerates drought.

Establishment. Difficult to establish from seed. Moderate fertility requirement.

SEEDING RECOMMENDATIONS: Plant in the fall at a depth of 0.5 in (1.3 cm) Seed 10-15 lb PLS per acre (11.2-16.8 kg/ha). There are 4,800 seeds per lb (10,560 seeds per kg).

Antelope Bitterbrush

Purshia tridentata



James Stubbendieck et al. (1997)

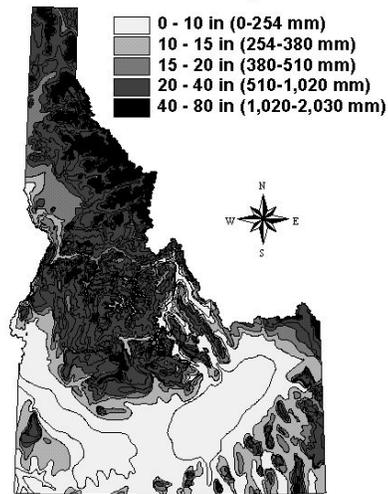
LIFE SPAN: Long-lived.

GROWTH HABIT: Evergreen shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Semi-erect and diffusely branched. Leaves are alternate, simple, wedge-shaped with a 3-lobed apex and greyish green. Twigs are gray to brown with short spur-like branches. Flowers are yellow. Roots can reach a minimum depth of 20 (51 cm). Grows 2-10 ft (.6-3 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 2-25 in (50-640 mm).

Elevation zone. Ranges from 3,500-9,000 ft (1,068-2,745 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions throughout the cold desert shrublands and beneath Ponderosa pine at the forested interface on warm, dry sites. Can withstand temperatures to -33 F (-36 C).

Soil type. Well-drained, sandy, gravelly, or rocky soils (pH 5.6-8.4).

APPLICATIONS:

Roadside suitability. Thrives under rigorous conditions. Tolerant of drought and cold conditions. Used in roadside plantings for soil stabilization, suited for disturbed sites.

Establishment. Grows rapidly. Seedlings are vigorous and drought tolerant. Intermediate results from seeding.

SEEDING RECOMMENDATIONS: Drill in fall at a depth of 0.5-1 in (1.3-2.5 cm) to reduce rodent predation. Seed 1-3 lb PLS per acre (1.1-3.4 kg/ha). There are 15,000 seeds per lb (33,000 seeds per kg).

Smooth Sumac

Rhus glabra



Robin Rose et al. (1998)

LIFE SPAN: Medium-lived.

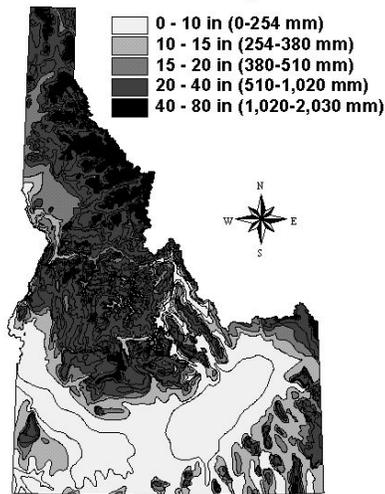
GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Elongated, dense panicles of small white flowers that develop into berry-like fruits that are dark red. Leaves are pinnately compound with 7-29 sessile, lanceolate leaflets. Roots can reach a minimum depth of 24 in (61 cm). Thicket-forming shrub that grows to 4-7 ft (1.2-2.1 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 10 in (250 mm).

Elevation zone. Ranges from 2,700-7,500 ft (824-2,288 m).

Habitat & Climate requirements. In well drained sites at the base of slopes, along stream channels and ravines in canyonlands in the Pacific Northwest. Can withstand temperatures to -33 F (-36 C).

Soil type. Well-drained, medium-textured, moist and fertile soil (pH 5.3-7.5).

APPLICATIONS:

Roadside suitability. Thicket forming. Often found along roadsides and in dry waste areas from natural recruitment. A very extensive and deep rooting system.

Establishment. Establishes well from seed, cuttings or transplants.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 0.75 in (2 cm). Seed 0.5-1 lb PLS per acre (0.56-1.1 kg/ha). There are 20,000 seeds per lb (44,000 seeds per kg).

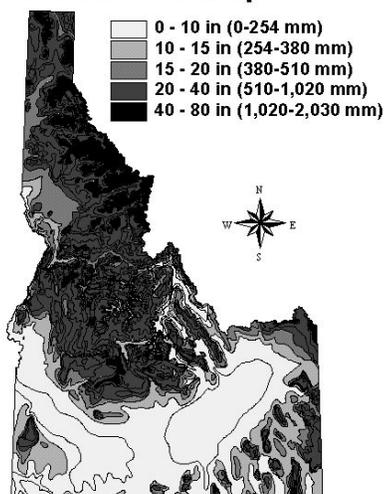
Skunkbrush sumac

Rhus trilobata



Clinton H. Wasser (1982)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 8 in (200 mm).

Elevation zone. Ranges from 1,900-8,000 ft (580-2,440 m).

Habitat & Climate requirements. Adapted to dry rocky hillsides, ravines, thickets, woodland and roadsides. Can withstand temperatures to -47 F (-44 C).

Soil type. Well-drained, moderately-coarse- to medium-textured soil with neutral pH (6.5-8.0).

APPLICATIONS:

Roadside suitability. Thicket forming. Used for stabilization and windbreak plantings. Tolerates grazing, fire, and drought. Extensive and deep rooting system.

Establishment. From seedling, cuttings, or transplants. Seeding success is intermediate to low.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 0.25-0.5 in (0.63-1.3 cm). Seed 0.5-1 lb PLS per acre (.56-1.1 kg/ha). There are 19,000 seeds per lb (41,800 seeds per kg).

LIFE SPAN: Medium-lived.

GROWTH HABIT: Deciduous shrub.

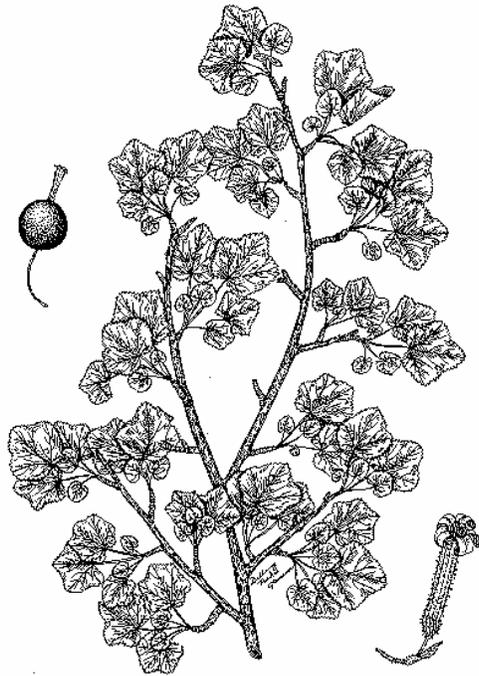
ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Aromatic. Leaves are alternate, simple, compound, and trifoliate. Twigs are greyish to reddish brown. Flowers are yellowish and spreading. Roots can reach a minimum depth of 16 in (41 cm). Grows up to 8 ft (2.5 m) tall.

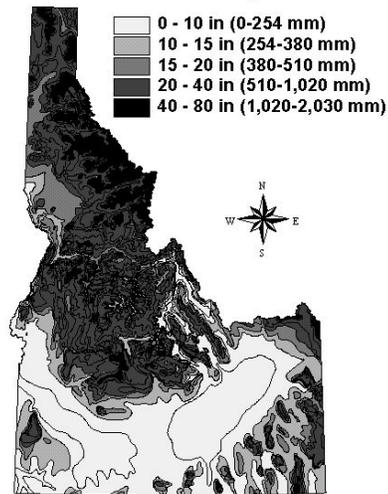
Wax Current

Ribes cereum



James Stubbendieck et al. (1997)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Approximately 14 in (360 mm).

Elevation zone. Ranges from 2,500-9,500 ft (763-2,898 m).

Habitat & Climate requirements. Adapted to open slopes, hills, and ridges. Can withstand temperatures to -23 F (-31 C).

Soil type. Well-drained, medium-textured, dry, rocky, or sandy soils with a neutral pH (6.5-7.5).

APPLICATIONS:

Roadside suitability. Medium height, rhizomatous and deep rooted for excellent slope stability.

Establishment. Medium growth rate, intermediate establishment by seed, and good establishment by transplants.

SEEDING RECOMMENDATIONS: Plant in fall at a depth of 0.25-0.5 in (0.63-1.3 cm). Seed 0.25-0.5 lb PLS per acre (.28-.56 kg/ha) PLS per acre. There are 350,000 seeds per lb (770,000 seeds per kg).

LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are waxy, alternate, simple, and 3-5 lobed. Stems are light or dark gray and glabrous. Flowers are fragrant, white, and pink. Fruits are yellow-red berries. Rhizomatous roots can reach a minimum depth of 12 in (31 cm). Grows up to 6.5 ft (2 m) tall.

Scouler Willow

Salix scouleriana



Charles Grier Johnson (1993)

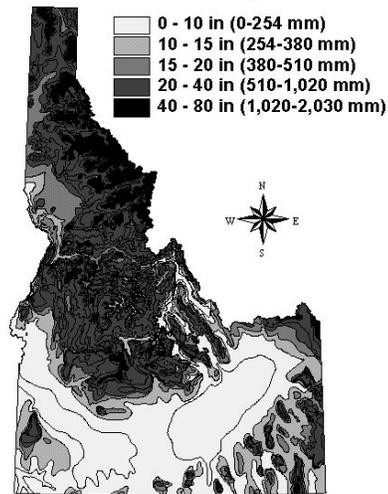
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous shrub/small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are alternate, spatulate with entire margins. Twigs are tall and stout with grey hairs. Flowers are catkins. Roots spread from a massive root crown and can reach a minimum depth of 12 in (31 cm). Grows 10-32 ft (3-10 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 18-35 in (462-897 mm).

Elevation zone. Above 3,000 ft (915 m).

Habitat & Climate requirements. Adapted to cool air drainages of uplands in North Idaho. Can withstand temperatures to -13 F (-25 C).

Soil type. Well-drained, medium-textured soil (pH 6.5-8.0).

APPLICATIONS:

Roadside suitability. Good soil binder. Valuable soil stabilization species. Proliferates following a disturbance. Tolerates acidic conditions. The only willow species that grows truly on upland sites.

Establishment. Easily established from cuttings and transplants. Grows rapidly, however difficult to establish from seeds.

SEEDING RECOMMENDATIONS:

Transplant root cuttings in the spring. There are 6,500,000 seeds per lb (14,300,000 seeds per kg).

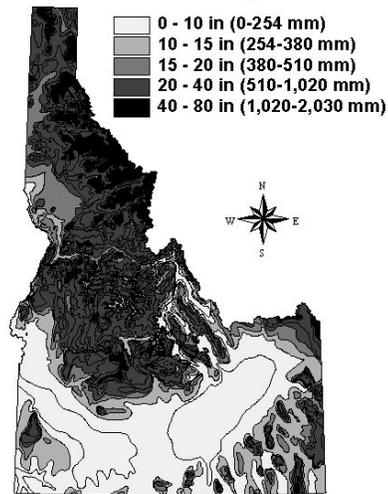
Blue Elderberry

Sambucus cerulea



Arthur Cronquist et al. (1994)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12 in (30 mm).

Elevation zone. Ranges from 0-10,000 ft (0-3,050 m).

Habitat & Climate requirements. Adapted to a wide range of climatic conditions along streams, in canyons, and on hillsides of the Western United States. Can withstand temperatures -38 F (-39 C).

Soil type. Moist, sandy, or clayey loams. Tolerates alkaline and saline soils (pH 4.9-7.5).

APPLICATIONS:

Roadside suitability. Used for roadside plantings because of its productivity, adaptability, and ease of establishment. Extensive rooting system with deep taproot.

Establishment. Easily established from seed cuttings and transplants.

SEEDING RECOMMENDATIONS: Seed in the fall. Seed 10-15 lb PLS per acre (11.2-16.8 kg/ha). There are 216,800 seeds per lb (476,960 seeds per kg).

LIFE SPAN: Intermediate-lived.

GROWTH HABIT: Deciduous shrub/small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Leaves are opposite and compound with toothed leaflets. Flowers are cream to white. Fruits are black berries. Roots are fibrous with a taproot that can reach 12 in (31 cm). Grows 6-20 ft (2-6 m) tall.

Common Snowberry

Symphoricarpos albus



Patricia A. Patterson et al. (1985)

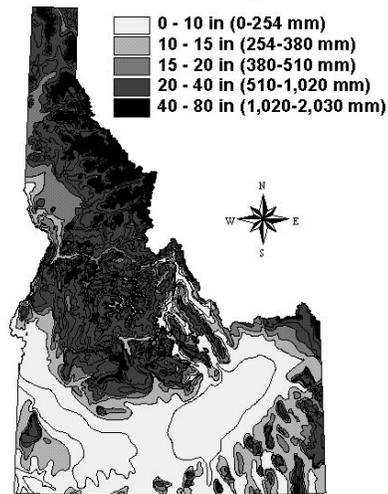
LIFE SPAN: Intermediate-lived.

GROWTH HABIT: Deciduous shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Erect. Branches are smooth. Flowers are white to pink, slender, and bell-shaped. Fruits are fleshy, globe-shaped, white berries. Leaves are elliptic and opposite. Roots can reach a minimum depth of 18 in (46 cm). Grows 2-4 ft (0.6-1.2 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 15 in (380 mm).

Elevation zone. Ranges from 2,400-9,000 ft (732-2,745 m).

Habitat & Climate requirements. Adapted to wooded hillsides and open slopes. Commonly associated with Ponderosa pine and Douglas fir open forest types. Can withstand temperatures to -38 F (-39 C).

Soil type. Well-drained, moist and dry, rocky soils of calcareous barrens, and gravelly banks.

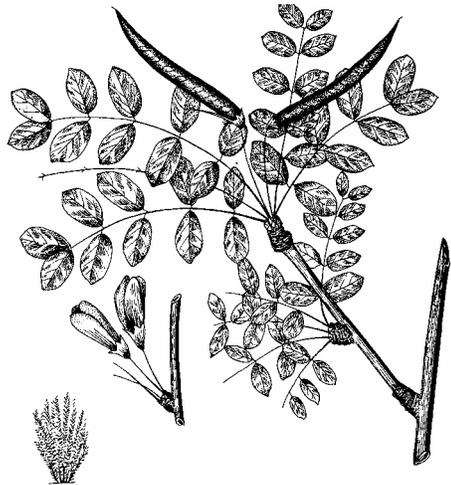
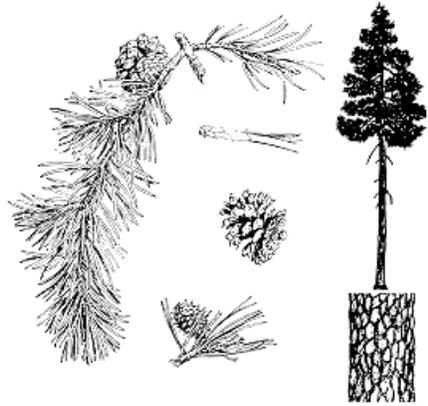
APPLICATIONS:

Roadside suitability. Thicket forming and low growing shrub. Well suited to rocky sites and gravelly road cuts. Excellent slope stabilizer.

Establishment. Reproduces by seeds and rhizomes. Seeds can be difficult to germinate when dormancy. Easy be established from transplants.

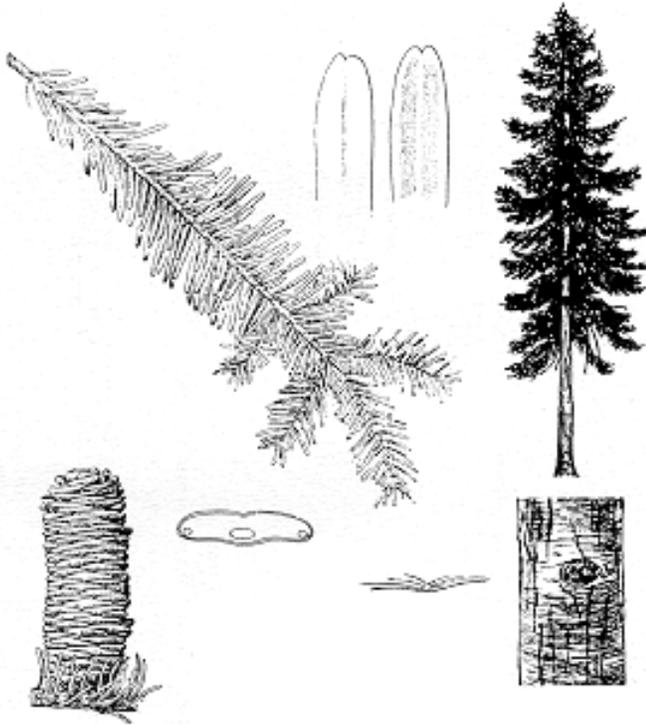
SEEDING RECOMMENDATIONS: Plant in the fall. Seed 5 lb PLS per acre (5.6 kg/ha). There are 76,000 seeds per lb (167,200 seeds per kg).

Trees



Grand Fir

Abies grandis



Patricia A. Patterson et al. (1985)

LIFE SPAN: Long-lived.

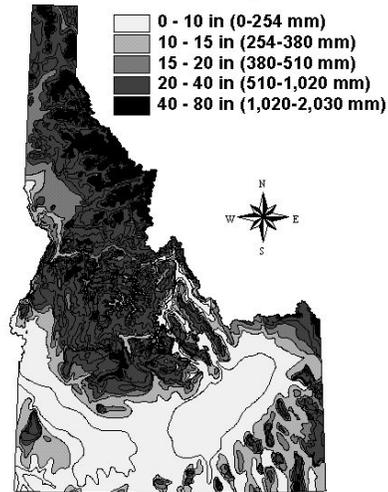
GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Needles are shiny green on top and whitish beneath. Crown is open and dome-like with flattened branches. Bark is thin, grooved, and dark grey. Roots are deep and spreading and can reach a minimum depth of 40 in (102 cm). Grows up to 250 ft (76 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 20-100 in (510-2,540 mm).

Elevation zone. Ranges from 2,300-3,275 ft (702-999m) in Northern Idaho.

Habitat and Climate requirements. Adapted to cold, humid summers and moderate winters on moist mountain slopes. Can withstand temperatures to -33 F (-36 C).

Soil type. Deep, well-drained, porous, alluvial soils (pH 4.5-7.5).

APPLICATIONS:

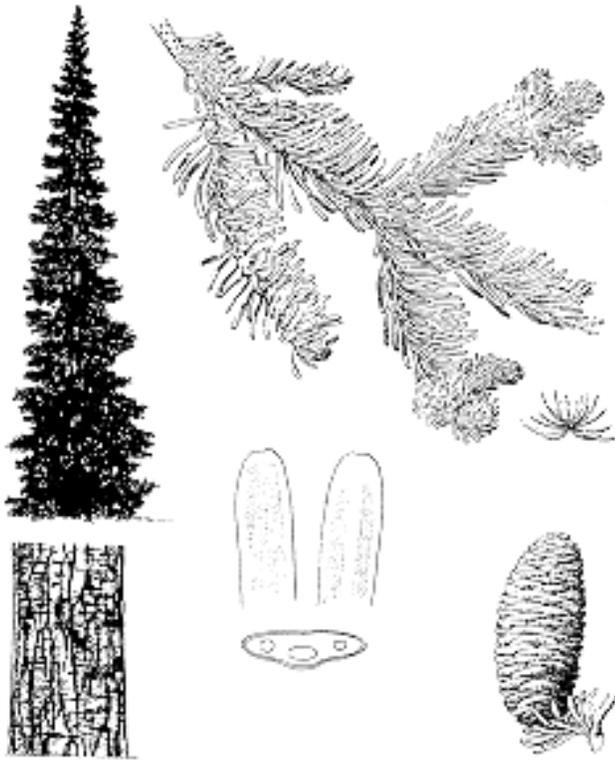
Roadside suitability. Tolerates shade. Deep rooted for slope stabilization.

Establishment. Fair results from seeding, excellent from transplants.

SEEDING RECOMMENDATIONS: Seeds require cold stratification for 15-30 days prior to sowing at a depth of 0.5 cm depth covered with mulch. Seeding rate 16 lbs PLS per acre (18 kg/ha). There are 20,408 seeds per lb (45,000 seeds per kg).

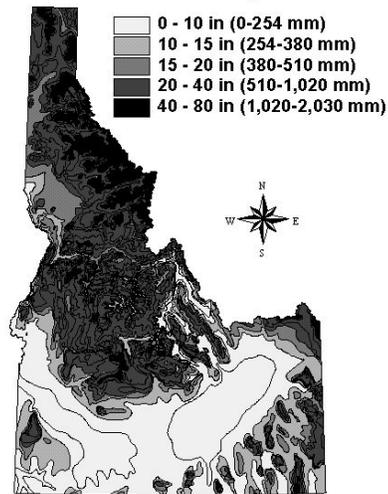
Subalpine Fir

Abies lasiocarpa



Patricia A. Patterson et al. (1985)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 25 in (640 mm) mostly in the form of snow.

Elevation zone. Ranges from 3,500-10,500 ft (1,068-3,203 m).

Habitat and Climate requirements. Adapted to the climatic conditions of cool, moist, subalpine to alpine areas. Can withstand temperatures to -51 F (-46 C).

Soil type. Largest trees are found in moist, porous soils. Persists on dry, thin soils as well as fairly deep, loose soils (pH 4.0-6.5).

APPLICATIONS:

Roadside suitability. Excellent for slope stabilization in subalpine settings. Well suited to cold, moist environments.

Establishment. Moderate results from seed, best from transplants.

SEEDING RECOMMENDATIONS: Plant in the spring. Seed 16 lb PLS per acre (18 kg/ha). There are 20,408 seeds per lb (45,000 seeds per kg).

LIFE SPAN: Long-lived.

GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are deep, blue-green, spear-like, and pointed upward on the top-sides of the branches. Crown is narrow. Bark is greyish, thin, and blistered. Stolonerous with shallow roots. Grows up to 137 ft (42 m).

Thinleaf Alder

Alnus incana



Patricia A. Patterson et al (1985)

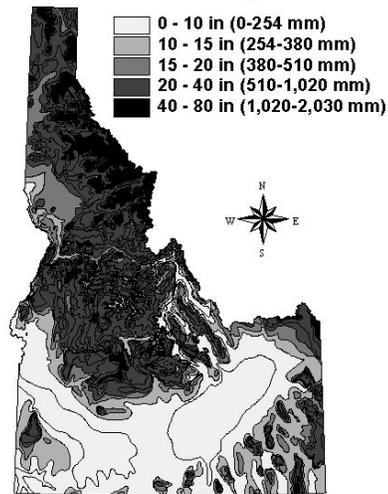
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous small tree/large shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are dark green and ovate to oblong and glabrous. Stems are slender and bent. Crown is dome-like. Bark is thin, smooth, and dirty greenish gray. Grows up to 40 ft (12.2 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. 20 in (513 mm) or more.

Elevation zone. Ranges from 2,500-8,000 ft (763-2,440 m).

Habitat and Climate requirements. Adapted to the climatic conditions of riparian and subirrigated areas within the Pacific Northwest. Can withstand temperatures to -33 F (-36 C).

Soil type. Moist rocky soils along streams and wetlands (pH 5.5-7.0).

APPLICATIONS:

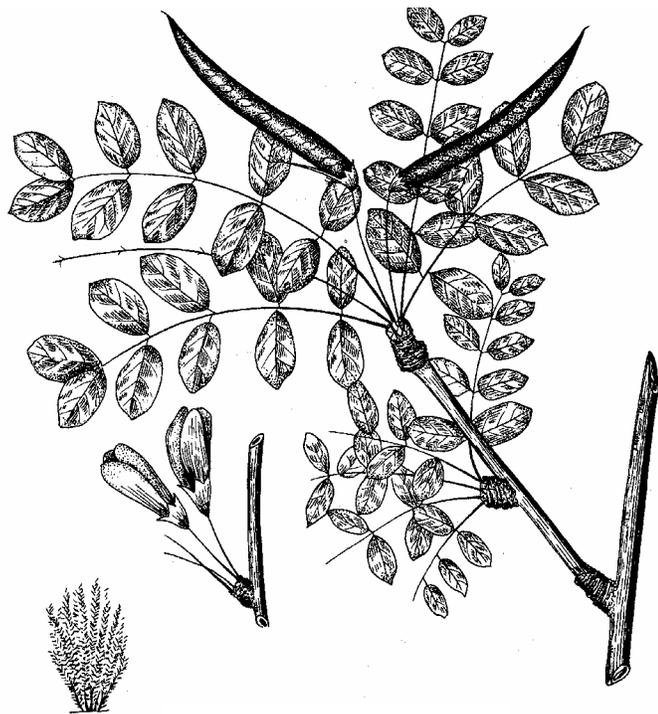
Roadside suitability. Forms thickets and has nitrogen-fixing root nodules. Deep rooted and rhizomatous.

Establishment. Easy to establish from transplants and moderate results from seed.

SEEDING RECOMMENDATIONS: Seed in the spring at a depth of 0.13-0.25 in (0.33-0.64 cm). Seed rate 5 lbs per acre (5.6 kg/ha). There are 10,000 seeds per lb (22,000 seeds per kg).

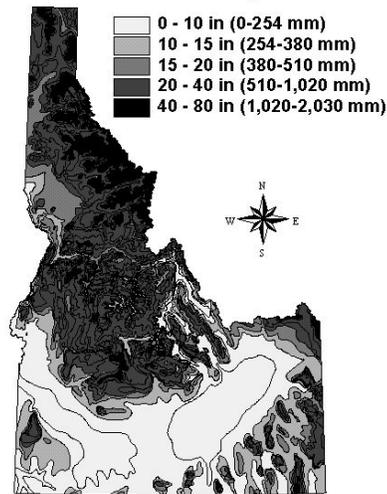
Siberian Peashrub

Caragana arborescens



Clinton H. Wasser (1982)

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 12 in (308 mm).

Elevation zone. Ranges from 2,500-4,000 ft (763-1,220 m).

Habitat and Climate requirements. Adapted to a wide range of conditions throughout the Intermountain Region. Drought and winter hardy, withstanding temperatures to -38 F (-39 C).

Soil type. Well-drained, dry soils. Does not tolerate wet soils, but does tolerate alkali conditions (pH 6.0-9.0).

APPLICATIONS:

Roadside suitability. Used for outer rows of windbreaks and recreational plantings. Winter-hardy. Tolerates drought and alkaline conditions. Nitrogen-fixing.

Establishment. Vigorous seedling growth. Mature in 5-7 years. Moderate results from seed, excellent from transplants and sprouts.

SEEDING RECOMMENDATIONS: Seeds may be drilled or broadcast in the spring at a depth of 0.25-0.38 in (0.64-0.97 cm). Plant 6 in (15 cm) apart. Seeding rate 7 lbs per acre (7.8 kg/ha). There are 12,000 seeds per lb (26,400 seeds per kg).

LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous tree/shrub.

ORIGIN: Introduced.

VEGETATIVE CHARACTERISTICS: Small and upright. Leaves are evenly pinnate with 8-12 leaflets. Branches are extended to the ground. Flowers are yellow and papilionaceous. Roots can reach a minimum depth of 16 in (41 cm). Grows 10-20 ft (3-6 m) tall.

Hackberry

Celtis reticulata



Charles Grier Johnson (1993)

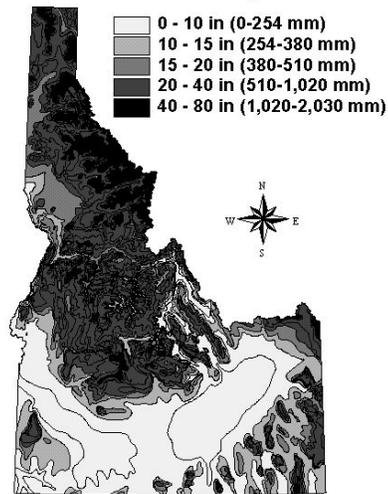
LIFE SPAN: Long-lived.

GROWTH HABIT: Small tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Bush tree with a small rounded crown. Bark has corky ridges. Leaves are thick and sandpapery. Fruit is spherical, reddish to orange. Strong taproot with spreading fibrous roots, reaching a minimum depth of 16 in (41 cm). Grows 9.8-20 ft (3-6 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum 17 in (431 mm).

Elevation zone. Ranges from 820-4,754 ft (250-1,450m).

Habitat and Climate requirements. Found along the Snake River and Salmon River canyons on southeast to westerly aspects on open slopes along waterways. Can withstand temperatures to -13 F (-25 C).

Soil type. Rocky, well-drained, wet soils (pH 7.0-8.0).

APPLICATIONS:

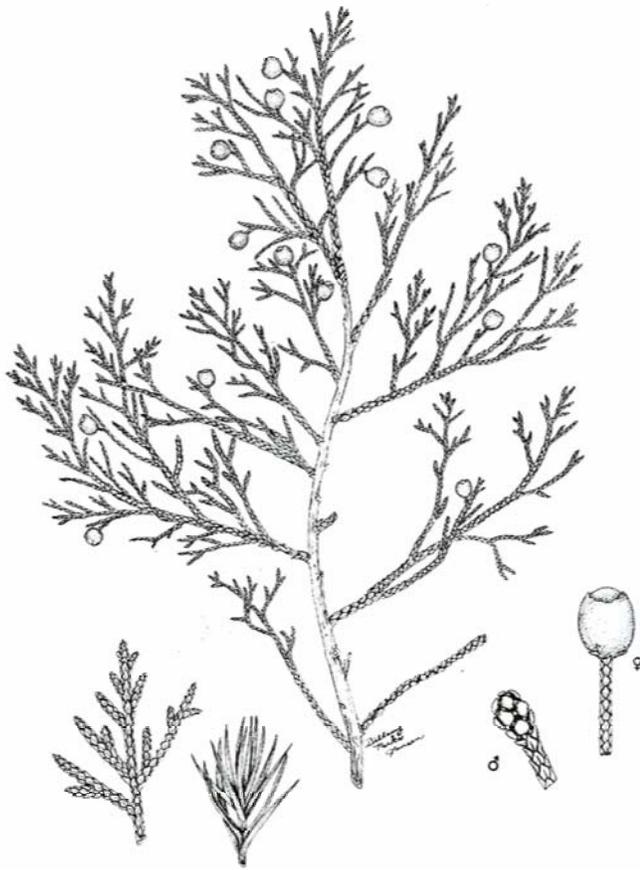
Roadside suitability. Used for environmental forestry and shelterbelt plantings. Resprouts following a disturbance. Potential species for rehabilitation in arid areas along waterways. Deep taproot with spreading fibrous roots for excellent slope stabilization.

Establishment. Slow growing. Poor establishment from seed, excellent from transplant.

SEEDING RECOMMENDATIONS: There are 4,870 seeds per lb (10,714 seeds per kg), however not recommended to establish from seed.

Rocky Mountain Juniper

Juniperus scopulorum



James Stubbendiek (1997)

LIFE SPAN: Long-lived.

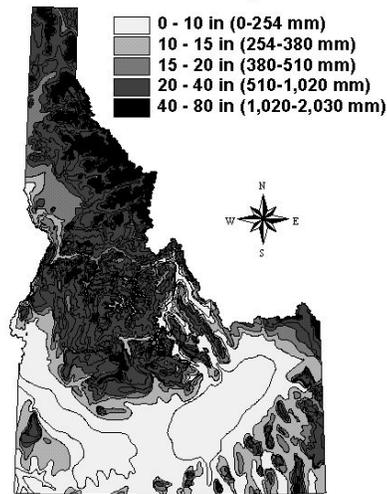
GROWTH HABIT: Evergreen tree/bushy shrub.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Dioecious. Leaves are dark green, scale-like, and pointed. Crown is irregular and rounded. Bark is stringy. Fruits are pea sized, clear-blue berries. Roots can reach a minimum depth of 20 in (51 cm). Grows 20-50 ft (6-15 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 10-20 in (250-510 mm).

Elevation zone. Ranges from 5,000-9,000 ft (1,525-2,745 m).

Habitat and Climate requirements. Adapted to a wide range of climatic conditions throughout the Rocky Mountain West. Best suited to moist sites at higher elevations. Can withstand temperatures to -38 F (-39 C).

Soil type. Adapted to a wide range of soils. Optimum conditions on rocky, gravelly, or sandy soils (pH 5.0-8.0).

APPLICATIONS:

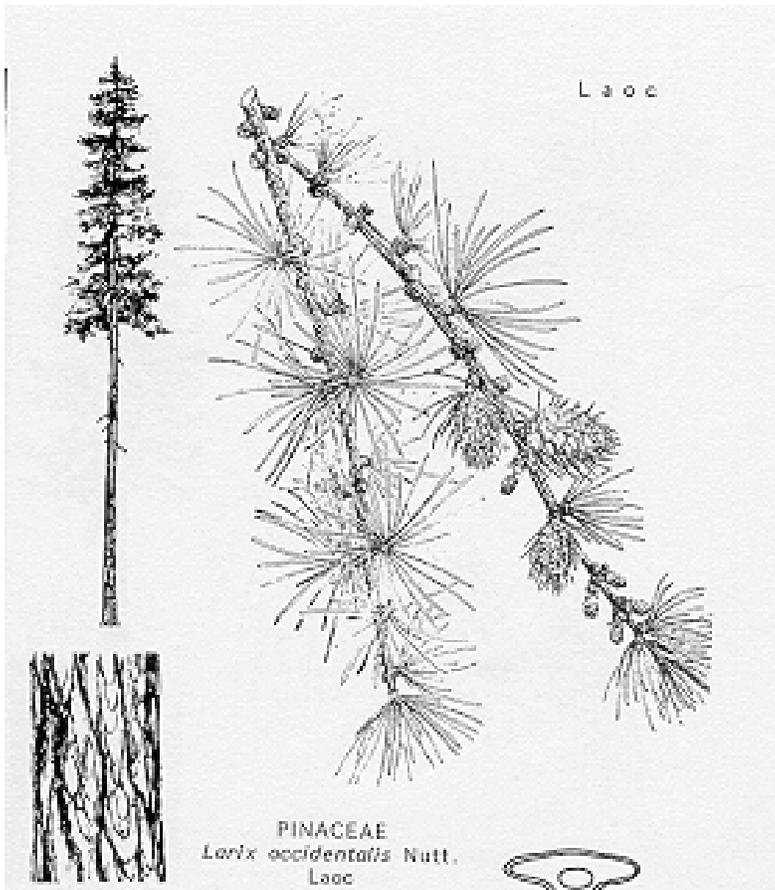
Roadside suitability. Used for windbreaks. Tolerates high water tables. Resistant to drought. Deep rooted and excellent slope stabilizer.

Establishment. Medium to rapid growth rate. Difficult to establish from seed, excellent results from transplants.

SEEDING RECOMMENDATIONS: Sow seeds in the fall. Seed 16 lb PLS per acre (18 kg/ha). There are 27,000 seeds per lb (59,400 seeds per kg).

Western Larch

Larix occidentalis



Patricia A. Patterson et al. (1985)

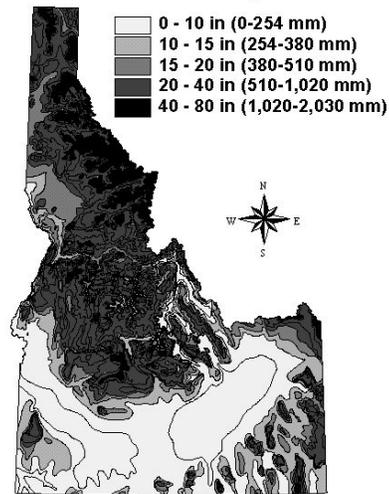
LIFE SPAN: Long-lived.

GROWTH HABIT: Deciduous conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Large coniferous tree, long, straight stem with relatively short, horizontal, straight branches. Leaves are deciduous and born in clusters of 25-40 on spur shoots. Roots are deep and wide spreading reaching a minimum depth of 20 in (51 cm). Grows 164 ft (50 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 20-30 in (510-760 mm).

Elevation zone. Ranges from 2,000-7,000 ft (610-2,135 m).

Habitat and Climate requirements. Adapted to north or west facing slopes with rain in the spring and fall and hot and dry summers. Can withstand temperatures to -43 F (-42 C).

Soil type. Deep, moist, porous, gravelly slopes (pH 6.0-7.0).

APPLICATIONS:

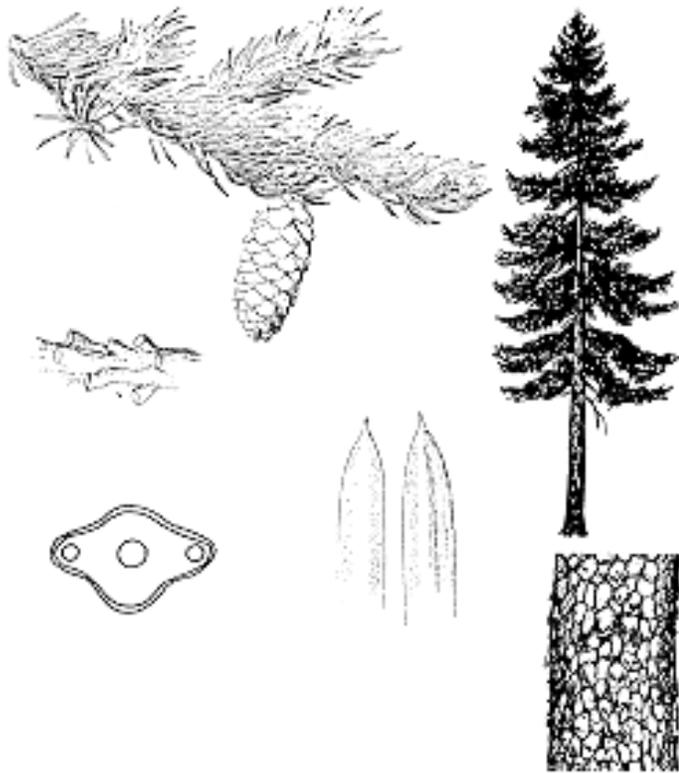
Roadside suitability. Windfirm and fire resistant. Recommended for reforestation and rehabilitation plantings. Tolerates drought. Deep rooted and aesthetic.

Establishment. High germination rate. Establishes readily from seed and transplants.

SEEDING RECOMMENDATIONS: Plant in the fall or spring at a depth of 0.13-0.25 in (0.33-0.64 cm). There are 98,182-197,411 seeds per lb (216,000-434,305 per kg).

Engleman Spruce

Picea engelmannii



Patricia A. Patterson et al. (1985)

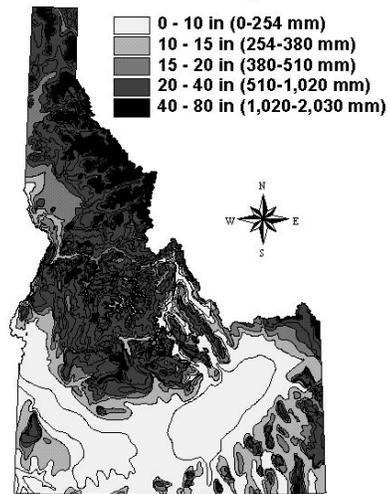
LIFE SPAN: Long-lived.

GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are deep, blue-green, rigid needles. Crown is spiral with branches extending to the ground. Bark is thin, scaly, and brownish red. Roots are shallow and spreading, reaching a minimum depth of 20 in (51 cm). Grows up to 180 ft (55 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Greater than 25 in (640 mm), largely in the form of snow.

Elevation zone. Ranges from 1,500-5,000 ft (458-1,525 m).

Habitat and Climate requirements. Adapted to the climatic conditions of cold humid sites and wet frost pockets in the montane zone. Prominent at edges of meadows, streams and lakes. Can withstand temperatures to -50 F (-46 C).

Soil type. Moist, well-drained, rich and loamy soils (pH 6.0-8.0).

APPLICATIONS:

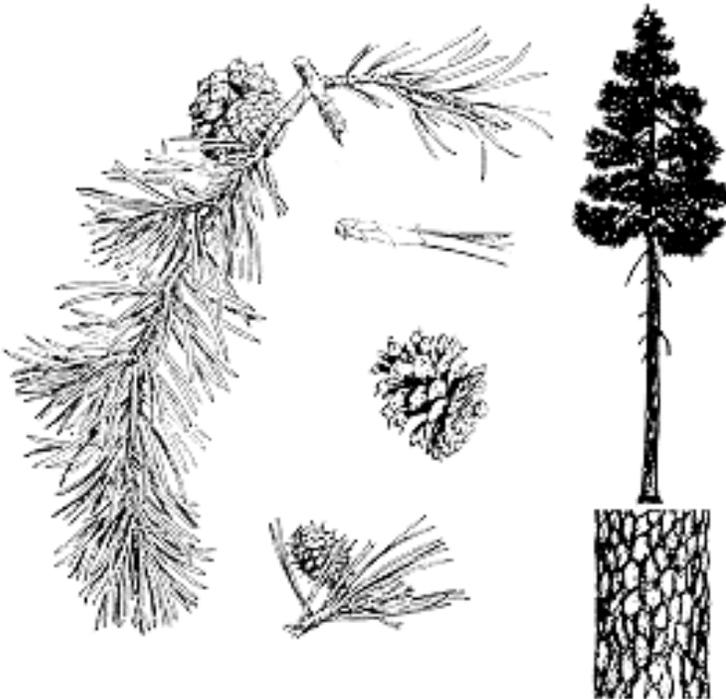
Roadside suitability. Tolerates shade and cold. Not as deep rooted as other conifers. Aesthetic.

Establishment. Prolific seeder and vigorous. Germinates best on moist mineral soil following cold stratification. Propagate by transplanting or seeding.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 16 lb PLS per acre (18 kg/ha). There are 12,000 seeds per lb (26,000 seeds per kg).

Lodgepole Pine

Pinus contorta



Patricia A. Patterson et al. (1985)

LIFE SPAN: Relatively short-lived.

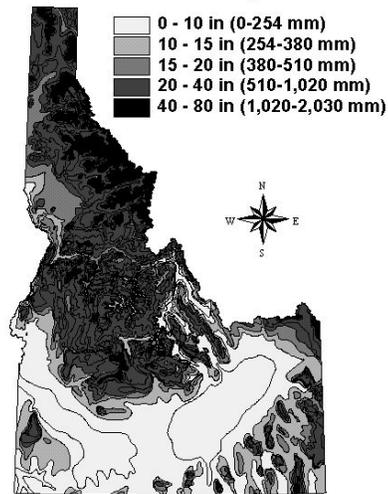
GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS:

Relatively short tree, small stem and crown. Leaves are yellow-green, long, and stiff in needle-like clusters of 2-3. Roots are shallow, reaching a minimum depth of 20 in (51 cm). Grows 50-100 ft (15-30 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 30-60 in (769-1,538 m).

Elevation zone. Ranges from 4,000-11,000 ft (1,220-3,355 m).

Habitat and Climate requirements. Adapted to a wide range of climatic conditions throughout the Pacific Northwest. Can withstand temperatures to -70 F (-57 C).

Soil type. Moist, well-drained, sandy-gravelly loams. Tolerates wet, acidic environments as well as thin, volcanic soils (pH 6.2-7.5).

APPLICATIONS:

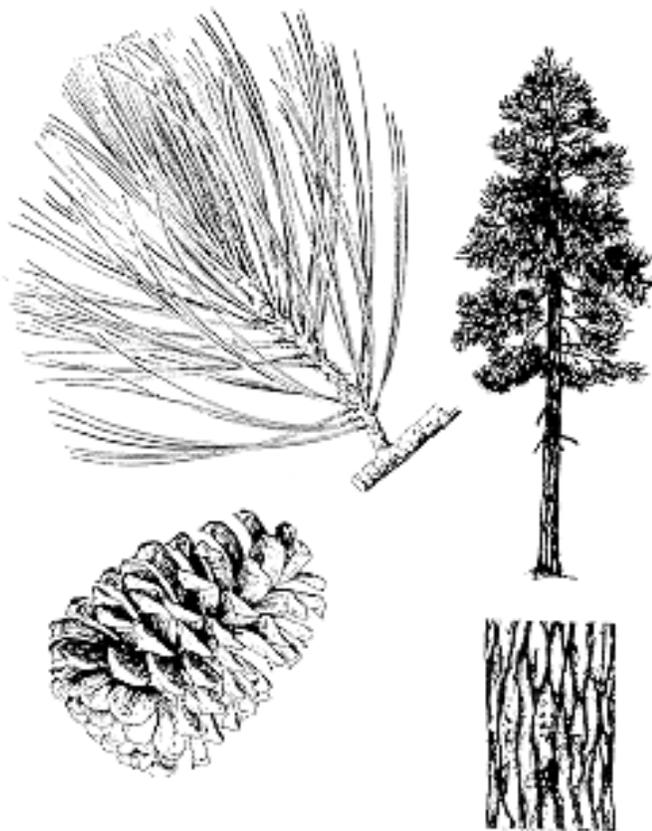
Roadside suitability. Medium-sized. Reproduces rapidly after a fire. Persists in frost pockets. Establishes and grows under a wide range of conditions.

Establishment. Vigorous reproduction from seeds and transplants.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 20 lb PLS per acre (22.4 kg/ha). There are 95,000 seeds per lb (209,000 seeds per kg).

Ponderosa Pine

Pinus ponderosa



Patricia A. Patterson et al. (1985)

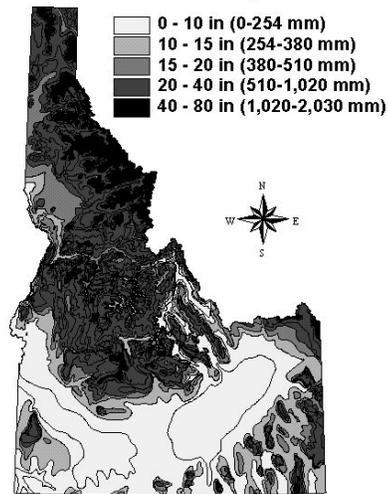
LIFE SPAN: Long-lived.

GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are long, dark-green, and needle-like in fascicles of 3. Crown is round to broadly cylindrical. Bark is gray-brown to reddish brown and deeply furrowed with age. Roots are moderately deep and wide spreading, reaching a minimum depth of 20 in (51 cm). Grows 80-200 ft (24-61 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Minimum of 10 in (250 mm) or more.

Elevation zone. Ranges from 2,000-9,000 ft (610-2,745 m).

Habitat and Climate requirements. Adapted to a wide range of dry areas and on southern exposures in the Rocky Mountain region. Can withstand temperatures to -36 F (-38 C).

Soil type. Adapted to a variety of soil conditions, generally in well-drained soils with a pH of 4.5 to 9.

APPLICATIONS:

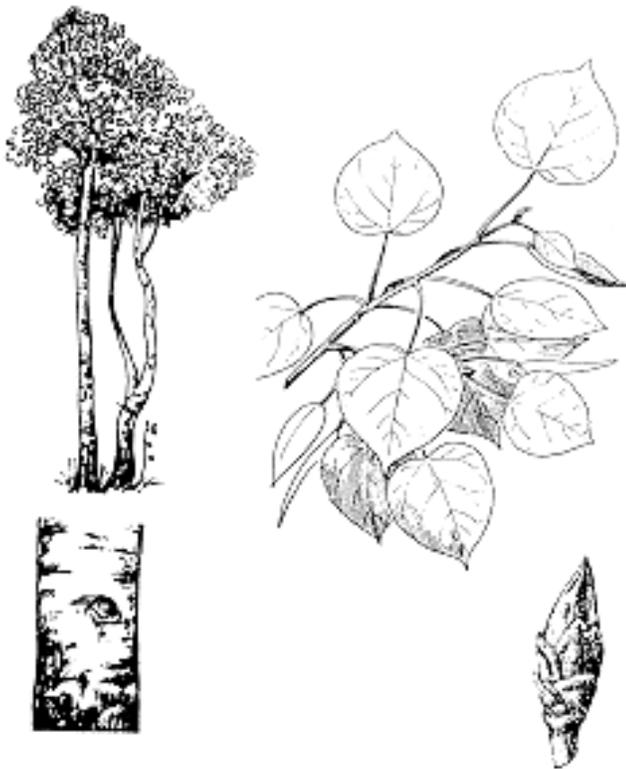
Roadside suitability. Used for landscaping and has excellent longevity in windbreaks. Requires good drainage and plenty of sunlight, however, adapted to a wide range of climatic and soil conditions. Deep rooted and aesthetic.

Establishment. Reproduction is vigorous and readily establishes from seeding or transplants.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 15 lb PLS per acre (16.8 kg/ha). There are 12,000 seeds per lb (26,000 seeds per kg).

Quaking Aspen

Populus tremuloides



Patricia A. Patterson et al. (1985)

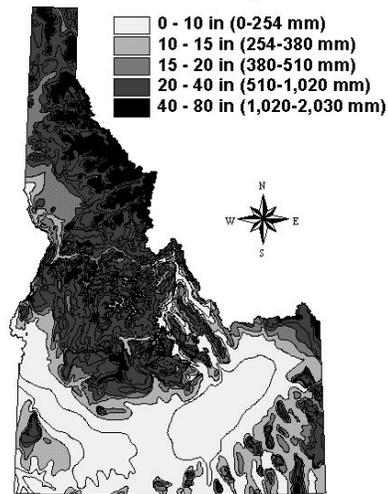
LIFE SPAN: Relatively short-lived.

GROWTH HABIT: Deciduous tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: A small to medium tree, forming dense colonies. Leaves are broadly ovate and yellow-green. Crown is rounded. Bark is green to white, thin and smooth, with black, scar-like marks. Rhizomatous roots reaching a minimum depth of 32 in (81 cm). Grows 75 ft (23 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 7-40 in (179-1,026 mm).

Elevation zone. Wide range of elevations in the Rocky Mountain region. Generally above 3,000 ft (950 m).

Habitat and Climate requirements. Moist, upland woods, mountain slopes and along streams.

Soil type. Well-drained, rich, humous soils. Occurs on nearly all soil types (pH 6.0-9.0).

APPLICATIONS:

Roadside suitability. Thicket forming. Establishes rapidly after a fire. Requires moist soils. Good slope stabilization and aesthetic.

Establishment. Establishes from seed or transplants.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 16 lb PLS per acre (18 kg/ha). There are 12,000 seeds per lb (26,000 seeds per kg).

Douglas Fir

Pseudotsuga menziesii



Patricia A. Patterson et al. (1985)

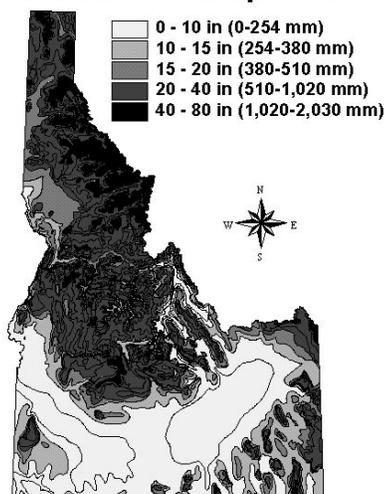
LIFE SPAN: Long-lived.

GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are dark to pale green and linear. Crown is compact and pyramidal with graceful, drooping branches. Flowers are inconspicuous. Roots are lateral, well-developed, strong, widespreading and can reach a minimum depth of 26 in (66 cm). Grows 100-120 ft (30-37 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 15-100 in (380-2,540 mm).

Elevation zone. Ranges from 2,000-11,000 ft (610-3,355 m).

Habitat and Climate requirements. Adapted to a wide range of conditions from moist to dry sites in the mid-montane forests. Most abundant in low to middle elevations. Can withstand temperatures to -33 F (-36 C).

Soil type. Well-drained, moist, deep, porous, gravelly, loam soils (pH 5.0-7.5).

APPLICATIONS:

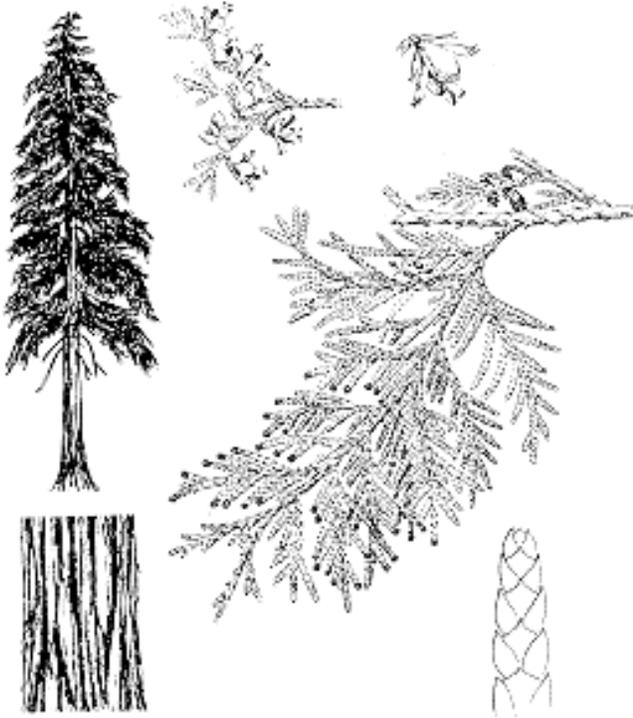
Roadside suitability. Tolerates shade and drought. Fairly easy to establish. Deep rooted and resistant to drought.

Establishment. Reproduction is abundant and vigorous. Prolific seeder. Prechilling will speed up germination. Can be established from seeds and transplants.

SEEDING RECOMMENDATIONS: Plant in the fall. Seed 10 lb PLS per acre (11.2 kg/ha). There are 38,000 seeds per lb (83,600 seeds per kg).

Western Redcedar

Thuja plicata



Patricia A. Patterson et al. (1985)

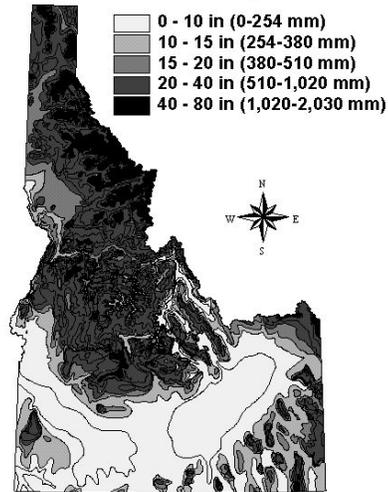
LIFE SPAN: Long-lived.

GROWTH HABIT: Conifer tree.

ORIGIN: Native.

VEGETATIVE CHARACTERISTICS: Leaves are scale-like, dark, yellow-green, and flat. Crown is cone-shaped with spray-like branches that spread down and outward. Trunk is fluted. Bark is red. Roots are shallow and widespreading. Grows up to 200 ft (61 m) tall.

Annual Precipitation



SITE REQUIREMENTS:

Precipitation zone. Ranges from 35-257 in (890-6,600 mm).

Elevation zone. Ranges from 2,000-7,000 ft (610-2,135 m).

Habitat and Climate requirements. Adapted to rich, moist to wet (often saturated) sites. Found in foothill to montane settings throughout the Pacific Northwest. Can withstand temperatures to -33 F (-36 C).

Soil type. Rich soils with abundant moisture (pH 5.0-7.5).

APPLICATIONS:

Roadside suitability. Makes a nice hedge if planted closely. Used for reforestation and riparian enhancement. Roots are fairly shallow, however can be established in dense stands. Shade tolerant.

Establishment. Rapid growth. High moisture requirement. Not easily established from seed, however, transplants are easily established.

SEEDING RECOMMENDATIONS:

Establishment from seeding is not recommended, however transplants in early spring are quite successful.

Revegetation Summary Tables

Grasses								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds /lb Seeds /kg
<i>Agropyron cristatum</i>	Crested wheatgrass	I	Bunchgrass	60-100	0-460	< 2,135	10-20 11.2-22.4	200,000 440,000
<i>Agropyron dasystachyum</i>	Thickspike wheatgrass	N	Sod-former	40-80	200-510	1,159-3,050	6-8 6.7-9.0	154,000 338,800
<i>Agropyron intermedium</i>	Intermediate wheatgrass	I	Sod-former	60-120	> 360	1,068-2,745	8 9.0	88,000 193,600
<i>Agropyron riparium</i>	Streambank wheatgrass	N	Sod-former	40-80	250-640	1,159-3,050	6-8 6.7-9.0	156,000 343,200
<i>Agropyron sibericum</i>	Siberian wheatgrass	I	Bunchgrass	36	150-300	< 2,135	6-8 6.7-9.0	170,000 374,000
<i>Agropyron smithii</i>	Western wheatgrass	N	Sod-former	31-91	250-360	305-2,745	10-15 11.2-16.8	110,000 242,000
<i>Agropyron spicatum</i>	Bluebunch wheatgrass	N	Bunchgrass	60-100	200-1,010	153-3,050	6-8 2.7-3.6	120,000-150,000 264,000-330,000
<i>Agropyron trachycaulum</i>	Slender wheatgrass	N	Bunchgrass	61-76	300-760	1,373-3,660	6-8 6.7-9.0	159,000 349,800
<i>Agropyron trichophorum</i>	Pubescent wheatgrass	I	Sod-former	33-36	280-410		10-12 11.2-13.5	100,000 220,000
<i>Avena sativa</i>	Oats	I	Bunchgrass	33-66	> 330	< 2,135	60-100 67.2-112.1	14,000 30,800
<i>Bromus carinatus</i>	Mountain brome	N	Bunchgrass		300-410	153-3,050	10 11.2	78,000-100,000 171,600-220,000
<i>Bromus inermis</i>	Smooth brome	I	Sod-former	33-100	300-460	> 1,220	8 9.0	125,000 275,000
<i>Bromus vulgaris</i>	Columbia brome	N	Bunchgrass	45-120	350-560	762-1,675		79,600-119,500 175,120-262,900
<i>Calamagrostis rubescens</i>	Pinegrass	N	Sod-former	60-100	460-1,010	0-3,050	1-2 1.1-2.2	2,646,000 5,821,200
<i>Dactylis glomerata</i>	Orchardgrass	I	Bunchgrass	60-120	280-510	1,983-2,745	2-3	654,000

							2.2-3.4	1,438,800
<i>Deschampsia caespitosa</i>	Tufted hairgrass	N	Bunchgrass		510-1,010	1,525-3,965	1-2 1.1-2.2	1,500,000 3,300,000
<i>Elymus cinereus</i>	Basin wildrye	N	Bunchgrass	60-240	130-510	0-2,745	7-9 7.8-10.1	130,000 286,000
<i>Elymus glaucus</i>	Blue wildrye	N	Bunchgrass	60-120	300-1,010	0-1,830	9 10.1	124,000-155,000 272,800-341,000
<i>Festuca arundinacea</i>	Tall fescue	I	Bunchgrass	50-200	380-1,016	1,152-3,408	6-8 6.7-9.0	227,000 499,400
<i>Festuca idahoensis</i>	Idaho fescue	N	Bunchgrass	30-100	250-1,020	244-3,600	4-8 4.5-6.7	450,000 990,000
<i>Festuca longifolia</i>	Hard fescue	I	Bunchgrass	30-35	300-1,010	152-3,600	10 11.2	565,000 1,243,000
<i>Festuca ovina</i>	Sheep fescue	I	Bunchgrass	20-40	230-610	1,068-3,355	3-10 3.4-11.2	680,000 1,496,000
<i>Festuca rubra</i>	Red fescue	N	Bunchgrass	40-100	460-1,010	1,128-2,438	4-10 4.5-11.2	615,000 1,353,000
<i>Festuca scabrella</i>	Rough fescue	N	Bunchgrass	30-122	510-1,010	< 3,050	16 18	200,000 440,000
<i>Hordeum vulgare</i>	Barley	I	Bunchgrass	60	> 300	< 2,135	60-100 67.2-112.1	12,500 27,500
<i>Koeleria cristata</i>	Prairie junegrass	N	Bunchgrass	30-60	300-510	< 2,288	1-2 1.1-2.2	700,000-2,315,000 1,540,000-5,093,000
<i>Oryzopsis hymenoides</i>	Indian ricegrass	N	Bunchgrass	10-60	0-380	0-2,500	6-8 6.7-9.0	141,000 310,200
<i>Phleum pratense</i>	Timothy	I	Bunchgrass	33-61	> 410	< 2,560	1-3 1.1-3.4	1,300,000 2,860,000
<i>Poa canbyi</i>	Canby bluegrass	N	Bunchgrass	33-61	230-510	< 1,525	5 5.6	926,000 2,037,200
<i>Poa compressa</i>	Canada bluegrass	I	Sod-former	15-50	380-1,010		1-4 1.1-4.5	2,500,000 5,500,000
<i>Poa nevadaensis</i>	Nevada bluegrass	N	Bunchgrass	50-100	250-380			1,082,000

								2,380,400
<i>Poa pratensis</i>	Kentucky bluegrass	I	Sod-former	< 101	> 460	< 3,050	2-3 2.2-3.4	2,177,000 4,789,400
<i>Poa sandbergii</i>	Sandberg bluegrass	N	Bunchgrass	3-30	200-410	305-3,660	2-4 2.2-4.5	917,000 2,017,400
<i>Sitanion hystrix</i>	Bottlebrush squirreltail	N	Bunchgrass	10-50	150-410		8-10 9.0-11.2	192,000 422,400
<i>Sporobolus airoides</i>	Alkali sacaton	N	Bunchgrass	50-100	150-250	1,000-2,300	2-3 2.2-3.4	1,750,000 3,850,000
<i>Sporobolus cryptandrus</i>	Sand dropseed	N	Bunchgrass	30-100	260-1,020	< 2,440	1 1.1	5,298,000 11,655,600
<i>Stipa comata</i>	Needle and thread	N	Bunchgrass	30-60	< 641	92-2,593	8 9.0	115,000 253,000
<i>Stipa occidentallis</i>	Western needlegrass	N	Bunchgrass	31-76	250-510	2,013-3,050	3-5 3.4-5.6	311,000 684,200
<i>Stipa thurberiana</i>	Thurber's needlegras	N	Bunchgrass	30-50	200-390	1,983-2,745	7 7.8	150,000 330,000
<i>Triticum aestivum</i>	Spring wheat	I	Bunchgrass	33-64	> 300	0-3,050	10-14 11.2-15.7	11,000 24,200

Forbs								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds/lb Seeds/kg
<i>Achillea millefolium</i>	Western yarrow	N	Forb	30-91	> 510	61-2,745	1-3 1.1-3.4	2,770,000 6,094,000
<i>Antennaria microphylla</i>	Rosy pussytoes	N	Forb	15	380-510	1,830- 2,745	1-2 1.1-2.2	8,000,000 17,600,000
<i>Arnica cordifolia</i>	Heartleaf arnica	N	Forb	15-61	250-890	305-3,355		220,000 484,000
<i>Aster glaucodes</i>	Gray aster	N	Forb	61-152	359-769	1,220- 3,050	5 5.6	540,000 1,188,000
<i>Balsamorhiza sagittata</i>	Arrowleaf balsamroot	N	Forb	41-76	200-360	1,312- 2,532	16 7.3	27,000 59,000
<i>Crepis acuminata</i>	Tapertip hawksbeard	N	Forb	20-70	200-510	< 2,440		800,000 1,760,000
<i>Eriogonum flavum</i>	Yellow buckwheat	N	Forb	10-41	356-508	~2,745	8-10 9.0-11.2	209,000 459,800
<i>Gaillardia aristida</i>	Blanketflower	N	Forb	46-61	410-641	< 2,440	10 11.2	132,000 290,400
<i>Geranium viscosissimum</i>	Sticky purple geranium	N	Forb	10-91	> 510	229-3,050	9 10.1	52,000 114,400
<i>Heracleum sphondylium</i>	Common cowparsnip	N	Forb	91-274	380-1,024	0-3,050	0.25-0.5 0.28-0.56	44,850 98,670
<i>Liatris punctata</i>	Dotted blazing star	N	Forb	10-80	254-510	853-2,438	12 13.5	30,000 66,000
<i>Linum lewisii</i>	Prairie flax	N	Forb	30-90	300-410	1,220- 3,355	8 9.0	293,000 644,600
<i>Lomatium dissectum</i>	Biscuitroot	N	Forb	10-31		0-3,050	2-4 2.2-4.5	134,240 295,328
<i>Oenothera caespitosa</i>	Desert primrose	N	Forb	20	381-1,000	900-2,015		1,000,000 2,200,000
<i>Penstemon eatonii</i>	Firecracker	N	Forb	30-102	250-410	1,007-	1.5-3	351,050

	penstemon					2,440	1.7-3.4	772,310
<i>Penstemon palmeri</i>	Palmer penstemon	I	Forb	122	250-410	1,068-1,983	3 3.4	610,000 1,342,000
<i>Penstemon strictus</i>	Rocky mountain penstemon	N	Forb	30-91	380-510	< 3,355	4 4.5	592,000 1,302,400
<i>Penstemon venustus</i>	Alpine penstemon	N	Forb	30-61	510-897	305-1,830	1.5-3 1.7-3.4	280,000 616,000
<i>Phlox diffusa</i>	Spreading phlox	N	Forb		> 350	1,200-2,440	1-3 1.1-3.4	907,000 1,995,400
<i>Sanguisorba minor</i>	Small burnet	I	Forb	51-64	310-640	305-1,830	2-5 2.2-5.6	55,000 121,000
<i>Senecia integerrimus</i>	Western groundsel	N	Forb	30-102	> 300	0-4,270	1-2 1.1-2.2	900,000 1,900,000
<i>Sphaeralcea coccinea</i>	Scarlet globemallow	N	Forb	8-30	200-300	915-2,135	4 4.5	500,000 1,100,000

Legumes								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds/lb Seeds/kg
<i>Hedysarum boreale</i>	Northern sweetvetch	N	Legume	25.4-61	> 250	>2,593	15 6.8	33,600 73,920
<i>Lupinus caudatus</i>	Tailcup lupine	N	Legume	30-61		< 3,203	11-35 4.9-15.9	21,000-135,000 46,000-297,000
<i>Medicago sativa</i>	Alfalfa	I	Legume	61	307-460	> 2,270	5-15 5.6-16.8	210,000 462,000
<i>Onobrychis viciaefolia</i>	Sanfoin	I	Legume	64	380-460	> 1,220	20 22.4	
<i>Trifolium repens</i>	White dutch clover	I	Legume	< 61	> 520	0-4,270	2-6 2.2-6.7	850,000 1,870,000

Grasslikes								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds/lb Seeds/kg
<i>Carex nebrascensis</i>	Nebraska sedge	N	Sedge	20-120		< 2,745	5 5.6	534,100 1,175,020
<i>Juncus balticus</i>	Baltic rush	N	Rush	< 110		< 3,050	1-2 1.1-2.2	109,301,000 240,462,200

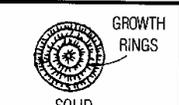
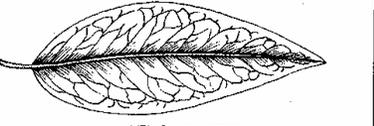
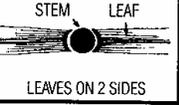
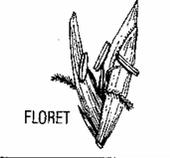
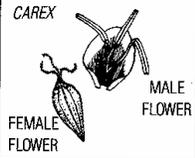
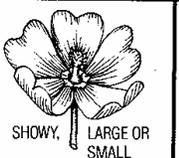
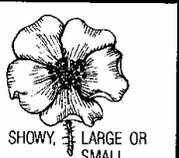
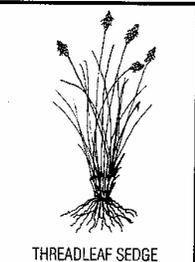
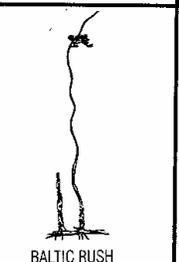
Shrubs								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds/lb Seeds/kg
<i>Acer glabrum</i>	Rocky mountain maple	N	Shrub	150-760	> 300	336-3,050	3-4 3.4-4.5	20,000 44,000
<i>Amerlanchier alnifolia</i>	Serviceberry	N	Shrub	100-460	> 300	< 2,745	1 1.1	25,000 55,000
<i>Arctostaphylos uva-ursi</i>	Kinnikinnick	N	Shrub	30	> 350	2,141- 3,511	2-3 2.2-3.4	37,900 83,380
<i>Artemisia arbuscula</i>	Low sagebrush	N	Shrub	10-400	200-360	2,135- 2,440	1 1.1	972,000 2,138,400
<i>Artemisia cana</i>	Silver sagebrush	N	Shrub	150	200-360	1,830- 3,233	1-3 1.1-3.4	850,000 1,870,000
<i>Artemisia nova</i>	Black sagebrush	N	Shrub	< 61	179-462	1,220- 2,440	1-3 1.1-3.4	907,200 1,995,840
<i>Artemisia tridentata</i> <i>var. tridentata</i>	Basin big sagebrush	N	Shrub	50-500	> 250	450-2,450	1-3 1.1-3.4	2,500,000 5,500,000
<i>Artemisia tridentata</i> <i>var. vaseyana</i>	Mountain big sagebrush	N	Shrub	51-127	250-360	1,220- 3,050	1-3 1.1-3.4	2,500,000 5,500,000
<i>Atriplex canescens</i>	Fourwing saltbush	N	Shrub	50-200	150-380	< 2,135	6-8 6.7-9.0	52,000 114,400
<i>Beberis repens</i>	Oregon grape	N	Shrub	30-100	> 460	305-3,050	0.25-1 0.28-0.56	45,000 99,000
<i>Ceanothus sanguineus</i>	Redstem ceanothus	N	Shrub	100-300	> 360	< 1520	0.25 0.28	131,900 290,180
<i>Ceanothus velutinus</i>	Snowbrush ceanothus	N	Shrub	100-300	> 360	1,068- 3,050	1-3 1.1-3.4	124,275 273,405
<i>Ceratoides lanata</i>	Winterfat	N	Shrub	< 80	130-640	610-3,050	5-10 PLS per hill	56,700 124,740
<i>Cercocarpus ledifolius</i>	Curlleaf mountain mahogany	N	Shrub	100-600	> 200	610-2,745	10 11.2	30,000 66,000
<i>Cercocarpus montanus</i>	True mountain	N	Shrub	< 370	> 250	1,220-	10	59,000

	mahogany					3,050	11.2	129,800
<i>Chrysothamnus nauseosus</i>	Rubber rabbitbrush	N	Shrub	30-213	> 200	610-2,745	1 1.1	400,000 880,000
<i>Chrysothamnus viscidiflorus</i>	Green rabbitbrush	N	Shrub	100	> 150	610-3,050	1-2 1.1-2.2	782,000 1,720,400
<i>Cornus stolonifera</i>	Redosier dogwood	N	Shrub	100-300	> 460	458-2,745	1 1.1	173,000 380,600
<i>Holodiscus discolor</i>	Oceanspray	N	Shrub	80-150	> 381	0-2,135	1-2 1.1-2.2	190,000 418,000
<i>Physocarpus malvaceus</i>	Ninebark	N	Shrub	100-200	0-256	1,560-3,240	1-2 1.1-2.2	756,000 1,663,200
<i>Potentilla fruticosa</i>	Shrubby cinquefoil	N	Shrub	30-61	> 410	1,670-3,355	20-30 PLS per sq. foot	1,000,000-1,300,000 2,200,000-2,860,000
<i>Prunus virginiana</i>	Chokecherry	N	Shrub	100-600	300-760	1,373-2,745	10-15 11.2-16.8	4,800 10,560
<i>Purshia tridentata</i>	Antelope bitterbrush	N	Shrub	60-300	50-640	1,068-2,745	1-3 1.1-3.4	15,000 33,000
<i>Rhus glabra</i>	Smooth sumac	N	Shrub	120-210	> 250	824-2,288	0.5-1 0.56-1.1	20,000 44,000
<i>Rhus trilobata</i>	Skunkbrush sumac	N	Shrub	< 250	> 200	580-2,440	0.5-1 0.56-1.1	49,000 107,800
<i>Ribes cereum</i>	Wax current	N	Shrub	< 200	> 360	763-2,898	0.25-0.5 0.28-0.56	350,000 770,000
<i>Salix scouleriana</i>	Scouler willow	N	Shrub	300-1,000	462-897	> 915		6,500,000 14,300,000
<i>Sambucus cerulea</i>	Blue elderberry	N	Shrub	200-600	> 30	0-3,050	10-15 11.2-16.8	216,800 476,960
<i>Symphoricarpos albus</i>	Common snowberry	N	Shrub	60-120	> 380	732-2,745	5 5.6	76,000 167,200

Trees								
Scientific name	Common name	Origin	Growth habit	Height (cm)	Precip. (mm)	Elev. (m)	Seeding rate (lb/ac) Seeding rate (kg/ha)	Seeds/lb Seeds/kg
<i>Abies grandis</i>	Grand fir	N	Tree	7,600	510-2,540	702-999	16 18	20,408 44,898
<i>Abies lasiocarpa</i>	Subalpine fir	N	Tree	4,200	> 640	1,068- 3,203	16 18	20,408 44,898
<i>Alnus incana</i>	Thinleaf alder	N	Tree	1,220	> 513	763-2,440	5 5.6	10,000 22,000
<i>Caragana arborescens</i>	Siberian pea tree	I	Tree	300-600	> 308	763-1,220	7 7.8	12,000 26,400
<i>Celtis reticulata</i>	Hackberry	N	Tree	300-600		250-1,450		4,870 11,000
<i>Juniperus scopulorum</i>	Rocky mountain juniper	N	Tree	600-1500	250-510	610-1,525	16 18	27,000 59,400
<i>Larix occidentalis</i>	Western larch	N	Tree	4,900	510-760	610-2,135		97,978-197,000 216,000-434,305
<i>Picea engelmannii</i>	Engleman spruce	N	Tree	5,500	> 640	458-1,525	16 18	12,000 26,400
<i>Pinus contorta</i>	Lodgepole pine	N	Tree	1,500-3,000	769-1,538	1,220- 3,355	20 22.4	95,000 209,000
<i>Pinus ponderosa</i>	Ponderosa pine	N	Tree	2,400-6,100	~ 250	610-2,745	15 6.8	12,000 26,000
<i>Populus tremuloides</i>	Quaking aspen	N	Tree	2,300	179-1,026	> 950	16 18	12,000 26,400
<i>Pseudotsuga menziesii</i>	Douglas fir	N	Tree	3,000-3,700	380-2,540	610-3,355	10 11.2	38,000 83,600
<i>Thuja plicata</i>	Western redcedar	N	Tree	6,100	890-6,600	610-2,135		

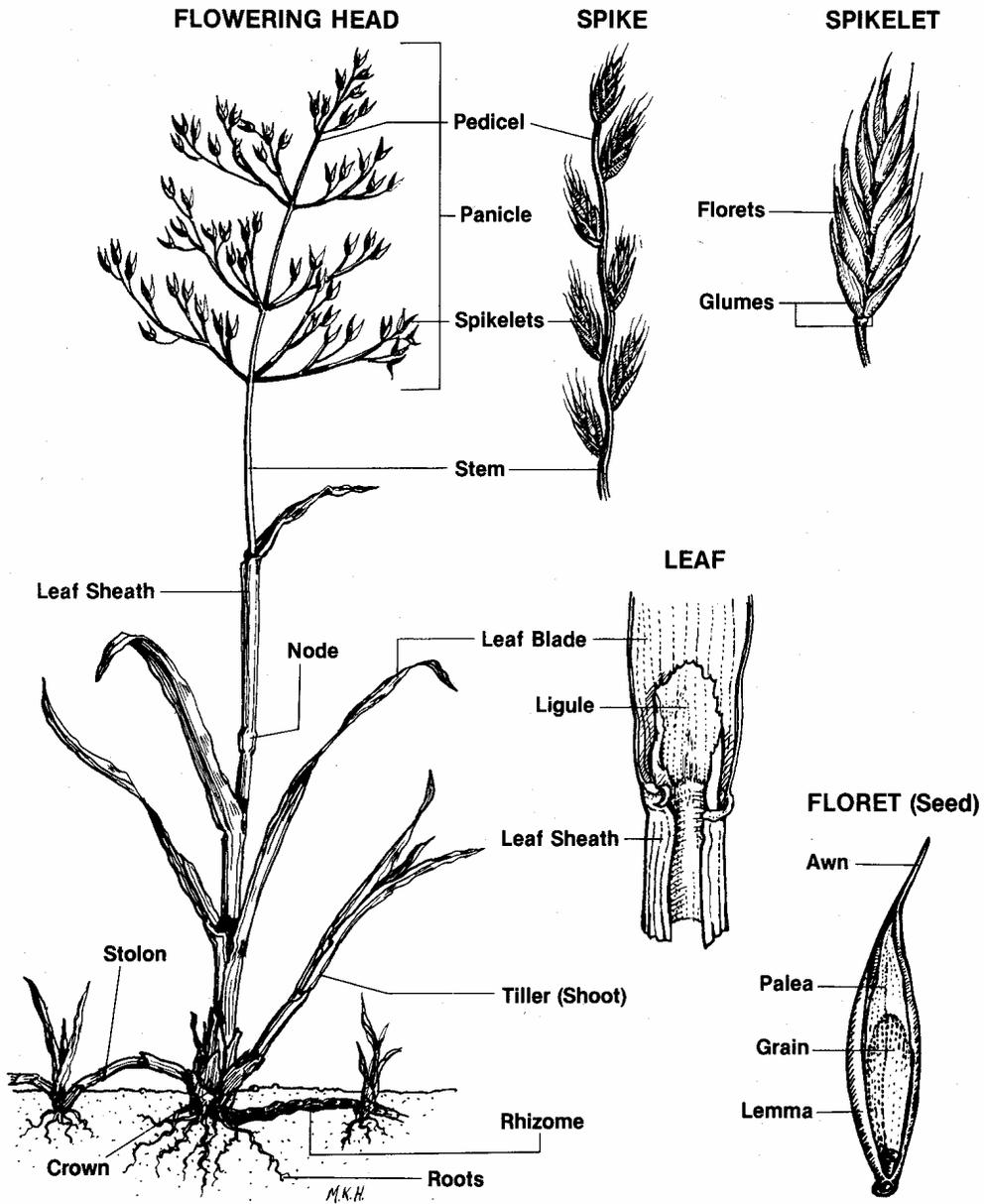
Appendix A

General Plant Identification

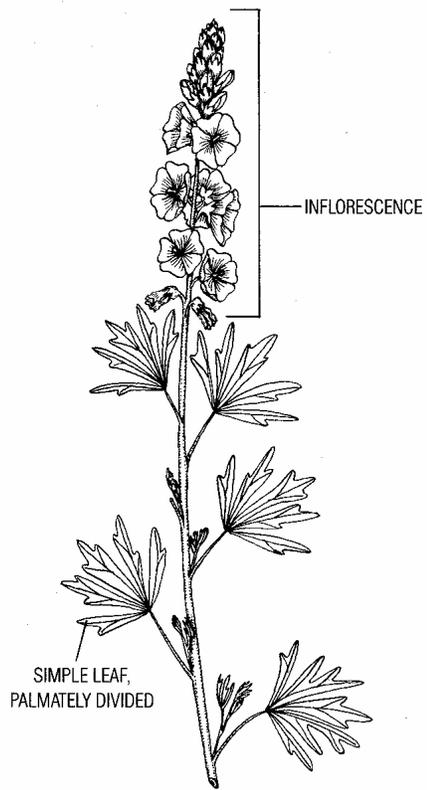
	GRASSES	GRASS-LIKES		FORBS	SHRUBS
		SEDGES	RUSHES		
STEMS CROSS-SECTION	 HOLLOW OR PITHY	 SOLID, NOT JOINTED	 SOLID OR PITHY	 SOLID	 GROWTH RINGS
LEAVES AND LEAF RANKING	 VEINS ARE PARALLEL			 VEINS ARE NETTED	
	 LEAVES ON 2 SIDES	 LEAVES ON 3 SIDES	 LEAVES ON 2 SIDES		
FLORETS AND FLOWERS	 FLORET	 CAREX FEMALE FLOWER MALE FLOWER	 MODIFIED FLOWERS	 SHOWY, LARGE OR SMALL	 SHOWY, LARGE OR SMALL
EXAMPLES	 WESTERN WHEATGRASS	 THREADLEAF SEDGE	 BALTIC RUSH	 SCARLET GLOBEMALLOW	 WILD ROSE

Plant Group Descriptions – This table shows a simple breakdown of plant groups, including grasses, grasslikes, forbs, and shrubs and contains the most defining characteristics of each group.

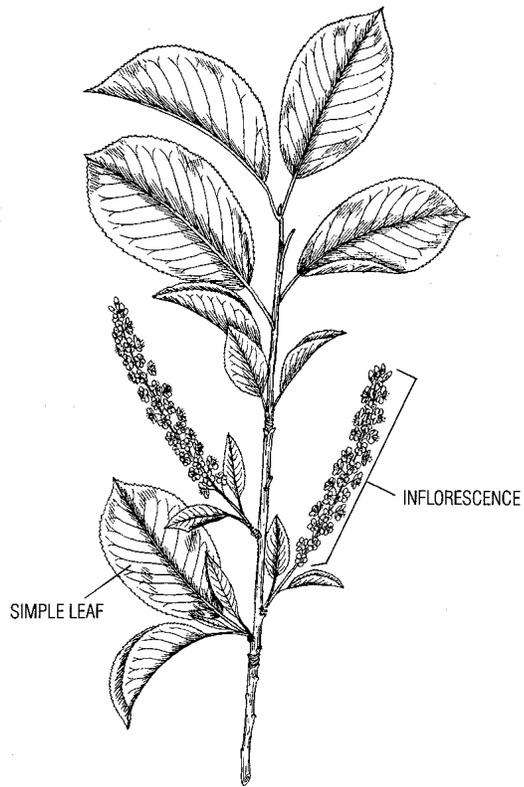
STRUCTURE OF GRASSES



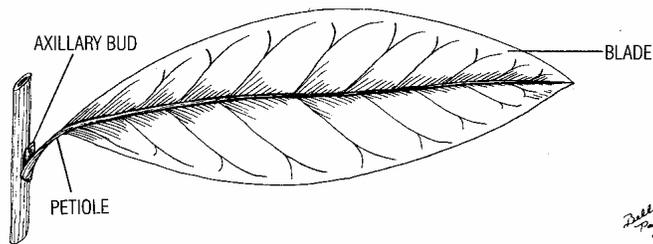
Structure of Grasses



FORB



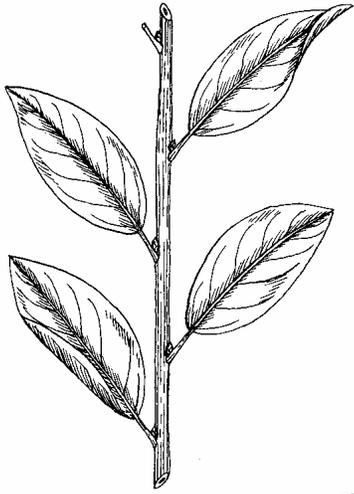
SHRUB



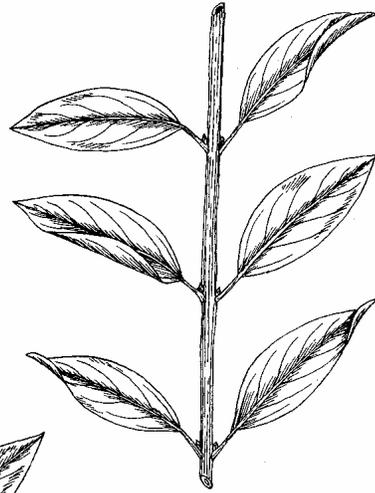
SIMPLE LEAF

*Delany
Purdue
Green*

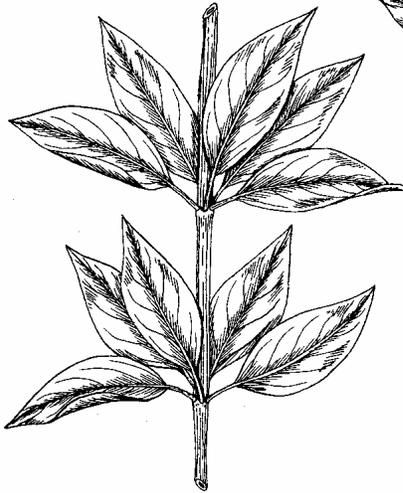
Structure of Forbs and Shrubs



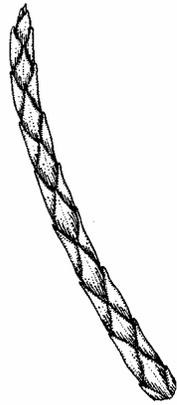
ALTERNATE



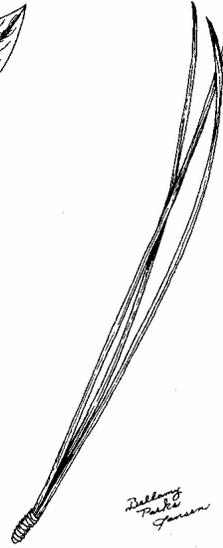
OPPOSITE



WHORLED



IMBRICATE



FASCICLED

*Ballou
Pitt
Jensen*

Leaf Arrangement

Appendix B

Glossary

Glossary

Based on definitions from:

North Dakota and Minnesota Range Plants. North Dakota Extension Publication # EB 69. By Kevin K. Sedivec and William T. Baker. North Dakota State University, Fargo, ND. 1997.

&

Idaho Soils Atlas. By Raymond J. Baker, Robert E. McDole, and Glen Logan. University of Idaho, Moscow, ID. 1983.

&

Field Guide to Forest Plants of Northern Idaho. General Technical Report INT-180. 1997. By Patricia A. Patterson, Kenneth E. Neiman, and Jonalea R. Tonn. USDA, FS.

&

North American Range Plants. By James Stubbendieck, Stephen L. Hatch, and Charles H. Butterfield. University of Nebraska. Lincoln, NE. 1997.

Acidic. An acid forming soil with low pH.

Aerial. An elevated position.

Alkali. A soil with a high pH (8.5 or more) with high exchangeable sodium which may interfere the plant growth.

Alluvial Material. Sand, gravel, or silt transported and deposited on land by moving water.

Alpine. Mountain heights above the timberline.

Alternate. Located singly at each node; not opposite or whorled.

Argillic. Consisting of clay, clayey.

Arid. A climate that lacks sufficient moisture for crop production without irrigation.

Aromatic. Fragrant or having odor; bearing essential oils.

Awn. A terminal, bristlelike appendage.

Basal. Located at or near the base of the plant.

Basic. Containing a base; alkaline.

Branchlet. The final division of the branch.

Bulb. An underground bud with thick, fleshy scales.

Caryopsis. A small, one-seeded fruit.

Catkin. A spike-like inflorescence of unisexual, apetalous, bracteate flowers.

Compound. Made up of two or more parts.

Corolla. All of the petals considered collectively.

Corymb. Strictly a simple, racemose, inflorescence that is flat-topped or round-topped because the outer pedicels are progressively longer than the inner; form of a corymb.

Crown. The upper part of a tree, including the living branches with their foliage.

Culm. The stem of grass or sedge.

Cylindrical. Shaped like a cylinder.

Cyme. A broad, flat inflorescence with the central flower blooming first.

Diffuse. Widely spreading.

Digitate. Compound with members arising from one point; palmately compound.

Divided. Separated or cut into distinct parts by inclusions extending to near the base or midrib.

Elliptic. Oval in shape, widest at the middle, and tapering equally to both rounded ends.

Elongate. Narrow; the length many times the width or thickness.

Entire. Whole; with a continuous margin.

Exfoliate. Shedding in flakes or thin layers.

Fertile. Capable of producing fruit; does not refer to stamen presence or absence in grasses.

Fibrous. Resembling or composed of fibers.

Flexuous. Bent alternately in opposite directions. A wavy form.

Fluted. Channeled; furrowed, as a column.

Friable. Crumbles easily.

Glabrous. Smooth and without hairs.

Glaucous. Covered with a whitish, waxy bloom that rubs off easily.

Horizon. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil forming processes.

Humid. Moist, damp air.

Inflorescence. A flower-cluster of a plant; the arrangement of the flowers on the axis.

Invasive. Having the nature of invasion.

Involute. Rolled inward, so that the lower side of an organ is exposed and the upper concealed.

Lance-shaped. Much longer than broad, widest near the base, and tapering to the apex.

Lax. Loose.

Layering. A shoot or twig of a plant, undetached from the stalk, bent down, and partially covered with soil so that it may take root.

Loam. Soil material that is 7-27 percent clay particles, 20-50 percent silt particles, and less than 52 percent and particles.

Lobe. A partial division of an organ, especially if rounded.

Margin. An edge, border.

Montane. Mountainous.

Mottled. Marked with spots or blotches.

Neutral. Not acidic or alkaline.

Oblong. Longer than broad with the sides nearly parallel.

Opposite. Arranged two at each node, on opposite sides of the axis.

Organic. Plant or animal residue in the soil in various stages of decomposition.

Ovate. Egg-shaped with the broader part near the base.

Panicle. An irregular compound inflorescence with pedicillate flowers.

Papilionaceous. Butterfly-like corolla with standard, wings, and keel.

Perennial. Lasting several years.

Pinnate. Compound leaf with leaflets arranged on both sides of the axis; odd pinnate if terminal leaflet is present, even-pinnate if terminal leaflet is absent.

Porous. Full of pores or tiny holes.

Propagate. To multiply; reproduce.

Pubescent. Covered with short, soft, downy hairs; a general term for any kind of hairiness.

PLS. Pure live seed.

Raceme. A simple, elongated inflorescence with pedicellate flowers.

Ray. Outer floret of Asteraceae with straplike corolla, no stamens, functionally pistillate; the branch of an umbel.

Reflexed. Abruptly bent or turned downward.

Rhizome. An underground stem, usually extending laterally and rooting at the nodes.

Robust. Healthy; full-sized.

Saline. A nonsodic soil containing sufficient soluble salts to impair productivity.

Scabrous. Rough; feeling rough to the touch.

Scale. Any thin, dry, appressed organ (usually a leaf or bract).

Seedbed. A bed of soil where plants are grown.

Serrate. With sharp teeth pointing forward.

Sheath. A tubular structure surrounding part or all of an organ; the portion of a grass leaf that surrounds the stem.

Silt. Individual mineral particles that range in diameter from the upper limit of clay (0.002 mm) to the lower limit of very fine sand (0.05 mm).

Simple. Not compound or branched.

Sod. Creating a dense mat with interwoven root systems.

Sodic. Containing sodium.

Solitary. Alone; one by itself.

Spike. A simple, elongated inflorescence with sessile flowers.

Spikelet. A small or secondary spike.

Stalk. The stem or axis of a plant.

Stolon. A horizontal stem that roots at the top or at the nodes; runner.

Stoloniferous. Bearing stolons.

Taproot. The primary descending root.

Temperate. A climate that is neither very hot nor very cold.

Terminal. Borne at or belonging to the extremity.

Tiller. A shoot from an adventitious bud at the base of a plant.

Tooth. A pointed projection or division.

Trifoliate. Having three leaflets.

Tropic. Very hot, sultry climate.

Tuber. A thick, short branch, usually subterranean, with numerous buds.

Tuft. Cluster; bunch.

Umbel. A flat-topped or rounded inflorescence in which pedicels or peduncles arise from a common point.

Viability. Being able to survive under conditions of wide geographical distribution.

Vigor. Active or healthy growth.

Wiry. Being thin and resilient.

Appendix C

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Species
Sketches

Species references

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Appendix D

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Antelope bitterbrush	92	Tailcup lupine	44
Arrowleaf balsamroot	52	Mountain big sagebrush	77
Baltic rush	42	Mountain brome	11
Barley	25	Rosy pussytoes	49
Basin big sagebrush	76	Nebraska sedge	41
Basin wildrye	17	Needle and thread	37
Biscuitroot	60	Nevada bluegrass	31
Black sagebrush	75	Ninebark	89
Blanketflower	55	Northern sweetvetch	43
Dotted blazing star	92	Oats	10
Blue elderberry	97	Oceanspray	88
Prairie flax	59	Orchardgrass	15
Blue wildrye	18	Oregon grape	79
Bluebunch wheatgrass	7	Palmer penstemon	63
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Columbia brome	13	Redoiser dogwood	87
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Crested wheatgrass	1	Rocky mountain maple	70
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Grand fir	99	Sheep fescue	22
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Appendix E

Topsoil Application for Revegetation of Roadsides

Topsoil Application for Revegetation of Roadsides

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ABSTRACT

Revegetation is the best solution to long-term erosion control problems on roadsides. Success of vegetation establishment on new road-cuts is dependent on the re-application of isolated topsoil following excavation and construction. Topsoil contains the essential nutrients and microorganisms required for plant growth. Vegetation establishment, promoted by the presence of topsoil, reduces surface erosion caused by unstable slopes. Available research and related publications are cited on the differences between topsoil and subsoil; the presence or absence of microbial activity and microorganism population changes over time in stockpiled topsoil; stockpile maintenance; and re-spreading stockpiled topsoil. The purpose of this report is to provide available research in a form that will aid in using stockpiled topsoil to promote long-term establishment of vegetation on roadsides.

INTRODUCTION

Bare soil surfaces are created when soil is excavated and moved during road construction. These newly established road-cuts are a source of surface soil erosion. Vegetation offers the best long-term protection against erosional forces of wind and rain on slopes and provides some degree of protection against shallow mass movement (Gray and Leiser 1982). Soil surfaces on roadsides have different physical, chemical, and morphological characteristics than the soil on the sites prior to road construction because topsoil and subsoil are commonly removed simultaneously (Staht *et al.* 1988). Topsoil is the dark-colored surface soil that contains essential nutrients and microorganisms necessary for successful vegetation establishment. Subsoil is the lighter-colored, mineral and clay layer location beneath the topsoil that contains little organic matter and is not conducive to vegetation growth (Persson and Funke 1988). Topsoil and subsoil are mixed when excavated simultaneously. As a result, vegetation establishment is difficult to accomplish because nutrients and microorganisms available to seedlings upon germination are reduced, and soil structure is altered. Conservation of topsoil by stockpiling it for re-application following excavation and road construction generally increases the success of vegetation establishment on new road-cuts. Over time, there are biological, chemical, and structural changes that occur in stockpiled topsoil as anaerobic conditions develop. These conditions can be prevented and manipulated by proper management techniques in order to ensure the preservation of essential topsoil characteristics necessary to accomplish successful vegetation establishment on new road-cuts. Stockpiles, for the purpose of this report, are mounds

of stored topsoil that may range from 1 m to more than 6 m in depth. Topsoil is stored in these mounds until a disturbed site, such as a road-cut, is ready for reclamation.

Although much is known about soil remediation, conservation, morphology, genesis, fertility, and microbiology, there is little research on the application of topsoil to roadsides as a medium for vegetation establishment. A summary of available research and related publications on the use of reapplied topsoil to disturbed sites will be a useful tool in determining if stockpiled topsoil can increase establishment and persistence of vegetation on roadsides.

The objective of this report is to provide a comprehensive literature review on stockpiling topsoil which includes information on topsoil and subsoil characteristics, the presence or absence of microbial activity in stockpiled topsoil, and stockpile maintenance and re-spreading techniques. The information presented here is intended to supplement preexisting information on revegetation and can be used by the Idaho Transportation Department to improve roadside revegetation success throughout Idaho. The value of this review extends also to other agencies and organizations responsible for successful vegetation establishment and erosion control.

TOPSOIL AND SUBSOIL CHARACTERISTICS

Topsoil and subsoil have distinct differences. Topsoil is dark in color, defined as the top 15-30 cm of soil, and acts as a media for root growth. It generally includes the A-horizon of the soil profile, which is the surface horizon of a mineral soil. The A-horizon is defined by McDaniel *et al.* (1997) as a layer of soil parallel to the ground surface with unique physical, chemical, and biological properties. The A-horizon is dark-colored

because of its high organic matter content. This layer is important in maintaining soil fertility and providing a favorable environment for root growth. Subsoil is made up of the B-horizon which tends to contain more clay and minerals than the A-horizon and has fewer plant roots associated with it. The B-horizon is often exposed to the surface during road construction. Exposure of the B-horizon reduces the success of vegetation establishment and increases the potential for surface erosion. Studies indicate that topsoil containing the A-horizon is a highly effective amendment for the improvement of chemical, physical, and biological properties of disturbed sites (Visser *et al.* 1984) because it is a natural medium for plant growth. A field study by McGinnies and Nicholas (1980) noted greater seedling establishment on mine spoil plots treated with re-applied topsoil compared to non-topsoiled mine spoil treatments. Following the first growing season, the researchers noticed a positive vegetative response on all mine spoils treated with re-applied topsoil.

MICROORGANISMS IN TOPSOIL

The success of revegetation on topsoiled sites is not attributed purely to the different physical characteristics of topsoil and subsoil. Microbial populations, such as bacteria and fungi that depend on topsoil for survival, play a critical role in vegetation establishment. Bacteria and fungi interact with plants in the rhizosphere, the ecological niche that comprises the surface of plant roots and the surrounding soil (Atlas and Bartha 1993). Topsoil contains the rhizosphere where the density of microorganisms is highest.

Studies point out that interactions between plant roots and soil microorganisms found in topsoil mutually satisfy nutritional requirements for soil microorganisms and associated vegetation. Microorganisms fulfill their nutritional needs and benefit plants in a variety of ways. They increase nutrient recycling and solubilization of minerals; synthesize vitamins, amino acids, auxins, and gibberellins (stimulants for plant growth); and deter plant pathogens (Atlas and Bartha 1993). When microbial populations are absent in the rhizosphere, plant growth can be impaired (Atlas and Bartha 1993).

Soil fungi produce essential metabolites for plant uptake, alter the pH to more favorable conditions, promote mineral nutrient cycles, and alter the availability of magnesium and potassium (Ingham 1997). Read (1997) explained that hyphae (threads that make up the vegetative portion of a fungus) are the main structural elements of mycorrhizal fungi. They have a symbiotic association with plant roots. These mycorrhizal associations are present in the root systems of most indigenous plant species (Steinbacher 1997). Hyphae either penetrate the cells of the plant root to form an “endomycorrhiza” or, as in most trees, they ensheath the root to produce an “ectomycorrhiza”. The importance of these microorganisms in topsoil has been emphasized by Stahl *et al.* (1988), who cite a number of studies where the presence of mycorrhizal fungi has improved the revegetation of disturbed lands.

Atlas and Bartha (1993) reported that soil microorganisms can protect plant roots from toxic levels of minerals by oxidizing them to a less toxic state. They further suggested that some bacteria synthesize compounds to increase the rate of seed germination and the development of root hairs to aid in plant growth. Other bacteria are capable of producing organic compounds to further stimulate plant growth.

ISOLATING AND REMOVING TOPSOIL

Microbial populations found in topsoil may be altered when topsoil is removed and put into a stockpile. Stripping soil is not a new technique in the road construction process. Nevertheless, stripping topsoil separately from subsoil is a new idea and may require a change in mechanical procedures. This process requires extra steps and more labor to avoid mixing topsoil with subsoil. After the topsoil is identified, it is then stripped from one construction site and either reapplied on another site that is ready for reclamation or hauled and stockpiled until the construction site is reclaimed (Stark and Redente 1987).

The extent to which topsoil is altered due to excavation and compaction from heavy earth-moving machinery during removal or in stockpile construction is unknown. Johnson *et al.* (1991) believed that the physical operations involved in stripping and construction of stockpiles subjected soil to forces that may have dramatic effects on physical properties of soil. Generally, the bulk density of stockpiled topsoil stripped from a road-cut is greater than that of similar undisturbed topsoil (Potter *et al.* 1988). Abdulkareem and McRae (1987) stated that along with physical properties, biological and chemical properties are changed in stockpiled topsoil as a result of the mechanized process of construction. If these stockpiles remain *in situ* for long periods of time before soil is reused there can be a substantial reduction in the “quality” of the topsoil. Basically, over long periods of time the revegetative capacity of soil in stockpiles declines. Nevertheless, it is believed that retaining topsoil for re-application on disturbed sites is beneficial for the long-term success of revegetation efforts and erosion control.

STOCKPILING TOPSOIL

In stockpiles, the “quality” of soil deteriorates over time. Abdul-Kareem and McRae (1987) believed that the most significant change is a reduction in organic matter content. New stockpiles do not receive the input of organic matter from plant roots or animals as occurs in intact topsoil prior to stockpile construction. There is high heterogeneity in organic matter within a stockpile. The variation of buried vegetation from zone to zone within the stockpile and inadvertent mixing with subsoil during stripping and mound construction affect the amount and locations of microbial populations throughout the topsoil stockpile (Johnson *et al.* 1991).

Stockpiled topsoil has decreased fertility as compared to undisturbed fresh soil (Persson and Funke 1988). The reduction of microorganism numbers is partially responsible for this. However, a revegetation study by Stark and Redente (1987) found that the stockpiled material produced greater above-ground total biomass than fresh soil treatments following revegetation. In this same study, the researchers found that fresh soil had substantially higher bitterbrush seedling emergence, production, and mycorrhizal colonization; stockpiled soil had slightly higher grass production. Stark and Redente (1987) also found that the use of stockpiled topsoil on reclaimed mine sites resulted in increased grass production. The adverse effect stockpiles have on mycorrhizal inoculum (mentioned earlier) causes a reduction in the establishment and production of plant species that have a high dependency on mycorrhizae for nutrient uptake. This study suggested that stockpiled topsoil reduces shrub emergence because of their greater dependence on fungal inoculation. Grass production, however, is not

negatively affected because grasses are not as dependent on mycorrhizae for nutrient uptake.

Duration of Storage

The suitability of topsoil for revegetation declines with long-term storage (Doll *et al.* 1894). As noted earlier, changes in the microbial environment occur over time. Surprisingly, Persson and Funke (1988) found that actual counts of bacteria, actinomycetes, and fungi did not decline with long-term storage; however, their relative distribution changed. Miller and Cameron (1976) reported that numbers of bacteria, fungi, actinomycetes, and algae were indeed reduced in stockpiled soils between 10 and 29 months when compared to nearby undisturbed sites. No differences in species diversity between stockpiled or undisturbed treatment sites were noted. During the initial period of stockpile storage, there were generally few significant differences between estimates of total viable organisms gathered from plate counts. Bacterial counts often are higher at the onset of stockpile construction, however, suggesting that the flush of decomposition caused by the physical disturbances of soil excavation releases previously-trapped organic matter (Johnson *et al.* 1991). Rives *et al.* (1980) reported that storing topsoil for three years reduced the levels of viable inocula relative to levels in adjacent undisturbed soil. Nevertheless, they found that during the three-year storage period, levels of viable propagules remained high enough to produce 81.7% infection by fungus in the root bioassays (Rives *et al.* 1980).

Changes in Microorganisms

Changes in the type, quantity, activity, and inoculation potentials of microorganisms are expected when topsoil is stockpiled. Johnson *et al.* (1991) found

that numbers of bacteria, fungi, actinomycetes, and algae in stockpiled soil were all lower than those in nearby undisturbed sites. However, fungi propagule numbers tended to be higher in topsoiled plots than in plots without topsoil (Lindemann *et al.* 1984) and there was no change in species diversity of bacteria and fungi in the stockpiled topsoil as compared to topsoil from non-disturbed sites. Williamson and Johnson (1990) found that the total biomass of bacteria and fungi varied among different stockpiles, but often was similar to that of unburied soil although most bacteria collected from the stockpiled topsoil was non-viable. Along with a decrease in microbial biomass, stockpiled soils had a considerable increase in mineral nitrogen content (Ross and Carins 1981). The increase in nitrogen appears to coincide with the depth of topsoil and the presence of anaerobic conditions.

Depth-related effects on the microbiology of stockpiled topsoil seem to be fairly consistent across studies. At the upper surface of stockpiles, fungal numbers were lower than in undisturbed soil (Visser *et al.* 1984). At lower depths, pH values were lower because anaerobic conditions increase with depth leading to a decrease in pH (Ross and Carins 1981). Generally, microbial numbers were similar to undisturbed soil while aerobic nitrifying bacteria decreased greatly compared to the undisturbed soils (Persson and Funke 1988). More specifically, Williamson and Johnson (1990) found that there was a decrease in viable aerobic bacteria, an increase in the occurrence of endospore-forming bacteria, and a decrease in fungal biomass at depths of 1 m. Depth by itself affects the microbial environment, but length of storage combined with depth may also be a factor causing change.

Time-depth-related effects on microorganism numbers in stockpiled soil were noted by O'Flanagan *et al.* (1963), who found that numbers of aerobic microorganisms declined with depths up to 2 m in a three-year-old mound. Thereafter, numbers of aerobic microorganisms remained similar down to 5 m. Studies have indicated that following restoration and revegetation using stockpiled topsoil, anaerobes and aerobes can increase rapidly (O'Flanagan *et al.* 1963; Persson and Funke 1988; Williamson and Johnson 1990), and sufficient mycorrhizal populations are intact to inoculate newly established vegetation (Abdul-Kareem and McRae 1987).

Maintenance of Stockpiles

Erosion can occur if stockpiles sit for long periods of time. An effective method of reducing erosion is to establish vegetation on the topsoil mound. When studying the production potential of stockpiled soil, Stark and Redente (1987) found that the vegetated portions of a stockpile have higher mycorrhizal inoculation potential than non-vegetated portions of the same stockpile. Also, after re-spreading the topsoil, there was higher grass production on the non-vegetated topsoil and higher seedling emergence of bitterbrush on the vegetated topsoil. This conclusion may be explained in terms of nutrient levels and mycorrhizal colonization. Specifically, the bitterbrush emergence was higher on the vegetated portion of stockpiled topsoil because it has greater dependency on mycorrhizal fungi than do grasses. Likewise, grass production was higher on the non-vegetated portion because grass does not need a strong association with mycorrhizal fungi.

IMMEDIATE RE-APPLICATION OF TOPSOIL

An alternative to stockpiling topsoil is to immediately reapply it to a road-cut as each step of construction is completed. Compared to stockpiled topsoil, freshly stripped topsoil enhances overall reclamation success because it has better chemical, physical, and biological properties than stored soil (Stahl *et al.* 1988). Rives *et al.* (1980) found that relatively high levels of viable fungal propagules were maintained by directly hauling topsoil onto disturbed sites rather than stockpiling it for later use. Furthermore, compared to stockpiled topsoil, fresh topsoil has a greater potential for improved water infiltration, water storage, nutrition, soil structure, and microorganism inoculation, all of which enhance the potential for successful revegetation efforts (Schuman *et al.* 1998).

TOPSOIL APPLICATION

Application of topsoil is recommended on 2:1 slopes or flatter, where native soils are unsuitable for vegetative growth. Upon completion of road construction, topsoil from stockpiles may be applied to exposed surfaces of road-cuts. It is important to apply topsoil over compatible soil textures. Failure to do so could cause topsoil to slough as water flows between the two soil layers of different permeability. Also, topsoil should not be applied when the subsoil is frozen or extremely wet. Thickness of topsoil should approximate original conditions. Redente *et al.* (1997) found that a thin layer of topsoil (15 cm) over a non-toxic mine spoil in Colorado was sufficient for the establishment and continued productivity of rangeland vegetation. After 10 years, Rendente *et al.* (1997) observed no difference in above-ground biomass between thick (60 cm) and thin (15 cm) layers of topsoil treatments. Species composition, however, was different between

the two groups. Grasses were dominant on sites with a thick layer of topsoil, while forbs were dominant on sites with a thin layer of topsoil. Differences in species composition were likely a result of the time-depth-related effects described earlier. Furthermore, there were more species occurring on the thin layer treatments compared to the thick layer treatments, suggesting that shallow depths of re-spread topsoil can support productive and diverse plant communities.

CONCLUSIONS

The presence of topsoil to re-establish soil microorganisms is essential for the revegetation of disturbed areas. Topsoil provides essential nutrients and microorganisms that are critical to the success of vegetation establishment. Johnson *et al.* (1991) concluded that the microbiology of stockpiled topsoils is highly complex. This report identifies the functioning of topsoil as a media for root growth and its importance for maintaining soil fertility. Isolating and removing topsoil may be an expensive step in the road construction process, yet it is invaluable to the long-term re-establishment of vegetation on the disturbed site. Stockpiling topsoil is generally unavoidable, as is the loss of some the benefits of topsoil. The extent of deterioration of topsoil in stockpiles has been greatly overestimated. With proper care, losses of viable soil can be minimized when topsoil is removed, piled, and re-applied.

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