Chapter Four - Vegetation Selection and Procurement

SPECIES SELECTION

Establishment of riparian plant species depends on proper selection of species, plant material procurement and handling, planting location, and establishment techniques (Hoag 1993a). The success of a bioengineering project is dependent on the holistic integration of these steps.

A vegetation inventory of the area will indicate suitable species for the project. In the inventory process, healthy, native stands should be located as possible harvest locations for cuttings. In degraded areas, one may need to look upstream or downstream for a healthy representative plant community. One should realize, however, that conditions at the representative plant community may vary from the project site. In these cases, a person knowledgeable in riparian vegetation will be extremely helpful. Regional classification systems of riparian and wetland sites can also be consulted, such as, *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen et al. 1995) and *Riparian Community Type Classification of Utah and Southeastern Idaho* (Padgett et al. 1989).

Different species have characteristics that may make them more suitable for a particular bioengineering project. For example, willows with a deep, spreading root system may stabilize a bank better than species with a shallow root system. Tree species may be appropriate in some cases when shade is a desired goal. However, they need to be planted out of the bankfull discharge area because they will not survive the frequent, high flows that occur in this zone.

Bioengineering methods should rely on both woody and herbaceous plant materials. Look for wetland areas with herbaceous plants that can survive in flowing water. Wetland plants like bulrush (*Scirpus* spp.) and cattail (*Typha* spp.) can act as a buffer to reduce the velocity of streamflows that intercept the bank. It is important to remember that anything to reduce the streamflow velocity before it intercepts the bank will help to ensure a successful bioengineering project.

Plant Species Information Table

Table 4-1 (on pp. 40-43) provides information on some woody riparian species found in the Great Basin and Intermountain Region. As the table shows, willow, cottonwood, and dogwood species are the most appropriate plants to propagate from hardwood cuttings. Other riparian plants such as alder and birch do not sprout from hardwood cuttings and should be obtained as potted plants from a nursery.

Table 4-2 (on pp. 44-45) provides information on wetland herbaceous species found in the region and that may be appropriate for bioengineering projects.

The table is based on published information as well as current, personal experience of the authors and others. Some differences may be noted in your particular area and application.

PLANT MATERIAL PROCUREMENT AND HANDLING

Woody plant materials for bioengineering are typically bare-root stock or dormant unrooted hardwood cuttings. The main benefits of using hardwood cuttings are; lower cost, ease of planting, depth of planting, local ecotype, and availability.

Hardwood cuttings can be divided into three general categories: pole, post, and bundled cuttings. Pole cuttings can be from shrub and

tree species and usually range in diameter from 1/2 to 3 inches. Post plantings are from tree species and range in diameter from 3 to 6 inches (Hoag 1993b). In general, larger diameter cuttings have more stored energy than smaller diameters and thus have a higher potential survival rate. Bundled cuttings are small diameter cuttings (no smaller than 3/8 inch) from different species with the branches left on that are used in techniques, such as wattles, brush layering, brush mattress, and vertical bundles.

Timing

Cuttings can be collected any time during the dormant season, from leaf fall to just before the buds begin to break in spring. Cuttings can also be collected during the growing season if all the leaves are removed from the stem prior to planting, although establishment success will be lower (Hoag 1993b).

Planting should be geared for periods during which the plants will have adequate moisture for establishment and yet will not be subject to high flow events. In this region, installation usually occurs after spring run-off. Occasionally, a high run-off year may push the planting window into early summer. Summer plantings should generally be avoided because of hot temperatures and dry conditions. It may be desirable to delay installation until fall. Fall plantings, however, are susceptible to frost heave and ice flows which may rip out roots that are not yet established. Even when planting occurs at a proper time, a flash flood event may damage the cuttings before they have had enough time to root in the streambank. Consequently, maintenance of the project is critical during the first 2 to 3 seasons.

Harvest of Cuttings

Cuttings should be thinned from healthy, native stands. Collect cuttings from live wood that is at least two years old. Avoid cuttings from old stems that are heavily furrowed, or infested with insect or disease, and young sucker growth. Thinning can be done with loppers, chainsaws, or brush cutters. Make sure the equipment is sharp enough to make clean cuts. In general, one should avoid thinning more than 2/3 of the total individual plant to avoid harming it (Fig. 4.1). In the case of a high water event, the remaining 1/3 of the plant may still be above water, and therefore, able to supply oxygen to the root system (Hoag 1993b). This also ensures that some habitat for songbirds and other wildlife remains while the other cuttings are becoming established.

Try removing cuttings from inside the crown area, and spread the harvesting activity throughout the stand to minimize visual impact. Always obtain permission from landowners before harvesting.

Trim off all side branches and the terminal bud (the bud at the growing tip) so energy will be rerouted to the lateral buds for more efficient root and stem sprouting. Cuttings can be tied into bundles to facilitate transporting and soaking.

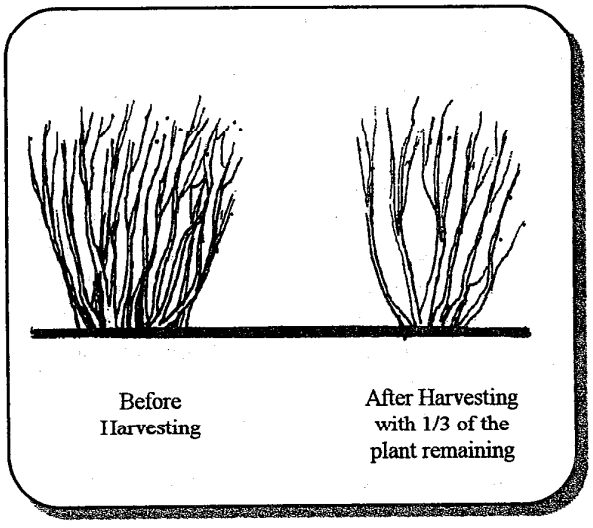


Fig. 4.1 *Collecting Cuttings*

Cutting length is dependent on the application. Cuttings should be long enough to extend 6-8 inches into the permanent water table or capillary fringe. At least one-half to two-thirds of the cutting should be below ground to prevent it from being ripped out during high flows. The cutting should be long enough to extend above the competing herbaceous vegetation and should extend down beneath the competing plant root mass. Be careful not to extend the top of the cutting too high if planted in the channel below the bankfull zone, because the cutting may be susceptible to major damage from debris and ice flows during runoff (Hoag 1993b).

If cuttings are collected well in advance of project construction, they must be stored in a cool (34-36° F) humid, dark place until ready to plant (i.e., root cellar or cooler). Cuttings can usually be stored for up to 6 months without significant reduction in rooting establishment and success.

Prior to planting, soak the cuttings in water for 5 to 7 days (minimum 24 hours). Soaking swells the root primordia and may leach out natural anti-rooting hormones found in the cuttings. Remove the cuttings from water before root tips emerge. When the cuttings are removed from the water, they should be immediately taken to the project site and planted (Hoag 1993b).

Other Forms of Plant Materials

Other forms of plant materials include container stock, bare root plants, transplant plugs, rhizomes, clumps, and seeds. Where appropriate, several different forms of plant materials can be planted to increase the chances for a successful project.

Nursery Stock

Container stock and bareroot material are generally acquired from a nursery. Nursery stock usually has good root development, energy reserves, and few pests. The main disadvantage is cost. Bioengineering techniques often rely on density of brush (i.e., brush trench) which would be difficult and costly to achieve with nursery stock. Nursery stock is best reserved for species that can not be propagated from cuttings.

Another thing to keep in mind is genetic variability within species. Plants of the same species have ecotypes that are best suited to a particular region. Some suggest that ecotypes generally do not range more than 100 to 200 miles of latitude from a particular site. However, this varies considerably based on the plant's breeding system. Consequently, one should find out where the nursery stock is originally from and determine if this meets the project's goals.

Transplant Plugs

Transplanting plugs of wetland herbaceous plants is often a viable method for incorporating these species in a project. Plugs should be 3 to 12 inches in diameter and 5 to 6 inches deep. They can be collected with a shovel or with a coring device made from an appropriate diameter of PVC pipe.

Generally, one can harvest about 1 square foot in a 10 foot square area without harming the plant community (Hoag and Sellers 1995). When collecting plugs, avoid areas that have noxious weeds such as purple loosestrife (*Lythrum salicaria*). Incorporation of seeds of unwanted species can be a significant drawback to the use of this method. Observation of proposed collection sites over a growing season can help to identify potential problems.

Key to Planting in the West

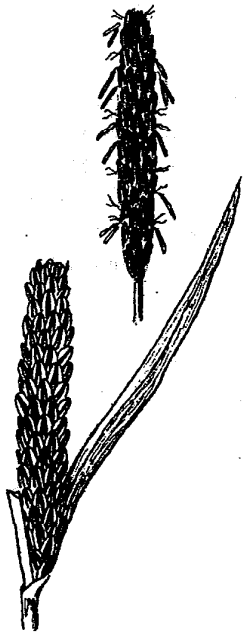
1. *Hydrology*
2. *Hydrology*
3. *Hydrology*

When collecting and transporting plugs, it is very important to keep the plants moist and cool. Styrofoam coolers filled with enough water to cover the roots are effective containers for transporting plugs. They can also be floated in the stream while planting at the project site (Hoag and Sellers 1995). Plugs can be planted whole or subdivided into 3 to 4 individual plugs.

Plugs can be transplanted during most of the growing season with good success. Transplanting in late summer should be avoided due to heat stress and limited time for establishment before the first frost. Tops of the plants should be cut off to reduce transplanting shock. Leave enough of top exposed so that it will stick up out of the water and allow oxygen to get to the roots.

Rhizomes

Rhizomes are the underground horizontal stems produced by some herbaceous plants such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) Rhizomes can be dug and divided into sections, taking care to keep at least one viable growth point or node on each section. Care must be taken to ensure that material being collected is young and healthy, generally indicated by firmness of the material.



Water Sedge
Carex aquatilis

These materials can be collected early in the spring before plants break dormancy or at the end of the growing season when the energy stored in the material is at its' greatest. The material can be planted at this time or stored in sand or peat. They should be kept at a cool temperature (40° F) until planting time (Marburger 1992). The growth node should be sticking up when planting these materials.

Clump Plantings

Clumps are large plugs that have a good functioning root system in addition to extensive above-ground biomass. Clumps are taken from existing stands, usually with a backhoe. Care should be taken so the backhoe operator does not dig too deeply. Usually 12 to 15 inches is enough to get most of the root mass. Minimal damage will occur if clumps are taken randomly from native stands.

Usually after one or two growing seasons; water, sediment, and remaining roots will fill in the holes. At higher elevations, where the growing season is short, this technique should be used with additional caution since it will take longer for the collection sites to revegetate. Holes should be backfilled and seeded if the growing season is short.

This is an extremely efficient technique that does not require the plants to root or develop above-ground material to be effective.

Seeds

Seeds can be used to increase the diversity of the site. Seeding in disturbed soil will decrease weed invasion that typically occurs on exposed soil.

Seeded areas can take longer than transplants to establish, so they should not be considered as an erosion control planting. Over the long term, however, seeding can provide additional root masses and above-ground biomass that will help reduce streamflow energy and promote sediment deposition. The Resource Section suggests possible references for determining an appropriate seeding mix and how to sow it.

PLANTING LOCATION

Observe the existing types of plants and their respective locations in relationship to the stream and water table (Fig. 4.2). This is the biological benchmark one is striving to create. Plants with flexible stems and rhizomatous root systems are usually located from the water-line to mid-bank zone. Larger shrubs are found from mid-bank zone to the top of the overbank zone. Tree species are usually found above the overbank zone in the floodplain. Wetland herbaceous species can be found throughout the streambank cross section, although most emergent aquatics will be found in the toe zone.

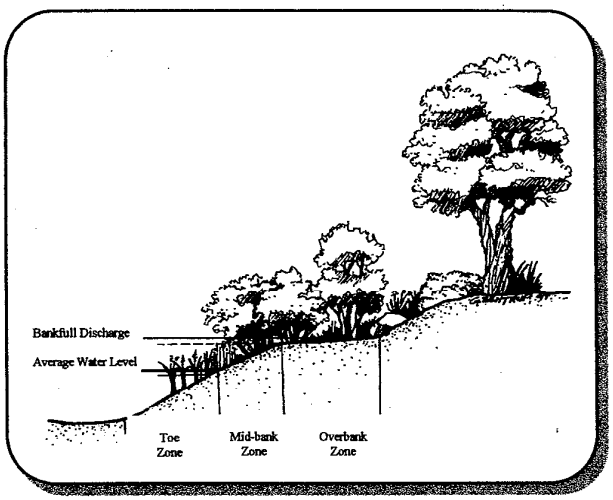


Fig. 4.2 *Planting Zones*

ESTABLISHMENT TECHNIQUES

Pole plantings are normally planted with planting bars, soil augers, and power augers. Post plantings are planted with post-hole diggers, tractor mounted posthole augers and a backhoe-mounted bar called "The Stinger" (see Post Planting Technique Sheet). Bundled cuttings are planted according to the specific technique. Water tables will often determine the planting method and planting depth.

Whatever the planting method, general establishment factors are important and should be considered.

General Establishment Factors for Woody Cuttings

1. Cuttings must reach the permanent water table or capillary fringe.
2. Minimize major damage to the buds when inserting a cutting in the hole. Avoid separating the bark from the cambium layer.
3. Make sure there are no air pockets around the cutting. Backfill with a soil and water slurry to remove air pockets.
4. Experiment with planting methods to determine a suitable method for your site conditions.

Note: Fertilizers and rooting hormone rarely improve success of high volume plantings enough to offset the cost and the extra labor involved.

MANAGEMENT

Determine the land management that is in place at the project site. If management changes are needed, make sure you get commitment from the landowner before you begin planting. If landowner does not agree to needed changes, the chances of implementing and maintaining a successful bioengineering project are unlikely.

If the site is grazed, temporary fences must be installed before planting to ensure that no grazing takes place for the first 2 to 4 years after planting. Grazing after that period may be allowed only after careful examination of the site and plantings. The buffer strip edge should be grazed only under controlled conditions. Use willows and other woody species along the water's edge as the key species to monitor when setting up a grazing management plan.

Wildlife Issues

Beaver, muskrats, ducks, geese, deer, elk, and other wildlife can do tremendous damage to new plantings. As part of the inventory process, one should identify if the site is in a deer or elk wintering range, if beaver or muskrat are active in the area, and if geese are commonly found on the site. If these wildlife are present on or near the site, bioengineering projects can still be installed, but the establishment period will be longer and the chances of success may be lowered.

"Come forth
into the light of things.
Let Nature be your teacher."

William Wordsworth

Generally, measures that are used to protect the planting will probably only be necessary for the first couple of years (your inventory should give a better idea of the length of time necessary). This allows enough time for good root growth. If the woody plants are browsed after they have been established for a year, they will generally resprout from the base.

Geese and other waterfowl can be kept from the plantings, especially the herbaceous components, by using temporary fencing such as electric fencing without the power. The area that needs to be protected can be fenced as a very narrow strip. Geese will not go into the fenced area as they avoid confining areas (Hoag 1993a). This fencing can be removed after 1 to 2 years.

Beaver and muskrat are the most difficult wildlife to manage in a bioengineering project. Various methods have been tried with various degrees of success. These methods include; cages around the base of the trees, repellents, tubes, and trapping. Trapping is probably the most effective, but must be done continuously to catch any immigrating animals. After the initial establishment period, beaver and muskrat can be desirable wildlife that will enhance the riparian area.

Booth's Willow

Table 4-1a Woody Species for Bioengineering in the Great Basin and Intermountain West

Species	Size/Form	Elevation Range[1]	Root Type	Rooting Ability from cuttings	Availability In Field[2]
Acer negundo Boxelder	Med. Tree	Low - Mid.	Moderately Spreading	Poor	Common
Alnus rubra Red alder	Med. Tree	Mid. - High	Shallow Spreading	Poor	Fairly Common
Alnus sinuata Sitka alder	Sm.-Med. Tree	Mid. - High	Shallow Spreading	Poor	Fairly Common
Alnus incana spp. tenuifolia Thinleaf alder	Sm.-Med. Tree	Mid. - High	Shallow Spreading	Poor	Common
Betula occidentalis Water birch	Lg. Shrub to Sm. Tree	Mid. - High	Shallow to Deep Spreading	Poor	Fairly Common
Cornus sericea Redosier dogwood	Med. Shrub	Mid.	Shallow	Moderate-need to nick & use hormon	Fairly Common
Crataegus douglasii Black hawthorn	Sm. Tree	Low - Mid.	Shallow to Deep Spreading	Poor	Fairly Common
Pentaphylloides floribunda Shrubby cinquefoil	Sm. Shrub	Low - Mid.	Shallow to Deep Spreading	Poor	Very Common
Philadelphus lewisii Mockorange	Sm. - Med. Shrub	Low-Mid.	Spreading Fibrous	Poor	Common
Populus angustifolia Narrowleaf cottonwood	Lg. Tree	Mid.	Shallow	Very Good	Very Common
Populus fremontii Fremont cottonwood	Lg. Tree	Low - Mid.	Shallow Fibrous	Very Good	Fairly Common
Populus tremuloides Quaking aspen	Med. Tree	Mid. - High	Shallow	Poor	Very Common
Populus trichocarpa Black cottonwood	Lg. Tree	Low - Mid.	Shallow Fibrous	Very Good	Very Common
Prunus virginiana Chokecherry	Med. - Lg. Shrub	Low - Mid.	Rhizomatous	Good from root cuttings	Common
Rhus trilobata Skunkbush sumac	Med. - Lg. Shrub	Low - Mid.	Deep Spreading Rhizomatous	Poor	Fairly Common
Ribes aureum Golden current	Sm. - Med. Shrub	Low - Mid.	Spreading	Good (in greenhouse)	Common
Rosa woodsii Wood's rose	Sm. - Med. Shrub	Low - Mid.	Shallow to Deep	Good (in greenhouse)	Very Common
Salix amygdaloides Peachleaf willow	Sm. Tree	Low	Fibrous	Very Good	Common
Salix bebbiana Bebb's willow	Lg. Shrub	Low to Mid.	Shallow to Deep	Good	Common

Footnotes:

U = Unknown

1. **Elevation Range:** data for this region.
   Low 2,000-4,500 feet
   Middle 4,500-7,000 feet
   High 7,000-10,000 feet
2. **Availability in the Field:** This refers to it's natural occurrence in the region. This is particularly important for species that may be harvested for hardwood cuttings. The order of the ranking is from least to greatest: Fairly Common, Common, and Very Common.
3. **Commercial Availability:** This refers to whether or not it is currently available in the nursery trade. Refer to the Resource section for information on a nursery guide.
4. **Tolerance to Deposition:** Regrowth from shallow coverage by soil.
5. **Tolerance to Flooding:**
   High Damage after 10 to 30 days of flooding
   Medium Damage after 6 to 10 days of flooding
   Low Damage after 1 to 5 days of flooding
6. **Tolerance to Drought:** Resistance to drought relative to native vegetation on similar sites.
7. **Tolerance to Salinity:** Resistance to salinity relative to native vegetation on similar sites.

Commerical Availability[3]	Deposition Tolerance[4]	Flooding Tolerance[5]	Drought Tolerance[6]	Salinity Tolerance[7]	Wildlife Value/Misc. Notes
Yes	High	High	High	Med.	
Yes	Med.	Med.	Low	Low	Big game browse upland bird food
Yes	Med.	Med.	Low	Low	Big game browse upland bird food
Yes	Med.	Med.	Low	Low	Big game browse upland bird food
Yes	Med.	Med	Low	Low	Big game browse
Yes	Low	High	Med.	Low	Big game browse, small mammal food upland bird food.
Yes	Med.	Low	High	Low	Browse for many species and cover
Yes	U	U	High	U	Big game browse
Yes	U	U	U	U	Big game browse
Yes	Med.	Med.	High	Med.	Big game browse
Yes	Med.	Med.	Med.	Med.	Big game browse
Yes	Low	Low	Med.	Med.	Big game browse
Yes	Med.	Med.	Med.	U	Big game browse
Yes	Low	Low	Low-Med.	Low-Med	Birds and small mammals eat fruits
Yes	High	Med.-High	Med.-High	Med.	Birds and small mammals eat fruits Can not tolerate long-term flooding
Yes	U	U	U	U	Birds and sma. mammals eat fruits
Yes	U	Low	Low-High	Low	Rosehips eaten by many species
Yes-limited	High	High	Low	Med.	Willows in general are good browse and provide excellent cover for many species
Yes-limited	High	High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species

References:

Brunsfeld, S.J. and F.D. Johnson. 1985. *Field Guide to the Willows of East-Central Idaho.* Forest, Wildlife & Range Experiment Station. University of Idaho Bull. #39.

Ditterberner, P.L. and M.R. Olson. 1983. *The Plant Information Network (PIN) Data Base Colorado, Montana, North Dakota, Utah, and Wyoming.* U.S. Fish & Wildlife Service FWS/OBS-83/36.

Platts, W. and Others. 1987. *Methods for Evaluating Riparian Habitat With Applications to Management.* USDA, Forest Service, Intermountain Research Station, General Technical Report INT-221.

USDA Natural Resources Conservation Service. 1992. *Soil Bioengineering for Upland Slope Protection and Erosion Protection.* USDA NRCS Engineering Field Handbook. Chapter 18.

Table 4-15 Woody Species for Bioengineering in the Great Basin and Intermountain West

Species	Size/Form	Elevation Range[1]	Root Type	Rooting Ability from cuttings	Availability In Field[2]
Salix boothii Booth willow	Med. Shrub	Mid.	Shallow to Deep	Moderate	Very Common
Salix brachycarpa Barrenground willow	Sm. Shrub	High	Shallow	Good	Common
Salix drummondiana Drummond willow	Sm. - Med. Shrub	Mid. - High	Shallow to Deep	Good	Common
Salix exigua Sandbar willow	Med. Shrub	Low - Mid.	Rhizomatous	Very Good	Very Common
Salix geyertana Geyer willow	Med.. Shrub	Mid.	Shallow to Deep	Good	Very Common
Salix glauca Grayleaf willow	Sm. - Med. Shrub	Mid. - High	Shallow to Deep	Need to treat with hormone	Fairly Common
Salix lasiandra Pacific willow	Sm. Tree	Low - Mid.	Shallow to Deep	Good	Common
Salix lasiolepis Arroyo willow	Med. Shrub	Low	Shallow to Deep	Moderate	Common
Salix lemmonii Lemmon willow	Sm. - Med. Shrub	Mid. - High	Shallow to Deep	Good	Fairly Common
Salix lutea Yellow willow	Med. - Lg. Shrub	Low	Shallow to Deep	Good	Very Common
Salix planifolia Planeleaf willow	Sm. Shrub	Mid. - High	Shallow to Deep	Moderate	Fairly Common
Salix scouleriana Scouler willow	Lg. Shrub	Low - Mid.	Shallow to Deep	Need to treat with hormone	Fairly Common
Salix wolfii Wolf willow	Sm. Shrub	High	Shallow to Deep	Erratic	Fairly Common
Sambucus coerulea Blue elderberry	Sm. Tree	Mid.	Rhizomatous	Poor	Fairly Common
Sambucus racemosa Red elderberry	Med. Shrub	Mid. - High	Spreading	Poor	Fairly Common
Shepherdia argentea Silver buffaloberry	Lg. Shrub	Low - Mid.	Rhizomatous	Poor	Fairly Common

Footnotes:

U = Unknown

1. **Elevation Range:** data for this region.
   Low 2,000-4,500 feet
   Middle 4,500-7,000 feet
   High 7,000-10,000 feet
2. **Availability in the Field:** This refers to it's natural occurrence in the region. This is particularly important for species that may be harvested for hardwood cuttings. The order of the ranking is from least to greatest:
   Fairly Common
   Common
   Very Common
3. **Commercial Availability:** This refers to whether or not it is currently available in the nursery trade. Refer to the Resource section for information on a nursery guide.
4. **Tolerance to Deposition:** Regrowth from shallow coverage by soil.
5. **Tolerance to Flooding:**
   High Damage after 10 to 30 days of flooding
   Medium Damage after 6 to 10 days of flooding
   Low Damage after 1 to 5 days of flooding
6. **Tolerance to Drought:** Resistance to drought relative to native vegetation on similar sites.
7. **Tolerance to Salinity:** Resistance to salinity relative to native vegetation on similar sites.

Commerical Availability[3]	Deposition Tolerance[4]	Flooding Tolerance[5]	Drought Tolerance[6]	Salinity Tolerance[7]	Wildlife Value/Misc. Notes
Yes-limited	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
No	High	Med. - High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species
Yes-limited	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
Yes	High	Med. - High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species
Yes-limited	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
U	High	Med. - High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species
Yes	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
Yes	High	Med. - High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species
No	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
Yes-limited	Med.	Med. - High	Low - Med.	Med.	Willows in general are good browse and provide excellent cover for many species
No	High	Med. - High	Low - Med.	Low	Willows in general are good browse and provide excellent cover for many species
Yes	High	Med. - High	Low - Med.	High	Willows in general are good browse and provide excellent cover for many species
No	High	Med. - High	Low - Med	Low	Willows in general are good browse and provide excellent cover for many species
Yes	Med.	Med.	Med.	Low	Fruits are important for birds
Yes	Med.	Med.	Med.	Low	Big game browse Fruits eaten by birds and small mammals
Yes	U	U	U	Low	Fruits eaten by birds and small mammals

References:

Brunsfeld, S.J. and F.D. Johnson. 1985. *Field Guide to the Willows of East-Central Idaho.* Forest, Wildlife & Range Experiment Station. University of Idaho Bull. #39.

Ditterberner, P.L. and M.R. Olson. 1983. *The Plant Information Network (PIN) Data Base Colorado, Montana, North Dakota, Utah, and Wyoming.* U.S. Fish & Wildlife Service FWS/OBS-83/36.

Platts, W. and Others. 1987. *Methods for Evaluating Riparian Habitat With Applications to Management.* USDA, Forest Service, Intermountain Research Station, General Technical Report INT-221.

USDA Natural Resources Conservation Service. 1992. *Soil Bioengineering for Upland Slope Protection and Erosion Protection.* USDA NRCS Engineering Field Handbook. Chapter 18.

Table 4-2 Herbaceous Species for Bioengineering in the Great Basin and Intermountain West

Species	Elevation Range[1]	Root Type	Hydrologic Regime[2]	Availability In Field[3]	Commerical Availability[4]
Beckmannia syzigachne Sloughgrass	Low-Mid.	Stoloniferous Annual	Seasonally-Flooded	Fairly Common	Yes-Seed & Potted
Calamagrostis canadensis Blue-joint reed grass	Mid.-High	Rhizomatous Perennial	Seasonally-Saturated	Common	Yes-Seed & Potted
Carex aquatilis Water sedge	Mid.-High	Rhizomatous Perennial	Up to 3" Water Depth	Fairly Common	Yes-Seed & Potted
Carex nebrascensis Nebraska sedge	Low-High	Rhizomatous Perennial	Seasonally-Saturated	Common	Yes-Seed & Potted
Carex utriculata Beaked sedge	Low-High	Rhizomatous Perennial	Seasonally-Saturated	Common	Yes Potted
Deschampsia cespitosa Tufted hairgrass	Mid.-High	Fibrous Perennial	Seasonally-Saturated	Common	Yes-Seed
Distichlis stricta Inland Saltgrass	Low-Mid.	Rhizomatous Perennial	Seasonally-Saturated	Very Common	Yes-Seed & Potted
Eleocharis palustris Spikerush	Low-High	Rhizomatous Perennial	Up to 6" Water Depth (maybe more)	Very Common	Yes-Seed & Potted
Glyceria striata Mannagrass	Mid.-High	Rhizomatous Perennial	Seasonally-Flooded	Fairly Common	Yes-Seed & Potted
Juncus balticus Baltic rush	Low-High	Rhizomatous Perennial	Seasonally-Saturated	Very Common	Yes-Seed & Potted
Juncus mertensianus Merten's rush	Mid.-High	Rhizomatous Perennial	Saturated	Fairly Common	Yes-Seed & Potted
Juncus tenuis Poverty rush	Mid.-High	Rhizomatous Perennial	Saturated	Fairly Common	Yes-Potted
Puchinellia nuttalliana Alkali grass	Low-Mid.	Fibrous Perennial	Seasonally-Saturated	Common	Yes-Seed & Potted
Scirpus acutus Hard-stem bulrush	Low-High	Rhizomatous Perennial	Up to 36" Water Depth	Very Common	Yes-Seed & Potted
Scirpus maritimus Alkali bulrush	Low-Mid.	Rhizomatous Perennial	Up to 6" Water Depth	Common	Yes-Seed & Potted
Scirpus pungens Three-square bulrush	Low-Mid.	Rhizomatous Perennial	Up to 6" Water Depth	Very Common	Yes-Seed & Potted
Spartina pectinata Prairie cordgrass	Low-Mid.	Rhizomatous Perennial	Seasonally-Flooded	Fairly Common	Yes-Seed & Potted
Typha latifolia Cattail	Low-Mid.	Rhizomatous Perennial	Up to 12" Water Depth	Very Common	Yes-Seed & Potted
Verbena hastata Blue vervain	Low-Mid.	Fibrous Perennial	Seasonally-Saturated	Common	Yes-Seed & Potted

Footnotes:

U = Unknown

1. **Elevation Range:** data for this region.
   Low 2,000-4,500 feet
   Middle 4,500-7,000 feet
   High 7,000-10,000 feet

2. **Hydrologic Regime:** This indicates optimal moisture conditions although local conditions are the best benchmarks for design. Seasonally-saturated species prefer soil that is saturated early in the season but later dries out. Seasonally-Flooded species prefer flooding in the early portion of the season. Saturated conditions indicates species that prefer saturated conditions all season long. The other species prefer standing water up to the depth that is described.

3. **Availability in the Field:** This refers to natural occurrence in the region. The order of the ranking is from least to greatest:
   Fairly Common
   Common
   Very Common

4. **Commercial Availability:** This refers to whether or not the t is species is currently available in the nursery trade. Refer to the Resource section for information on a nursery guide.

5. **Rate of Spread:** This refers to the horizontal rate of growth. These rates are only guidelines since rates will vary with growing season, elevation, soil, etc.
   Rapid Over 1.0 ft. per year
   Medium Approximately 0.5 ft. per year
   Slow Approximately 0.2 ft. per year

6. **Tolerance to Acidity:** Resistance to acidity relative to native vegetation on similar sites.

7. **Tolerance to Salinity:** Resistance to salinity relative to native vegetation on similar sites.

Height	Rate of Spread[5]	Acidity Tolerance[6]	Salinity Tolerance[7]	Wildlife Value	Notes
36"	Rapid	U	U	Waterfowl and small mammal food	Palatable forage grass
24-36"	Medium	Med.	Low	Small mammal food and upland bird cover	Excellent soil stabilizer
10-24"	Medium	Med.	Low	Waterfowl food and cover	
10-24"	Medium	Low	Medium	Waterfowl food and cover, small mammal cover	Tolerates heat if provided with adequate moisture
10-40"	Rapid	Med.	Low	Waterfowl and small mammal food	Also known as *C. rostrata*
18-30"	Medium	Med.	Med.	Small mammal cover	
12-18"	Medium	Low	High	Waterfowl food	
6-30"	Rapid	Low	Med.	Waterfowl food	Excellent soil stabilizer
24-36"	Rapid	U	Low	Waterfowl and big game food	Excellent soil stabilizer
18-24"	Medium	Med.	Med.	Waterfowl food	Tolerates wide range of hydrologic conditions
4-16"	Medium	U	U	U	
6-12"	Medium	U	U	U	
6-12"	Medium	Low	High	Small mammal cover	Tolerates high akaline sites
Up to 6'	Rapid	Low	Med.	Waterfowl food and cover, small mammal cover	Excellent soil stabilizer
24-36"	Medium	Low	High	Waterfowl cover and food	Tolerates high akaline sites
24-48"	Rapid	Low	Med.	Waterfowl food and cover, small mammal cover	Tolerates some hydrologic drawdown
24-48"	Rapid	Low	Med.	Small game cover	Not palatable for livestock
Up to 6'	Rapid	Med.	High	Waterfowl food and cover, small mammal cover and food	Can be invasive
18-30"	Slow	U	Low	Upland bird food	Very fibrous root system

References:

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