TECHNICAL NOTE

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REVISION

DESCRIPTION, PROPAGATION, AND ESTABLISHMENT OF WETLAND - RIPARIAN GRASS AND GRASS-LIKE SPECIES IN THE INTERMOUNTAIN WEST

J. Chris Hoag, NRCS, Aberdeen, Idaho (Ret.)
Derek Tilley, Agronomist, NRCS, Aberdeen, Idaho
Dan Ogle, Plant Materials Specialist, NRCS, Boise, Idaho
Loren St. John, PMC Team Leader, NRCS, Aberdeen, Idaho

A healthy wetland system with a diverse plant community. Photo by Derek Tilley

This technical note describes propagation protocols and establishment methods and considerations for wetland and riparian area creation and enhancement. It provides species descriptions for several wetland grass and grass-like species commonly used in the Intermountain West.

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INTRODUCTION

Wetland grass and grass-like species, including sedges (*Carex spp.*), spikerushes (*Eleocharis spp.*), bulrushes (*Scirpus spp.*) and rushes (*Juncus spp.*), are critical components of riparian and wetland revegetation for several reasons. The above ground biomass provides roughness that cause stream velocity to decrease and sedimentation to occur. Because of their fast growing and dense root systems, sedges and rushes are especially valuable for stream bank and shoreline stabilization. Grasses and grass-like species also provide wildlife habitat for a variety of terrestrial and aquatic species. Additionally, many wetland plant species create a root matrix used by microbes that capture pollutants, providing a buffer between runoff and downstream water ways.

Wetland plant root systems are important means of stabilizing degraded sites. Researchers have found that Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*), produce approximately 212 and 72 ft/in^3 of roots in the top 16 inches of the soil profile respectively. In comparison, the upland grass, Kentucky bluegrass (*Poa pratensis*) has 19 ft/in^3 of roots in the same soil profile. Using these densely rooted species for soil bioengineering increases the strength and structure of the soil, and thereby reduces stream bank erosion. Most soil bioengineering applications emphasize the use of woody riparian plants; however, using herbaceous wetland plants in conjunction with larger woody species is significantly more effective for stream bank stabilization than using woody species alone.

Water purification is a natural function of wetlands. Wetland plants are widely used for constructed wetland systems (CWS) and buffer strips. Wetland plants provide habitat for colonizing microbial populations which live on the plant roots and breakdown various nutrients found in the water. The above-ground biomass also serves as nursery sites for periphyton, a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus. The periphyton serves as an important food source for invertebrates, tadpoles, and some fish. It can also absorb contaminants; removing them from the water column and limiting their movement through the environment.

Defining Riparian Planting Zones

Establishment of riparian and wetland plants depends largely on proper selection of species, plant material procurement and handling, site preparation, and establishment techniques. The success of a project is dependent on proper planning and the complete integration of these factors.

In a generalized sense, there are 5 planting zones in a riparian area beginning near the permanently inundated toe zone and proceeding upslope to the rarely flooded upland zone (figure 1). When planning a project, it is important to examine the existing vegetation and its respective locations in relationship to the stream and water table. Planting wetland species in their natural position along a shoreline gradient increases the chance of successful establishment, and ensures the longevity of the planting.

It is useful to find a bench mark site. A reference site similar to the project site should be located to determine site potential. Attempt to match the different species naturally growing in the reference site. Look for wetland herbaceous plants in all of the riparian zones present. Deep water wetland plants such as bulrush (*Schoenoplectus* spp.) and cattail (*Typha* spp.) can act as a buffer, reducing the velocity of stream flow that intercept the bank. They survive and thrive in areas where woody plants will not grow. Shallow water species such as sedges (*Carex* spp.) and rushes (*Juncus* spp.) are important for strengthening and holding stream banks with their dense root systems. Wetland herbaceous species can be found throughout the stream bank cross section, although most emergent aquatic plants are found in the toe zone. Hoag (2001) provides additional details on water levels in the riparian planting zones.

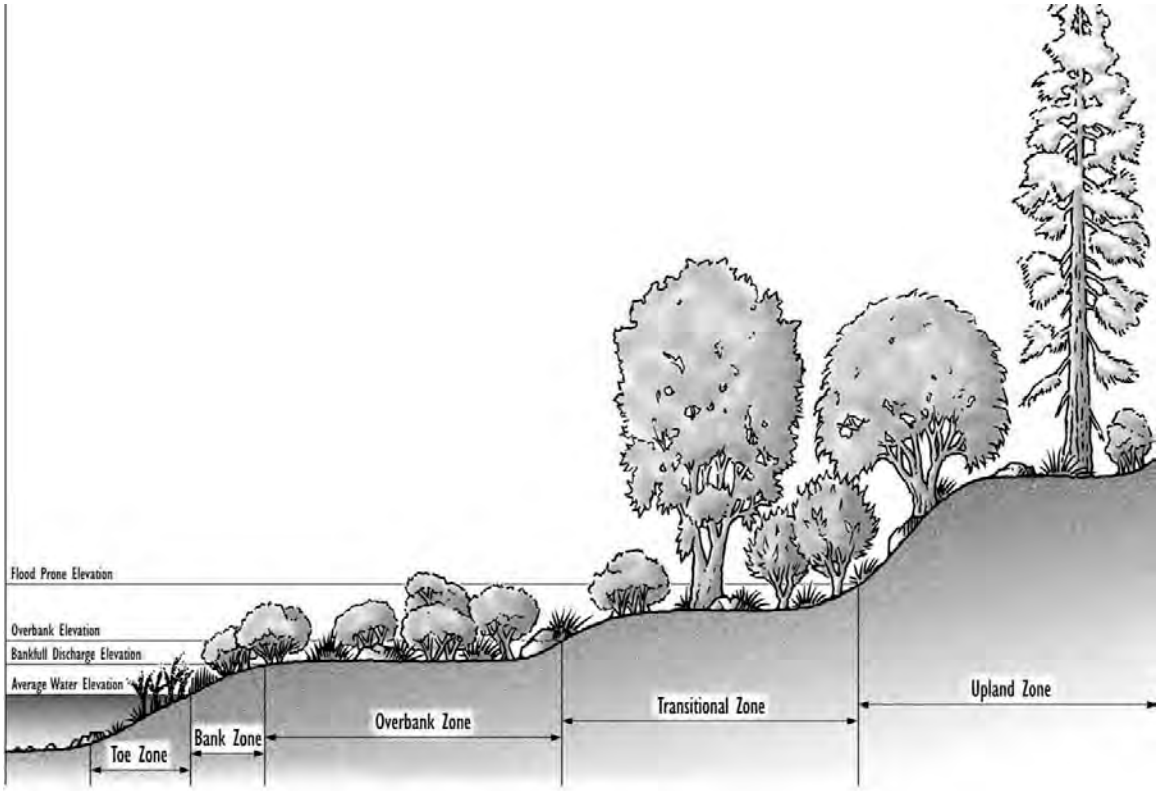


Figure 1. A general depiction of a riparian area from the toe zone to the upland zone. (From Hoag, 2001).

Riparian areas can be viewed as a series of hydrologic zones based on inundation levels and durations (Figure 2). Zones 1, 2 and 3 are part of the toe and bank zones. Zone 1 is the deep water pool. This area is a permanent pool reaching 3 or more feet in depth. Zone 2 is the shallow water bench. This is the beginning of the fluctuating water area and is typically 2 to 18 inches deep. Zone 3 is the shallow water fringe. This area is 0 to 2 inches deep with fluctuating water levels and is regularly inundated. Zone 4 is the shoreline fringe, a permanently moist zone which is periodically inundated with water. Zone 5 is typically a dry terrace which is only inundated during flood events. Zone 6 is the upland zone which is seldom or never inundated with water.

Figure 2 shows the hydrologic zones found in the riparian planting section of a shoreline or stream bank. Bank full discharge elevation is typically found at the top of hydrologic zone 3.

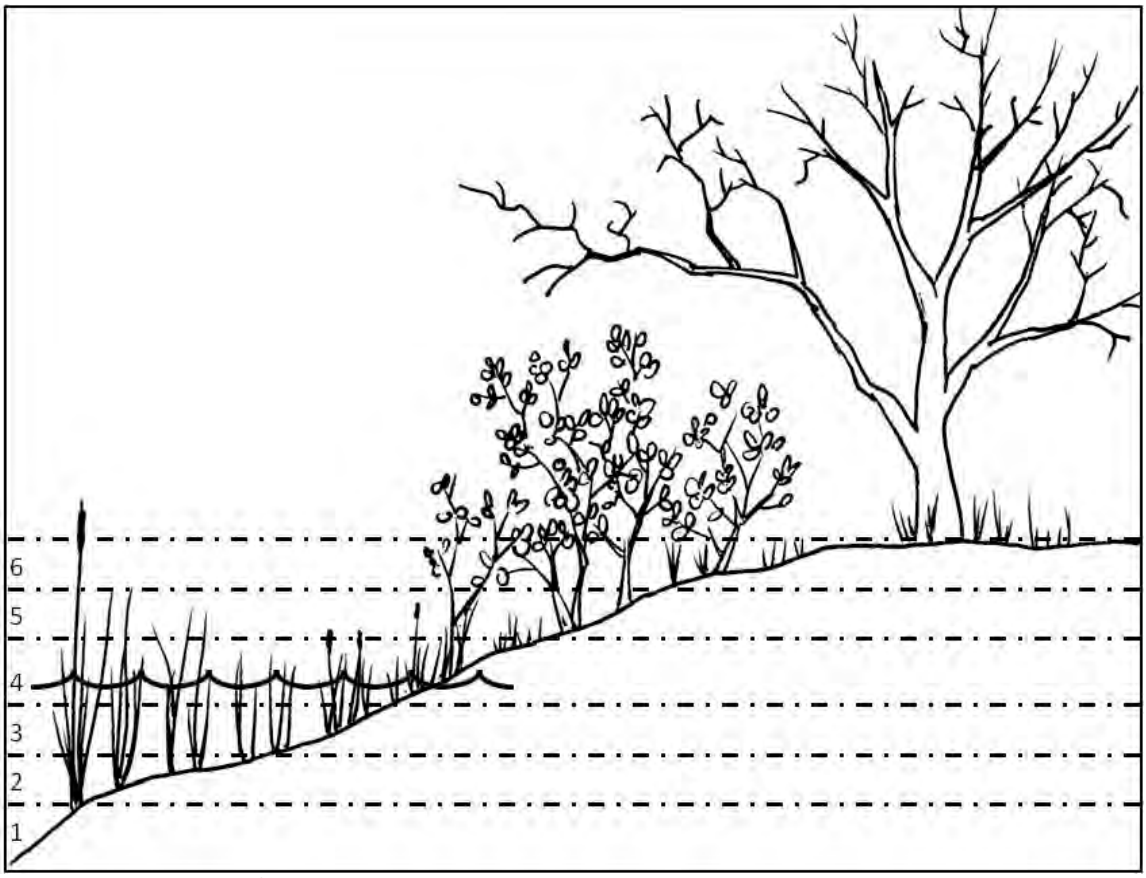


Figure 2. Hydrologic zones for planting herbaceous species in the Intermountain West. Drawing by Derek Tilley, based on Ogle and Hoag, 2000. Zone 1= Deep water pool; Zone 2=Shallow water bench; Zone 3= Shallow Water Fringe; Zone 4= Shoreline Fringe; Zone 5=Terrace; Zone 6= Upland.

Not all riparian or wetland areas will contain all of the zones mentioned. Rocky areas and steep slopes often preclude one or more zones. A cut bank could produce a stream profile with a toe zone cutting straight to an upland area.

Figure 3 shows a riparian area displaying all of the major riparian zones from the toe zone to the upland zone; however not all zones are present on each side of the stream.

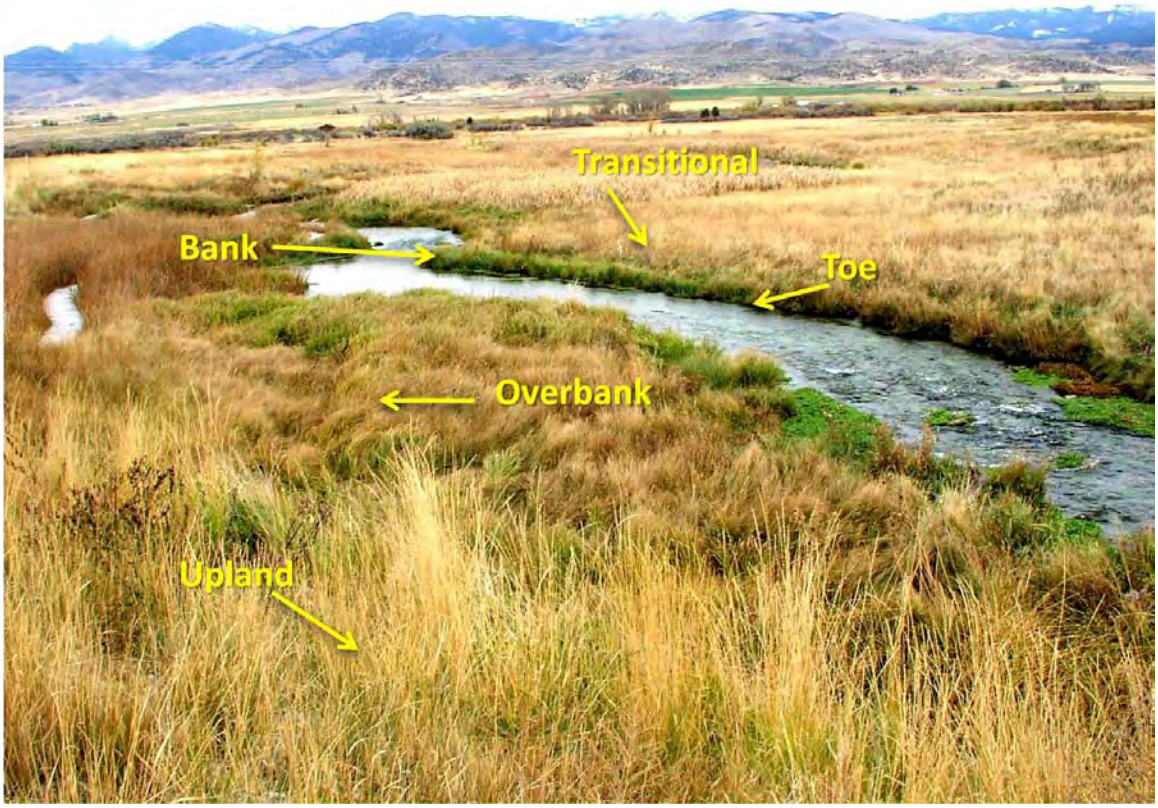


Figure 3. Several riparian zones are evident in this photo from Sheridan Creek, Montana. Note that the far bank does not have a significant overbank zone. Photo by Chris Hoag

Indicator Categories

Plant species are classified based on their likelihood to occur in wetland or upland environments (Table 1). The different categories reflect the range of estimated probabilities (expressed as a frequency of occurrence) of a species occurring in wetlands versus non-wetlands across the entire distribution of the species. A frequency, for example, of 67-99% (Facultative Wetland) means that 67 to 99% of occurrence would be in wetlands. Positive (+) or negative (-) signs are used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

The wetland indicator categories should not be equated to degrees of wetness. Many obligate wetland species occur in permanently or semi-permanently flooded wetlands, but a number of obligates also occur in and some are restricted to wetlands which are only temporarily or seasonally flooded. The facultative upland species include plants which may be adapted to exist in a number of sites (including wetlands), to species in which the plants always occurs in wetlands.

Table 1. Wetland Indicator Codes and probability values (USDA-NRCS, 2011)		
Indicator Code	**Wetland Type**	**Comments**
OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67-99%), but occasionally found in non-wetlands.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34-66%).
FACU	Facultative Upland	Usually occurs in non-wetlands (estimated probability 67-99%), but occasionally found on wetlands (estimated probability 1-33%).
UPL	Obligate Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.

DIRECT SEEDING

Seeding is useful to increase the diversity of the site, but is generally not recommended for establishment of all plants in a wetland or riparian project. Many plant species commonly associated with wetland and riparian areas are extremely difficult to establish by seeding under field conditions (e.g. *Carex* spp. and *Schoenoplectus* spp.); however seeding should be considered for areas to be planted with grasses, usually located in hydrologic zones 4, 5, and 6. Seeding the proper species in disturbed sites can decrease weed invasion that often occurs on exposed soils. Seeded areas take longer than using transplants to establish. In addition, new seedings should not be considered to be immediate erosion or weed control plantings. Over the long term, however, seeding provides additional root structure and above ground biomass that reduces stream flow energy and promote sediment deposition.

Seeding Grasses

There are four main factors to consider when planning the seeding phase of the revegetation operation. These factors include 1) season of seeding, 2) seeding rates, 3) method of application, and 4) species selection.

It is important to determine the appropriate time to plant, because some species may require stratification before germination will occur. Ideally, the site should have been prepared the previous fall if a spring seeding is desired. Usually spring seedings are planted between periods of wet and dry weather. If spring seedings are to be effective, they should be completed as early in the spring as possible and prior to spring rains. There may be difficulties getting farm equipment onto the site to prepare a seedbed in the spring following a wet winter that has saturated the soil profile, therefore it is generally recommended to conduct site preparation in the summer, fall or early winter prior to seeding.

The two methods of direct seeding are broadcast and drill planting. A primary consideration when direct seeding is seeding depth. Generally, very small seed will be planted at very shallow depths, around 0 to 1/8 inch; small seeds are planted at shallow depths, around 1/8 to 1/4 inch, and medium to large seed at depths of 1/4 to 1/2 inch. Soil texture is also a factor in determining proper planting depths; finer soil textures are generally planted shallower than coarse textured, sand and gravel soils.

If the seedbed is rough, broadcast planting is recommended. Hand-cyclone seeders and air seeders or blowers are good, inexpensive means for broadcasting seed. Care should be taken to insure an even distribution of seed over the area being seeded. Seed should be covered or pressed into the soil following broadcast planting by harrowing, packing or rolling. A cultipacker, roller harrow with the tines up or a heavy sheep's-foot roller are acceptable methods to cover seed. These implements help insure good seed to soil contact. When broadcast seeding, the standard seeding rate recommended for drill planting should be doubled.

Drilling seed into a prepared seedbed also has advantages. Seeding depth and seed distribution are more accurate and controlled with a drill. Good stand establishment can be accomplished with row spacing widths of 6 to 21 inches. The rows will fill in naturally via seed recruitment or by spread via rhizomes.

Seeding rates are dependent on many factors including planting method, species, site conditions, climate, and others. All seeding rates should be based on Pure Live Seed (PLS). PLS is calculated as (percent purity X percent viability / 100). The rates used in this guide are for establishing full stands or monocultures using a target of 20 to 30 seeds/ft² for the larger seed size accessions (< 500,000 seeds per pound), and 40 to 50 seeds/ft² for the smaller seed size accessions (> 500,000 seeds per pound). To create a seed mixture, the seeding rates should be adjusted to reflect the percentage of the individual species in the mixtures. For broadcast seeding and critical area seedings, these rates should be doubled. See Idaho Plant Materials Technical Notes 7 and 24 for further information on calculating seed mixtures.

Seeding grass-like species

Most wetland species are very difficult to direct seed in the wild. Seed of grass-like wetland species such as sedges, rushes and bulrushes need three things to germinate: 1) heat, 2) water, and 3) light. The requirement for light means that wetland plant seed should be placed on the soil surface, and not covered with soil. Drilling is therefore not a viable option, because drilled seed will be planted too deep and covered by soil. Drills may be used if seed tubes are pulled to allow seed to dribble onto the soil surface (mimicking broadcast seeding) and then lightly press seed into soil with packer wheels or drag chains.

Many wetland species have a very hard seed coat that may take up to a year or longer to break dormancy before the embryo will germinate. As a result, many species require special stratification treatments such as acid washes, mechanical scarification, or pre-chilling to prepare the seed for planting. Often, depending on species, dormant seeding (seeding during the late fall or early winter after the plants have gone dormant) can naturally assist with breaking seed dormancy.

Not having absolute control of the water going into the wetland or riparian area is often a problem that occurs when seeding wetland species. If water level cannot be controlled properly, the newly planted seed will float to the water surface and move to the water's edge where wave action will deposit the seed in a very narrow zone. The seed will germinate and the stand will generally be successful as long as the hydrologic conditions are maintained for the planted species. With good water control, the seed should stay in place and the stand will cover the entire wetland bottom instead of just around the fringe.

Using direct seeding of herbaceous plants as the primary means of vegetating a site requires strict attention to planning, and control of site hydrology, during the establishment period. In addition, it is important to understand the specific germination or stratification requirements of the targeted species. Successful establishment of herbaceous vegetation by direct seeding is possible. However, direct seeding of herbaceous species is not typically used as the primary means of revegetation of wetland species. It is primarily a method to increase the overall species diversity in a wetland, particularly around the perimeter and to establish populations of specific target species.

Hydroseeding

Hydroseeding is the use of water under high pressure as a carrier to disperse seed onto a target site. The seed is often mixed with a mulch, either fiber or wood, to retain moisture and protect the seed from exposure. Tackifiers or glues are also used to help hold the seed and mulch in place once it is applied to the soil. Hydroseeding can be effectively used for seeding grasses and some wetland species.

Aberdeen PMC staff is investigating the feasibility of hydroseeding pre-germinated seed of wetland sedges and rushes. This technique involves uniformly germinating seed prior to hydroseeding it onto the site. The goal is to place the germinants in a well prepared moist environment, so that the newly formed roots quickly penetrate the soil surface. Once the roots are anchored, flooding events are far less likely to displace and redistribute the seed.

TRANSPLANTS - Greenhouse Production

Establishing vegetation on a site with herbaceous plugs of greenhouse grown material has a much higher rate of establishment than seeding or the transplanting of wildlings. For many wetland species, successful greenhouse propagation requires a seed treatment followed by hot and humid greenhouse growing conditions. This often requires stratification of seed under cold-moist conditions for varying periods of time.

For cold/moist stratification, the seed is placed in a permeable material, which is then placed in another container filled with wet soil media or sand. Another stratification technique is to place the seed in a green, sphagnum moss "tea". Aberdeen PMC uses 8 g of sphagnum moss in 1 cup of water with 1 to 2 tablespoons of seed in a stapled coffee filter. After the stratification period the seed is retrieved and planted in moist soil containers at air temperatures of about 100º F.

Research at Aberdeen has shown that seed of some species respond positively to soaking under aerated water treatments. Seed of Nebraska sedge (*Carex nebrascensis*) and water sedge (*C. aquatilis*) soaked in mason jars with an aquarium aerator, germinated significantly faster and more uniformly than non-aerated treatments. This technique can be used for greenhouse production and hydroseeding.

After stratification, the seed is planted on the soil surface and pressed in to create good contact between the seed and soil. The seed should be illuminated for 24 hours a day for the first month of establishment. Aberdeen PMC uses 400-watt metal halide lamps.

Herbaceous wetland and riparian plants can be irrigated with overhead sprinklers or placed in tanks for subsurface irrigation. Regardless of the irrigation method, it is important to keep the soil surface moist. A misting schedule of 2 to 3 minutes every hour during daylight hours is a good starting point. As the plants grow, the watering duration should be increased to promote root development and elongation. The between-watering interval can increase as plants develop.

Tanks and troughs provide an excellent means of irrigating wetland plants (Figure 4). The water should be filled to just below, the soil surface. Capillary action will transfer water to the seed on the soil surface. Covering the propagation tanks with clear plastic while the seeds are germinating, helps keep the environment warm and humid. If seedlings are damping off, try flooding the soil. Leave the soil completely submerged under about 1/4 to 1/2 inch of water for about two weeks. After this period lower the water level. This will reduce fungus and may stimulate more stubborn seed to germinate. Do not flood the soil if the seed has not germinated or seed will float and move out of the cells.

Figure 4. Sedge seedlings (*Carex* spp.) growing in propagation tanks at Aberdeen Plant Materials Center. Photo by Derek Tilley

Using these techniques, 22 in^3 plants can be grown from collection to full size in approximately 100 days. Plugs can be held in the greenhouse if necessary for extended periods of time with minimal maintenance. Reducing greenhouse temperatures to 75 to 80° F will slow growth and prevent plugs from quickly becoming root bound.

If growing the plants is not an option and they must be purchased, several things should be considered. It is important to find a grower who is willing and able to grow wetland plants that can be difficult to propagate. The grower must understand the special propagation requirements associated with wetland species. The grower should understand the project plant requirements in terms of height and size at the time that the contract is signed. When determining whether to accept the plant materials, look at the roots in addition to the top growth. The top and root growth should be about the same in terms of density. Always remove several plants from their containers to look at the roots. The roots should extend to the bottom of the container, but they should not be root bound (wound around the inside of the container). The roots should have several well-developed rhizomes in addition to hair roots. The tops should be vigorous and meet

the project specifications. If the top growth is too short, the plants will be in danger of drowning if planted in water that is too deep. The out-planting date should be determined before going to the grower so they know when the plants need to be ready. Check with the grower occasionally especially early on, to make sure that germination (the most difficult stage) and early establishment has been successful. If problems occur, there might still be time to go to another grower or to adjust your planting date.

Wildings

Wildland harvested wetland plants are easily transplanted because of their well developed root systems. A rule-of-thumb is to dig no more than 1 ft² of plant material from a 4 ft² area. It is not necessary to harvest deeper than 5 to 6 inches. This depth provides enough root mass to ensure good establishment at the project site while retaining enough of the transplants' root system below the harvest point to allow the plants to grow back into the harvest hole in approximately one growing season (Figure 5) or less.

Figure 5. Clumps of wetland wildings being harvested by shovel and placed in a galvanized metal bucket for transport. Photo by Aberdeen PMC staff

Transplants, or wildings, can be taken at almost any time of the year. PMC collections have been taken from March to October with little difference in establishment success. If plugs are taken during the summer months, cut the top growth to about 4 to 5 inches above the standing water height or 10 inches, whichever is greater. Research at Aberdeen PMC has shown that covering the cut ends with water will not kill the plant, but will significantly slow establishment and growth rates. The plants may die if left submerged for extended periods of time. Cutting the tops also increases the survival rate of transplants that are transported long distances.

Do not remove soil from the plug. Leaving soil on the plug increases the establishment rate by about 30%. Beneficial organisms commonly found on the roots of wetland plants are important in the nitrogen and phosphorous cycles. These organisms may not be present at the planting site. Conversely, leaving soil on the plug will increase the volume and weight of material transported to the planting site. There is also an increased risk of transporting weed seed to the planting site. The collection location should be inventoried to determine if the site is infested with weeds. If weeds are present, it is not a suitable donor site.

Four to six individual plant plugs can be obtained from a 1 ft² harvested clump. The plugs can either be chopped with a shovel very rapidly or they can be cut accurately with other tools so they will easily fit into predrilled, set diameter holes. Make sure the length of the plug is related to the saturation zone at the planting site. The bottom of the plug should be in contact with the saturation zone. Match the amount of water, or hydrologic zone, with the wetland plant species. See the appendix for information on the hydrologic zones that different plant species will tolerate.

Rhizomes

Rhizomes are horizontal underground stems that send out roots and above ground shoots from nodes. Many riparian – wetland species are rhizomatous including cattails (*Typha* spp.), bulrushes (*Schoenoplectus* spp.), and sedges (*Carex* spp.).

Rhizomes can be dug and divided into sections, taking care to keep at least one viable growth point or node on each section. Collected materials should be young and healthy.

Rhizomes should be collected early in the spring before plants break dormancy or at the end of the growing season when the plant reserves are at their highest. Rhizomes can be planted when harvested or stored in sand or peat moss for later use. Rhizomes should be kept shaded and cool (<40° F) until planting time. For planting, use the methods discussed previously in "Wetland Transplant Establishment".

Wetland Sod
Commercially produced "Wetland Sod" consists of native wetland plants hydroponically grown in coconut fiber (coir) that can be laid down to provide rapid plant establishment and immediate erosion protection (figure 6). Wetland sod can also be salvaged from wild donor sites. Because wetland sod consists of very mature plants, this technique can tolerate greater initial hydrologic stress.

Figure 6. Commercial Wetland Sod being harvested from production ponds. A well developed root system is one of the main advantages to this material type . Photo courtesy of North Fork Native Plants.

For wildland sod harvesting, a sod mat, as large as 8 feet long and at least 6 inches deep, is cut from a donor wetland area and placed into areas with matching hydrologic conditions. The mat is cut from the wetland with shovels and a front-end loader modified with a sharp-edged steel plate. Mats are loaded onto flatbed trucks for transport to the recipient wetland. The sod mats are then placed together in a bricklaying fashion on the soil surface of the prepared site, and secured with wooden stakes. Do not leave gaps between the sod mats. Best results are achieved if the soil is moist but well drained at the time of cutting. This reduces weight, helps the mat stay intact, and reduces "sticking" of the mat as it is being transferred on and off the transfer plate. Avoid areas that have unwanted weeds as sod mat donor sites. Incorporation of seed 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 before they occur.

Sod mats from natural riparian-wetland areas may be transplanted successfully at any time, but early season provides the best opportunity for future root growth, plant development, and stand establishment. Since relatively large areas of the donor wetlands are impacted, this method should be used primarily as a salvage technique.

Commercially produced wetland sod has the advantage of being easier to install and does not require the use of heavy equipment. Typically commercial wetland sod can be staked in place at anytime during the year as long as hydrological conditions are suitable. For riparian applications many designers like installation to immediately follow peak stream flow. Depending on stream flows and natural precipitation wetland sod may need to be irrigated the first growing season to ensure establishment.

WETLAND TRANSPLANT ESTABLISHMENT
It is easier to install transplant materials in saturated soil than dry soil. The soil should be super saturated so that a planting hole can be easily dug with a bare hand. Flooding the site prior to planting also allows the opportunity to determine if the watering system is working properly.

Figure 7. Greenhouse grown sedges being transplanted into semi-wet soil at a wetland site. Photo by Chris Hoag

Hand planting is more successful (and easier) with fine textured soils than with coarse textured soils (Figure 7). Plug trays can be placed in Styrofoam coolers for transport (lid is not required).Cover the roots with water while in transit then drain off most of the water at the planting site so the cooler will float. The cooler can be used to move the plugs around the

wetland as you plant. Select a spot in the wetland to place a plug. Dig the hole deep enough for the plug. Push the plug into the hole and pack soil around it with your hand. Ensure all roots are covered with soil. Start at one end of the planting site and work toward the opposite end.

Figure 8. In one to two growing seasons, the majority of the open space has been closed by rhizomatous spread. Photo by Chris Hoag

Aberdeen PMC research on plug spacing indicates that most wetland plants will spread at least 9 to 12 inches in a growing season. If the project budget does not allow for the purchase of enough plants to cover the wetland bottom, plugs can be planted on 18 inch centers. Also consider planting them in copses, groups or patches that are about 10 ft^2. Space the copses about 10 feet apart. The copses can be planted to different species according to the site hydrology. Over time, the plants will spread into the unplanted areas.

The planting window for wetland plants is quite long. In southern Idaho, plugs have been planted from early April through late October with good success. Planting plugs in late fall or winter may result in high mortality due to frost heaving in heavier textured soils.

The availability of water is critical. Wetland plants like it hot and wet and tend to spread faster with hoter temperatures. It takes plants longer to initiate growth if planted in early to mid spring; however this creates a longer establishment period for root and shoot development. Fall planting generally results in lower establishment success because of the shorter growing season and potential frost heaving damage.

Wetland plants can be successfully established in a variety of soil textures from heavy clay with no organic matter to coarse gravels. The biggest obstacle with planting in gravelly or rocky soils is digging the holes. Soil texture will often dictate what equipment can or should be used at a given site. In clay bottoms, a small bulldozer or tractor with a ripper tooth can be used to dig lines across the bottom about 8 inches deep where wetland plugs can be placed.

WATER MANIPULATION

Young plants developing from seed or plant fragments do not have the same flood-tolerance as mature plants of the same species. They are not tolerant of complete inundation, particularly during the first growing season. Establishment success of herbaceous emergents, shrubs and trees is often increased if water levels are controlled and fluctuated if possible the first growing season to allow only short flooding and inundation periods (Figure 9).

Water management is also important throughout the life of the wetland for proper plant community management. When designing a wetland project, the design engineers should thoroughly understand the importance of water control to the establishment, management, and overall function of the vegetation in the wetland system. If hydrologic control (control of the amount of water coming in and going out of the system) is not built into the system from the start, plant establishment may be severely inhibited and opportunities for future plant community management will be handicapped.

After planting, slowly release the water into the wetland. Young plants have not fully developed the aerenchymous (air filled) tissue necessary for them to survive in anaerobic soils and standing water. The aerenchymous tissues in the plant shoots allow a supply of oxygen to the roots, so it is important to not raise the water over the top of the establishing emergent vegetation. After planting, water should be raised to no more than about 1 inch above the soil surface. Too much water at this time may stress the young plants. Maintain the water at about 1inch for a few days. This will inhibit the germination and growth of any terrestrial species that may be present in the wetland. The water level can then be lowered to the soil surface for 2 to 3 weeks. This will expose the mud surface, stimulating wetland seeds that were brought in with transplants to germinate and increase the rate of establishment and spread of the transplants. Then raise the water level 1 to 2 inches for another few days followed by lowering the water to the substrate

surface for another 2 to 3 weeks. After this period, slowly raise the water level to 4 to 6 inches for a few days. Then dry down again as mentioned earlier.

If the plants are not showing stress, continue to carefully raise the water level to as much as 12 to 20 inches deep if possible. These suggested water level depths should be modified based on the species and size of plants used. Some species will not tolerate inundation at these suggested depths or durations. When in doubt, defer to the hydrology conditions at natural reference sites where the species occurs. The goal here is to inundate the transition zone between wetland and upland as much as possible to control invading terrestrial species. After about 2 to 3 weeks, lower the water level to about 2 to 3 inches.

For the rest of the growing season, adjust the water level to maximize the desired community type. The key to determining the appropriate water level is to monitor the emergent wetland plant community. Raise the water level if weed problems arise. Lower the water level to encourage emergent wetland plant growth and spread. The key is to fluctuate the water level. Natural wetlands rarely have a constant water level. Under stagnant conditions, many species that cannot tolerate a constant water level will begin to die, and species more tolerant to standing water will increase. The plant diversity that was so carefully planned may be lost.

Management during the establishment year is critical to ensure the plants do not get too much or too little water. Weed control is important especially during the establishment year because of the low water levels and exposed, non-vegetated areas. A good weed control plan needs to be in place before planting. Monitoring the planting for 3 to 5 years after the establishment year will help maintain the planting, and will provide useful information for future plantings.

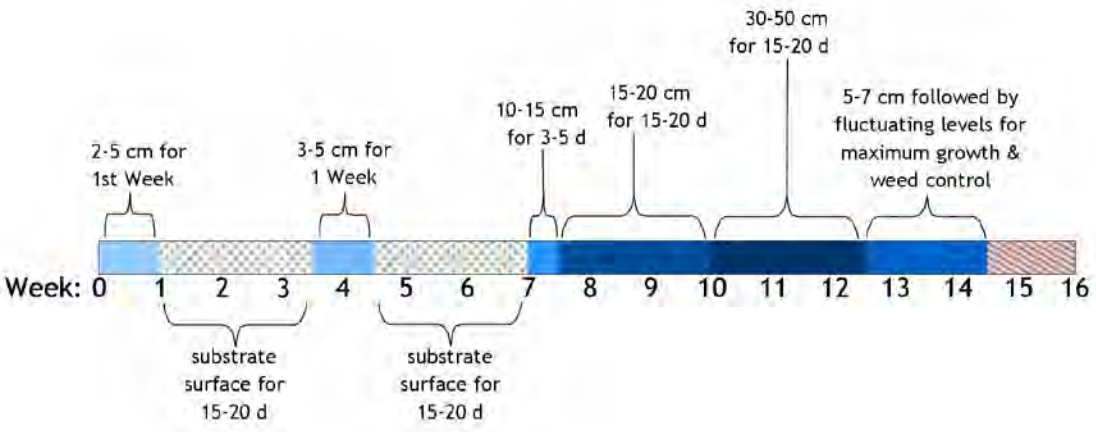


Figure 9. Timeline showing a series of flood and draw-down periods for successful herbaceous wetland plant establishment. Fluctuating water levels encourage wetland plant growth and eliminate terrestrial weeds from planting sites.

SUMMARY

A riparian-wetland restoration, enhancement or development project should include baseline data, a good design, evaluation criteria and methods, a monitoring plan, and a management plan. Clear objectives and goals provide benchmarks for project assessment.

Some replanting may be necessary to ensure a fully vegetated stream bank or wetland in a short time frame. Use native locally grown seed or plants if possible, to improve stand establishment and persistence. Maintenance and monitoring recommendations can be found in Bentrup and Hoag (1998).

Prescribed grazing is recommended if the site is located in a grazing management area. Defer grazing for 1 to 2 growing seasons to allow full stand establishment. Long-term grazing management should employ systems that control the time period and duration of grazing to assure the planting will meet management objectives. Temporary fencing and offsite livestock water development may be used to facilitate management of the site.

All wetland restoration or development project plans should be developed to meet NRCS Standard and Specification guidelines.

Plant Data Sheets

American Sloughgrass
Beckmannia syzigachne

American sloughgrass. Gary Larson. USDA NRCS. 1992. *Western Wetland Flora: Field office guide to plant species.* Courtesy of USDA NRCS Wetland Science Institute.

Alternate Names
Slough grass; western sloughgrass

Description
General: Grass Family (Poaceae). American sloughgrass is a cool season annual or short lived perennial C-3 grass that is commonly found in shallow marshes or sloughs. Its shallow root system supports a leafy stem, which may be as tall as one meter. American sloughgrass is classified by most floras as an annual species; however, there are reports of American sloughgrass over wintering in several plots and nurseries at Brookings, South Dakota. The branched inflorescence is classified as a closed panicle. The spikelets have very short pedicels and are arranged on only one side of the panicle branches. Spikelets disarticulate below the glumes, and are one or two flowered.

Distribution
American sloughgrass is widespread in the cooler parts of Eurasia and North America in marshes and ditches throughout the northwest and north central states and is occasional in the northeast.

Uses
American sloughgrass is palatable to all classes of livestock and is frequently hayed or grazed. American sloughgrass is a forage grass of some prominence west of the Mississippi River. Forage nutritional data indicate it is high in protein and nonstructural carbohydrates.

It colonizes denuded wetland soils resulting from mud flat exposure. Its seeds provide food for migratory water fowl. The variety 'Egan' was selected and released for wetland restoration and erosion control in Alaska.

Adaptation
American sloughgrass is adapted to conditions in the northern United States and southern Canada, Alaska. American sloughgrass is well adapted to low, irrigated, alkaline soil, and is classified as a preferential halophyte which exhibits its best growth on saline soils, but will also grow on non-saline soils. It performs best on clay soils covered by a shallow layer of organic matter. American sloughgrass found grows in association with wetland species such as needle spikerush (*Eleocharis acicularis*), arrowhead (*Sagittaria* spp.), *and milkwort* (*Glaux maritima*).

Establishment
Propagation of American sloughgrass via seed is the preferred method since there aren't any dormancy restrictions that inhibit rapid and uniform germination. The planting site should be prepared and tilled to discourage weeds during the establishment period. Late fall planting is recommended to allow fall establishment, or a dormant seeding, which would promote early spring establishment. The free flowing spikelets present no difficulty for conventional planting equipment. Spikelets should be planted at a depth of 0.3 to 0.6 inches deep in the soil.

Management
Stands tend to decline after 4 or 5 years due to competition when more aggressive grass species become established in the American sloughgrass stand. Seed shatter prior to harvesting remains a moderate problem. The Alaska Plant Materials Center has found that if 'Egan' is grown on upland farm land without irrigation, the plants will be stressed to the point of disease onset.

Plant Production
Panicles of American sloughgrass bagged to prevent cross pollination exhibited 100% seed set. This would indicate that it is a self pollinated species and probably does not depend on much out crossing for sexual reproduction.

Low seed viability and poor germination rates have been reported for American sloughgrass. Plant propagation in the greenhouse may require initiating germination under alternating temperature conditions for some ecotypes.

At Pullman, Washington, seed is sown in the greenhouse in 10 cu. in. Ray Leach Super cell conetainers filled with Sunshine #1 and covered lightly. Head space of ¼ to ½ inch is maintained in conetainers to allow deep watering. A thin layer of pea gravel is applied to prevent seeds from floating. Conetainers are watered deeply. Trays are placed in the greenhouse under lights for 8 hours at 72 to 75° F, and then moved to a side room at 50° F for 16 hours in the dark. Alternating temperatures are continued in this manner for 2 weeks, and then the trays remain in the greenhouse at constant temperatures. Since the seed is covered, it is unlikely that light has an effect on germination. The planting medium is kept moist until germination occurs. Germination usually begins in 10 days and is complete in 15 days.

Cultivars, Improved, and Selected Materials (and area of origin)
'Egan' American sloughgrass was named and released as a cultivar by the Alaska Plant Materials Center at Palmer, Alaska in 1986. The original seed collection was made by James R. Stroh, July 26, 1973. The seed was harvested from a single plant growing on a gravel road fill site off Steese Highway in Gold Stream Valley, North of Fairbanks, Alaska. The name Egan was selected in honor of William A. Egan, the first and fourth Governor of the State of Alaska. Governor Egan signed into law the act creating the Alaska Plant Materials Center in 1972. Breeder and Foundation seed production will be maintained by the Alaska Plant Materials Center. Foundation class seed will be available from the Alaska Seed Growers, Inc. to seed growers for the production of certified class seed.

Bluejoint Reedgrass
Calamagrostis canadensis

Bluejoint reedgrass. Photo by Robert H. Mohlenbrock USDA SCS 1989. Midwest Wetland Flora

Alternate Names
Bluejoint or Macoun's reedgrass

Description
General: Grass Family (Poaceae). Bluejoint reedgrass is a tall, erect, cool season perennial C-3 grass that is found in wet meadows and prairies. The creeping rhizomes and rootstocks of this species result in natural stands having a hummocky, uneven appearance. The erect stems are slender and not branched and can be 3 to 6 feet tall. The leaves are elongated and very narrow, with a bluish green color and are rough to the touch. The caryopses are ellipsoidal, yellow-brown, smooth, and about 0.04 to 0.06 inches long. The inflorescence is an open panicle with a caryopsis borne singly in each spikelet. Bluejoint reedgrass flowers from June to August and is wind pollinated.

Distribution
Bluejoint reedgrass has a distribution from Greenland to Alaska south to North Carolina, Kansas, and California.

Habitat: Bluejoint reedgrass survives best in moist to saturated soils, but not soils inundated by water. The species has an extremely broad distribution and a wide ecological amplitude occurring in diverse wetland areas. Bluejoint reedgrass is typically a subdominant species in sedge (*Carex*) meadows, and occurs in open woods, especially after fire and logging. Other grasses associated with *Calamagrostis* include Prairie cordgrass (*Spartina pectinata*), American sloughgrass (*Beckmannia syzigachne*), common rivergrass (*Scolochloa festucacea*), and fowl bluegrass (*Poa palustris*).

Uses
Bluejoint reedgrass is a wetland species that has forage value for deer, bison, and cattle. It produces good quality hay when harvested prior to heading. Forage quality is highest about three weeks before boot stage. It also has value as a food for waterfowl.

Adaptation
Mature bluejoint reedgrass stands tolerate thick build up of litter and mulch. This species occurs in highly organic peat and clay soils, but prefers a silt type soil. This species is adapted to a variety of temperature (-40 to 105° F) and precipitation regimes. It stands up well to winter conditions and is extremely winter hardy. The species demonstrates broad ecological amplitudes occurring in lowland wetlands to windswept alpine ridges. It has a wide pH tolerance (pH 5 to 8) from acidic soils to more alkaline water. It can tolerate fresh to slightly brackish water.

Establishment
Seed is more commonly used for revegetation projects than vegetative materials. Seed production is highly variable among ecotypes and low production results in higher seed costs. Panicles can be collected by hand in wetter sites and combined on drier sites. Panicles should be harvested before seed shatter for maximum seed production. There are approximately 3.5 to 4.0 million seeds per pound. Obtaining clean seed of C*alamagrostis* are difficult due to the tufts of hairs attached to the lemma bracts. Panicles are threshed with a hammer mill to remove lemmas and hair tufts from lemmas. Seed fed into a hammer mill operating at 1200 rpm's with a 0.5 inch screen diameter round hole will dislodge 60 % of the caryopses from the lemmas and remove 25 to 30 percent of the hairs from the lemmas.

Seeds of bluejoint reedgrass do not appear to have any complicated germination requirements. *Calamagrostis* seed remains viable (greater than 84%) for at least two years after collection and storage. This species had no dormancy or after ripening requirements and germination is not improved by scarification, stratification or light treatments.

Management

Clipping can improve late season forage quality. Bluejoint seeds are much smaller than those of most other forage grasses and require specialized processing after harvest. Their small size results in generally poor seedling vigor, thus requiring very shallow seeding and effective weed control during establishment.

Heavy grazing and trampling by cattle breaks grass rhizomes and adds to soil compaction in wet meadows. Heavy grazing reduces stands of bluejoint which allows invasion by other wetland grasses, sedges, reeds, rushes, and smartweeds. The invasion of manna grass (*Glyceria grandis*) is the best indicator of grazing disturbance in the prairie pothole region.

Pests and Potential Problems

The nematode *Subanguina calamagrostis* invades the leaf tissue of the grass and forms galls that cause the leaves to become twisted and contorted. A fungus, *Dilophospora alopecuri*, also invades leaves of the grass due to the entry wound caused by the nematode.

Cultivars, Improved, and Selected Materials (and area of origin)

'Sourdough' bluejoint reedgrass is a cultivar developed by the Alaska Experiment Station for revegetation uses. 36 collections from the interior, western and south central Alaska were combined into a synthetic population to produce 'Sourdough'. The cultivar 'Sourdough' tolerates severe cold and wind under arctic and alpine conditions, and resists snow mold infestations. Breeder and foundation class seeds are maintained by the Alaska Plant Materials Center. Registered and certified class seeds are available through the Alaska Seed Growers, Inc.

WATER SEDGE
Carex aquatilis Wahlenb.

Water sedge (*Carex aquatilis*). Photo by Teresa Prendusi

Alternate Names

Leafy tussock sedge

Description

General: Sedge Family (Cyperaceae). Water sedge is a sod-forming perennial grass-like plant growing 6 to 40 inches tall. Plants arise singly or in groups connected by thick, long rhizomes. The stems or culms are triangular in cross section with leaves are borne on the lower half of the stems. The blades are 0.06 to 0.22 inches wide and can be shorter or longer than the culms. Each culm has a leaf-like, 1.2 to 7.5 inch long, bract subtending the inflorescence. The inflorescence consists of 1 to 3 staminate spikes above 2 to 3 pistillate spikes, often with some androgynous (male and female spikes with male flowers above the female) transitional spikes. The terminal staminate spike is 0.4 to 1.4 inches long. The pistillate spikes are 0.6 to 1.8 inches long and 0.12 to 0.20 inches wide. Each fruit (achene) is subtended by a lanceolate to rounded, blackish or black purple scale, shorter to longer and narrower than the perigynia. The scale has a green to pale brown midrib. Each achene is enclosed in a perigynium, a leathery sack-like structure. The perigynia are 0.08 to 0.13 inches long. The achenes are lenticular (lens shaped) with 2 stigmas.

Distribution

Water sedge is a circumboreal species. In North America it occurs from the Arctic to as far south as California, Arizona, New Mexico and Virginia.

Habitat:

Water sedge occurs in wet and boggy meadows, stream banks, and pond and lake margins. It is often found with other wetland herbaceous species including other sedges (*Carex* spp.), rushes (*Juncus* spp.), and bulrushes (*Schoenoplectus* spp.). It can be found in large monoculture stands and also in open areas of riparian sites associated with willows (*Salix* spp.) and cottonwood (*Populus* spp.) plant communities.

Uses

Grazing/rangeland/pasture:

Water sedge stays green late into the summer providing good forage when other food sources have gone dormant. Livestock utilization of water sedge is dependent on the time of year and other available forage. It is listed as good palatability for cattle, domestic sheep, and horses with fair nutritional value.

Wildlife:

Water sedge is grazed by numerous species of geese, swans and other waterfowl. The vegetation also provides a source of cover. The plants are eaten by bison, caribou, mule deer, white-tailed deer, and elk. Water sedge sod forms overhangs along streams providing cover for fish.

Erosion control:

This species has exceptional value for shoreline erosion control due to its prolific rhizomatous root system. It has also been used to revegetate mined peatlands.

Ethnobotanical:

Water sedge has been used by several North American native peoples for various purposes. The Gosiute Indians boiled and ate parts of the plant, while Alaska natives ate raw stem bases. The Hesquiat Tribe also used the leaves for basket fiber.

Adaptation
Water sedge can be found from sea level to over 11,000 feet in elevation. It is adapted to temperatures reaching as low as -4° F. Water sedge grows in sites where the water table is near the soil surface in the toe and bank zones, and can withstand 1 to 2 months of submersion. This species is shade intolerant; it likes open disturbed areas. Depending on the site, water sedge can act as a pioneer or climax species.

Establishment
Wild plants can be collected and transplanted directly into the desired project site. Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site and the hole left at the collection site may fill with undesirable species.

For wetland plantings using greenhouse grown transplants or wildings, plant at 0.5, 1 or 2 foot spacing for uniform ground cover in 1, 2 and 3 years respectively. Seedlings can be hand-planted or dibbled into moist soil or standing water.

Management
The soil should be kept saturated with no more than 1 to 2 inches of standing water until the plants are well established and the aerenchymous material (the above ground biomass) is about 12 inches tall. Fluctuating water levels during the establishment period may speed establishment and spread. Water levels can be managed to enhance rhizome spread and to control weeds.

Seed and Plant Production
Water sedge is wind pollinated and primarily cross pollinated. Flowers bloom from late May to September depending on latitude. It reproduces is largely asexual via spreading rhizomes. Seedling recruitment occurs, but is infrequent.

Collection and Cleaning: Seed is most commonly collected by hand. Fruiting heads can be cut from stems using shears or a hand scythe. Seed is hard and brown when ripe.

Seed is air dried in paper sacks for several weeks prior to processing. Seed is removed from stem using a hammer mill with a 0.25 inch screen. Seed is then pre cleaned using a small-lot air screen cleaner with a 0.07 inch screen to remove stems and other inert matter. The perigynium is then removed from the seed using a corrugated rubbing board or hammer mill and then re-cleaned with a 0.06 inch screen and light air. Purities of over 95% are typical. There are approximately 450,000 seeds/lb with perigynium still intact, and 900,000 seeds/lb with perigynium removed.

Greenhouse Plant Production: A 30 day cold/moist stratification may be used, but research at the Aberdeen Plant Materials Center shows that this is not necessary with hot temperatures and high moisture levels. For 10 in^3 conetainers, place 5 to 25 seeds on the soil surface and press the seed in for good seed-to-soil contact. Seed should not be covered with any soil or sand, but kept moist with an overhead mist irrigation schedule of 2 minutes/hr from 9:00 am to 5:00 pm for the first 30 days. Day time greenhouse temperatures range from 90 to 110° F. Night time temperatures average around 85° F. Grow lights are kept on during nighttime hours. First emergence occurs around 5 to 7 days after planting. Full stands (90 to 100%) are reached in 12 days.

After full establishment, plants can be fertilized once per week with Miracle Grow All Purpose Plant Food (15-30-15). After 30 days the irrigation amount should be increased to 3 minutes/hr from 9:00 am to 5:00 pm and grow lights are turned off. Greenhouse day time temperatures are reduced to 85 to 90° F. Plants are ready for transplanting in 3 months.

Cultivars, Improved, and Selected Materials
Wild collected seed is commercially available, but there are no known releases of water sedge.

Nebraska Sedge
Carex nebrascensis

Nebraska sedge inflorescence with pistillate (female) spikes below and staminate (male) spikes above.

Description

General: Nebraska sedge is a native, perennial, heavily rhizomatous wetland plant. It forms a dense deep root system with up to 0.6 lb/ft² of root biomass in the top 8 inches of the soil. The stems are upright and triangular. The plants growing in saturated soils will grow to about 35 inches. The leaves are longer or shorter than the stem, up to 0.5 inches wide, and often with a bluish tinge. The flowers are borne in spikes. Male and female spikes are usually separate and on the same plant (monoecious). One or two male spikes are found above the female spikes. They are narrowly cylindrical and up to 2 inches long. There are 2 to 5 female spikes, 0.5 to 2 inches long and the lowest spike is subtended by a leafy bract. Plants flower in June to August. The fruits are brown lenticular (lens shaped) achenes, up to 0.08 inches long. Seed ripens in August to September. They are surrounded by a "leathery capsule" called a perigynium. Perigynia are elliptic to ovate, 0.12 to 0.16 inches long and yellowish brown to light brown in color. There are approximately 1.2 million perigynia/lb. The perigynium is not held tightly in the seed head and high winds and frost will cause the perigynia to drop off.

Nebraska sedge seed which has been processed to remove the perigynia. Some remnant perigynium pieces can still be seen. Photo by Derek Tilley

Distribution

Nebraska sedge is common throughout the western Midwest and western United States.

Uses

Wildlife and Livestock: Nebraska sedge is a valuable forage species used by big game and livestock. The annual production and nutrient levels are quite high. It has half the protein level of alfalfa. It provides cover for nesting waterfowl, seeds for small mammals and birds, and muskrats and geese graze the shoots. It can be used as a key species to determine grazing pressure. It has moderate to good palatability early in the season, but becomes tough in late summer.

Conservation Uses: This species has utility for erosion control, constructed wetland system applications, wildlife food and cover, wetland creation and restoration, and for increasing plant diversity in wetland and riparian communities. Its dense root mass (1,400 inches of roots per cubic inch of soil) makes this species resistant to soil compaction and erosion. It also makes it an excellent choice for soil stabilization in wetland and riparian sites. Nebraska sedge is used extensively in bioengineering techniques, because of its root system. The rhizomes also form a matrix for many beneficial bacteria making this plant an excellent choice for wastewater treatment.

Adaptation

Nebraska sedge is an obligate wetland species. It grows in areas that are saturated, and can handle standing water for long periods as long as there are periods where the soils dry. The sites where it is found rarely have the water table drop more than 1 m below the root zone late in the growing

season. It can tolerate total inundation for about 3 months. Nebraska sedge tolerates alkaline conditions very well.

Establishment
Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 12 to 18 inches will fill in within one growing season. The soil should be kept saturated with no more than 1 to 2 inches of standing water until the plants are well established and the aerenchymous material (the above ground biomass) is about 1 foot tall. Fluctuating the water level during the establishment period may speed establishment and spread. Water levels can be managed to enhance rhizome spread and to control weeds.

Management
The soil should be kept saturated with the water table rarely dropping below the root zone. This species can tolerate periods of drought and total inundation. Water levels can be managed to control terrestrial weeds.

Seeds and Plant Production
Collection and cleaning: Seeds may be collected by hand striping the seed from the plant or clipping it using a pair of hand shears. A power seed harvester may also be used. The perigynia is often mistaken for the seed. In many cases, especially if there is a frost during flowering, the seed will not fill, but the perigynia will still form. It is recommended the collector open several perigynia to see if it actually contains a seed.

A hammer mill can be used to break up large debris and knock the seed loose from the stem. Cleaning can be accomplished using a seed cleaner with a No. 8 top screen and a No. 20 bottom screen. Screens should be sized so desired seed will fall through and debris and weed seed are removed. Air velocity should be adjusted so chaff and empty perigynia is blown away. Air flow and screen size may require adjustment to optimize cleaning process for given situation. Once the seed is cleaned, the perigynia must be removed. It can be removed with a seed scarifier or a sandpaper box. The seed is then re-cleaned using the top and bottom screens to separate the seed from the empty perigynia.

The germination rate may be enhanced by removing the perigynia and by stratifying the seed in a mixture of water and sphagnum moss at 35° F for 30 days. Seeds need light, moisture, and heat for germination. Place seeds on surface of soil and press in lightly to assure good soil contact. Do not cover seed. Soil should be kept muddy. Greenhouse should be kept hot (90 to 100° F). Germination should begin within about one week. Maintain moisture until plants are to be transplanted.

Wild transplants: Wild plants can be collected and transplanted directly into the desired project site. As long as no more than approximately 2 ft^2 and 5 to 6 inches deep is removed from any 10 ft^2 area, the hole will fill in within one growing season. Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site and the hole left at the collection site may fill with undesirable species.

Pests and Potential Problems
Few insect or disease problems have been encountered in the greenhouse. Aphids will feed on the stems, but little or no damage has been noted and the vigor of the plant has not been affected.

Cultivars, Improved, and Selected Materials (and area of origin)
The Aberdeen PMC has released four performance tested ecotypes of Nebraska sedge from the PMC service area. Centennial Selection was collected from the Centennial Marsh Wildlife Management Area (WMA) in Camas County, ID and was selected for use in Land Resource Region (LRR) B West. The Modoc Selection was selected for use in LRR D North. It was collected from the Modoc National Wildlife Refuge (NWR) near Alturas, CA. The Sterling Selection comes from the Sterling WMA, north of Aberdeen, ID and was selected for use in LRR B East. The Ruby Lake Selection was selected for use in LRR D South. The collection site was at the Ruby Lake NWR in Elko County, NV. Generation 0 (G0) seed is maintained at Aberdeen PMC. Later generation seed is not produced, maintained or available through the USDA-NRCS Plant Materials Center. To make collections of these Nebraska sedge releases, contact the appropriate managing agency for the original collection site.

TUFTED HAIRGRASS
Deschampsia caespitosa

Tufted hairgrass. Photo, courtesy of Christian Fischer.

Alternate Names
Salt and pepper grass, tussock grass, blue-green hairgrass, fescue-leaved hairgrass.

Description
General: Grass Family (Poaceae). Tufted hairgrass is a native perennial cool season bunchgrass with mostly basal leaves that grows 8 to 60 inches tall. The panicle is 2 to 20 inches long, loose and open, sometimes nodding, shiny, and glossy. Spikelets are 2-flowered, usually shiny, and purplish to tawny. Spikelet branches are thin but stiff and rough to the touch. Glumes are lanceolate, acute, glabrous or scaberulous. The glumes are 0.12 to 0.20 inches long. Lemmas are 0.08 to 0.16 inches long, and often purplish at the base with callus hairs. The palea has a bifid tip, with a twisted and slightly geniculate awn that is 0.16 to 0.24 inches long.

It is a highly variable species with widely varying taxonomic treatments. The species can be very long lived, with individual tussocks surviving 30 years or more. In North America, low elevation coastal types are often much larger, coarser, and more robust compared to interior and alpine or subalpine populations.

Distribution
Tufted hairgrass has global distribution in moist arctic and temperate regions of the world. In North America, it occurs from Greenland to Alaska and south in the western United States into Northern Mexico. It has limited distribution in the Black Hills and northern Great Plains. It is found from Minnesota to Maine and south to Iowa, Illinois, Ohio and Georgia. Some European populations have been introduced to North America and it is cultivated in Hawaii.

Habitat
Associated plants commonly found growing with tufted hairgrass include sedges, rushes and bentgrass. In western North America tufted hairgrass may dominate plant communities above treeline. It occurs along moisture gradients from the middle of lee slopes with early melting snowdrifts to the bottoms of lee slopes with very wet meadows. Tufted hairgrass culms and leaves are often killed by wildfire but root crowns generally survive all but the most severe fires.

Uses
Grazing/haying: In the Rocky Mountain and Intermountain regions of North America, tufted hairgrass provides good to excellent forage for all classes of livestock and is often cut for hay from native meadows. Hay yields can be as much as 1.5 tons per acre. In western Oregon and Washington, yields of 1.5 to 8.5 tons per acre have been reported.

Forage palatability for livestock is rated fair to good, and the nutritional energy value is fair and protein value is poor. On rangelands in California, cattle readily consume tufted hairgrass prior to maturity. Due to its tendency to grow in cool, moist environments, it remains green and succulent throughout the growing season and is grazed readily during the summer. However, it is considered a species of lower forage value in low elevation coastal environments of Oregon, Washington and California. It withstands grazing and trampling very well.

Restoration and reclamation: It is used for restoration of moist to seasonally wet meadows and freshwater wetlands, and for stabilizing disturbed stream banks, canals, shorelines and upper tidal marshes. It is also used for acid and heavy metal mine spoil reclamation, alpine and boreal revegetation, grassed waterways, turf, and ornamental applications.

Wildlife: Utilization by deer, elk, antelope, bison, bear, horses and rabbits is variable. Cover and food values for small mammals, birds and waterfowl are rated poor to good, depending on wildlife species and location. Tufted hairgrass is a larval food plant for several butterfly species in North America and is a host for at least 40 species of moths and butterflies world-wide.

Adaptation

Tufted hairgrass occurs from sea level to 14,000 feet elevation on moderately moist to seasonally flooded, water logged sites in 20+ inch annual precipitation zones. It prefers full sun but can be found in partially shaded environments (rarely found under dense shade) with a wide variety of soil types from gravel to clay textured soils and soil pH ranging from 3.5 to 7.5. Some populations have strong tolerance to heavy metals and high soil acidity. Salinity tolerance is generally considered low, but plants occurring in upper tidal marshes may be more salt tolerant. Some populations also tolerate sites with low fertility.

Establishment

Tufted hairgrass has approximately 1,300,000 seeds per pound. The recommended full seeding rate is 1.5 pounds pure live seed (PLS) per acre. Seed that has been delinted (hairs and awns removed from the hulls by a debearder or brush machine) flows more readily and precisely through standard drills and broadcast seeders.

The species is slow to establish the first year but can dominate a site by the third year if seeding rates are heavy (2 to 3 pounds per acre). If used as a component of a seeding mix, adjust to percent of mix desired and it should be limited to no more than ¼ to ½ pound per acre if species diversity is a goal. For critical area or broadcast seeding, double the seeding rate. The seedbed should be firm and weed-free. Weeds should be controlled by mechanical cultivation or with herbicides prior to seeding.

Most seeding in interior or alpine regions is accomplished in late fall or early winter as a dormant planting as most sites are too wet during the spring and early summer. Some populations, particularly alpine seed sources, can have dormant seed and benefit substantially from 45 to 90 days of cold moist stratification. In certain areas, including coastal, low elevation regions with milder winters, sowing non-dormant seed is done in spring, late summer, or early fall depending on rainfall patterns and soil moisture conditions. Because of the small size of the seed and the advantage of sun light which enhances germination, shallow seeding depth (0 to ¼ inch) or only a light mulch covering is recommended. Starter fertilizers are generally not recommended for reclamation or restoration plantings where soils are well developed. However, establishment on highly eroded or depleted sites can benefit from soil amendments and fertilization based on a soil test, and high seeding rates. For reclamation of sites contaminated with heavy metals or acidic soils, it is recommended to use seed sources from similar sites.

Tufted hairgrass seed. Steve Hurst @USDA-NRCS-PLANTS Database.

Management

Tufted hairgrass is slow to establish the first year but can dominate a site by the third year if seeding rates are high and conditions allow. Once established, use a rotational, moderate use grazing system since this species often declines with continuous, season long use. Defer grazing each spring until soils are dry enough to prevent damage to the soils and plants and defer grazing at least one year after wildfire to allow recovery. Grazing practices should allow for ample seed set at least once every 3 to 4 years to maintain stands.

Species composition within tufted hairgrass meadows is very sensitive to changes in water

table. Lowering of the water table by channel cutting, poor road locations and drought have changed site potential and favored the expansion of Kentucky bluegrass (*Poa pratensis*) and perennial forbs in central Oregon. Raised water tables favor increase in sedge and rush dominance.

Pests and Potential Problems
Tufted hairgrass is susceptible to diseases including ergot, several rusts, stripe smut, blind seed, several leaf spots, rapid blight, and the turf disease, take-all patch. Insect pests include aphids, billbugs and leafhoppers.

Irrigation
In western Oregon, irrigation is seldom required for newly fall sown or established stands due to high precipitation between fall and spring. However, spring plantings require periodic irrigation throughout the first summer of establishment. In areas with lower precipitation or droughty soils such as the intermountain west, growing season irrigation may be required every year for stand maintenance and seed production. It is recommended that stands be irrigated prior to flowering (not during pollination if sprinkler irrigated) and after seed harvest. In the fall, soil moisture levels should be brought to field capacity by early September.

Plant Propagation
Tufted hairgrass can be established from transplants or sod. At the Aberdeen, Idaho Plant Materials Center, container (plug) plants are easily propagated in 10 cubic inch conetainers. Seed is pressed into the surface of a 1:1:1 mix of coconut fiber, compost and perlite and kept moist with an overhead mist irrigation schedule of 2 minutes per hour during the day and day time greenhouse temperatures of 90 to 110° F for approximately three months before out-planting.

Cultivars, Improved, and Selected Materials (and area of origin)
'Nortran' was developed by the Agricultural and Forestry Experiment Station of the University of Alaska – Fairbanks in 1986. It was selected from collections made in Alaska and Iceland that tolerate acidic soils, low fertility and cold and wet locations. It has the ability to reseed itself on disturbed lands, is persistent under continual cutting or foraging and may be resistant to many rusts and snow molds. Breeder and Foundation seed is maintained by the Alaska Plant Materials Center.

'Peru Creek' was released by the Upper Colorado Environmental Plant Center, USDA Forest Service and the Colorado Agricultural Experiment Station in 1994. The original source is from Summit County Colorado at an elevation of 11,300 feet. In comparison trials, Peru Creek was the only accession that produced large forage yields and viable seed on mine spoils with pH 3.2 to 4.0. Peru Creek is recommended for revegetation of high elevation sites with low pH (acid) soils. Breeder and Foundation seed is maintained by the Upper Colorado Environmental Plant Center.

Tillamook Selected Class Germplasm was released by the Corvallis, Oregon Plant Materials Center and the Oregon Agricultural Experiment Station in 2002. The original source is from a coastal estuary in Tillamook Co., Oregon, at an elevation of less than 10 ft. It was selected for high plant vigor, clipping response, and foliage appearance from collections made in western Oregon and western Washington. The germplasm is intended for erosion control and revegetation along freshwater and slightly brackish waterways in coastal zones of Oregon and Washington.

Willamette Selected Class Germplasm was released by the Corvallis, Oregon Plant Materials Center and the Oregon Agricultural Experiment Station in 2002. The original source is from Linn Co., Oregon, at an elevation of 225 ft. Selected from the same assembly of populations as Tillamook Germplasm, it also ranked high in plant vigor and clipping response among other factors. The intended uses include streambank and shoreline stabilization, revegetation of seasonal freshwater wetlands, and wildlife cover in the western interior valleys of Oregon and Washington below 1500 ft in elevation.

Inland Saltgrass
Distichlis spicata

Inland saltgrass. Photo by Linda lee, USC Herbarium

Alternate Names
seashore saltgrass, spike grass, alkali grass

Description
General: Grass Family (Poaceae). Inland saltgrass is a native, dioecious low-growing, perennial grass, with scaly rhizomes. Culms are erect, reaching up to 16 inches, but are typically shorter in dense colonies. Lower leaves consist of sheaths only, which are overlapping and glabrous. Leaves are mostly cauline and vertically two-ranked. Blades are firm with the edges often flat at the base and folded or rolled inward meeting in the middle, therefore, appearing attenuate. Blades are generally less than 2 inches long. The ligules are stiff, membranous and apically ciliate. Staminate spikelets are 6 to 14 flowered and yellowish. Pistillate spikelets are 3 to 10 flowered

Distribution
Inland saltgrass is found throughout most of North America from British Columbia and Saskatchewan in the north, and southward to California, Texas and Florida.

Habitat:
Inland saltgrass forms pure stands on saline wetland fringes and other saline sites including salt flats, desert playas, saline meadows, and ditchbanks. It often forms a dense sod in black greasewood communities; however, where soil salinity becomes greater than 1 percent, black greasewood yields to inland saltgrass.

Uses
Livestock: Due to its rigid stiff foliage, inland saltgrass is grazed only when other, more preferred forage has been eliminated. It has a low nutrient value.

Wildlife: Inland saltgrass is utilized by rodents and small birds for cover, nesting and feeding. Seeds are eaten by small mammals and waterfowl.

Wetland Restoration: The dense rhizomes and its ability to colonize depleted soils make this an attractive species for restoring saline wetlands, and for stream bank protection. Establishment is slow however, taking 2 to 3 years for site stabilization.

Adaptation
Inland saltgrass is adapted to saline, fine textured soils that are sub-irrigated or receive occasional inundation. The spreading rhizomes allow inland saltgrass to colonize disturbed and barren sites too saline for other grass species. Inland saltgrass is highly drought tolerant and tolerant of flooding, and burning.

Establishment
Inland saltgrass may be propagated by seeds, which are produced many times in a growing season and are dispersed by wind and water. However, it is more often propagated by its extensively creeping underground rhizomes. Rhizome cuttings should not be allowed to dry out. Under proper conditions, they may be stored up to 28 days. It is recommended that the rhizomes be stored in a temperature range of 35 to 50° F and in 60 to 75% relative humidity. Rhizomes are can be planted any time of the year at a depth of 1 to 2 inches. However, rhizomes sprout better at 77 to 86° F.

Management
Saltgrass can be managed by burning between September and February biannually, when the water level exceeds the soil surface. Following burning, four inches of re-growth should be

obtained before grazing is allowed. Water control systems may need to be installed to maintain correct water levels to avoid prolong inundation, which kills saltgrass. Cattle walkways are usually installed to make the forage more accessible.

Pests and Potential Problems
Saltgrass is the alternate host for the red rust (*Puccinia aristidae*, also known as *Puccinia subnitens*) that infects spinach. Although the red rust disease is difficult for shippers to detect, it grows rapidly during transit. Since little is known about this disease, there are no recommended control techniques. Saltgrass eradication has been the only method used so far because the pathogen cannot complete its life cycle without this alternate host plant.

Control
This species can behave invasively in some situations. Contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Cultivars, Improved, and Selected Materials (and area of origin)
'LK517f saltgrass' is a California native, perennial, warm season grass with extensive creeping, yellowish, scaly rhizomes forming large colonies. Establishment should be in late spring using rhizomes or plugs planted on one-foot centers. Irrigation water should be applied the first summer to ensure stand establishment. LK517f is used for riparian restoration and bank and shoreline stabilization.

CREEPING SPIKERUSH
Eleocharis palustris

Creeping spikerush. Photo by Derek Tilley

Alternate Names
Eleocharis macrostachya, common spikerush

Description
General: Sedge Family (Cyperaceae). Creeping spikerush is a perennial, heavily rhizomatous wetland plant that is found from low to mid elevations. It has a dense root mass that extends deeper than 16 inches in the soil profile. The stems are singular or in small clusters, upright, round, and may reach 48 inches in height (height is dependent on the depth of water in the growing environment). The leaves are reduced to sheaths clustered at the base of the stems. The flowers are borne in a terminal spikelet, 1 flower per scale with 2 stigmas. Plants typically flower from June through September. The seeds are yellow to brown lenticular achenes, 0.06 to 0.10 inches long including tubercle, and subtended by up to 8 bristles. The seed ripens in late August to October. Seeds are held tightly in the seed head for a long period of time.

Distribution: Creeping spikerush is found from the West Coast of the US, east to the Upper Peninsula of Michigan, and south to Louisiana.

Uses
Wildlife and Livestock: Creeping spikerush has moderately high protein content in the spring and good digestibility. The tops are heavily grazed by both livestock and big game animals, especially after the seeds have ripened. It produces nesting cover for waterfowl and ducks eat the seeds and geese graze the shoots.

Conservation Uses: This species has utility for erosion control, constructed wetland system applications, wildlife food and cover, wetland creation and restoration, and for increasing plant diversity in wetland and riparian communities. Its dense root mass makes this species an excellent choice for soil stabilization in riparian and wetland sites. The rhizomes also form a matrix for many beneficial bacteria making this plant an excellent choice for wastewater treatment.

Adaptation
Creeping spikerush grows in wet meadows, irrigation ditches, springs, seepage areas, freshwater marshes, rivers, and along lakeshores. It is a pioneering species that populates mud flats very quickly as the water draws down. It can grow in areas that are flooded in the spring and saturated in the fall and in flooded conditions where the water is up to 3 feet deep for most of the growing season. It is an obligate wetland species that prefers fine texture soils in neutral to alkaline or saline conditions. It spreads rapidly by rhizomes and occasionally seed. It will spread into areas that are too deep for seedling establishment. It will develop a thick root mass that is resistant to compaction and erosion; however, its roots grow less deeply than Nebraska sedge (*Carex nebrascensis*). It can fix atmospheric nitrogen and make it available to other plants in the wetland community.

Creeping spikerush grows on sites that are either permanently flooded or seasonally flooded. The plants can grow and thrive in permanent water up to 3 feet deep, or they can survive in areas where the water table drops to 12 inches below the surface late in the season. Creeping spikerush grows in areas that can be totally inundated for up to 3 to 4 months.

Establishment
Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 12 to 18 inches will fill in within one growing season.

The soil should be kept saturated. Allow no more than 3 inches of standing water at any time during the first growing season. Raising and lowering the water level during the establishment year will speed the spread of the plants. Water levels should be managed to enhance rhizome spread.

Management
Standing water should be no deeper than 3 feet and should fluctuate throughout the growing season. If deeper water levels are desirable, increase the depth slowly over the course of the growing season. This species can tolerate periods of drought and total inundation. Water levels can be managed to enhance or reduce spread as well as control terrestrial weeds.

Seeds and Plant Production
Collection and cleaning: Seeds may be collected by hand striping the seed from the plant or clipping it using a pair of hand shears. A power seed harvester may also be used.

A hammer mill is used to break up the large debris and knock the seed loose from the stem. Cleaning can be accomplished using a seed cleaner with a No. 12 top screen and a solid bottom screen. Screens should be sized so desired seed will fall through and debris and weed seed are removed. Air velocity should be adjusted so chaff is blown away. Air flow and screen size may require adjustment to optimize cleaning process for given situation.

Creeping spikerush seed. Photo by Derek Tilley

Special procedures: The germination rate may be enhanced by lightly scarifying the seed and then stratifying the seed in a mixture of water and sphagnum moss at 2°C for 30 to 45 days.

Greenhouse: Seeds need light, moisture, and heat for germination. Place the seeds on the surface of the soil and press in lightly to assure good soil contact. Do not cover the seed. Soil should be kept moist. The greenhouse should be kept hot (32°C to 38°C). Germination should begin within about one to two weeks. Maintain the moisture until the plants are transplanted.

Wild transplants: Wild plants can be collected and transplanted directly into the desired site. As long as no more than 4 dm2, 13 to 15 cm deep, is removed from any 1 meter square area, the hole will fill in within one growing season. Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site, and the hole left at the collection site may fill with undesirable species.

Pests and Potential Problems
Few insect or disease problems have been encountered in the greenhouse. Aphids will feed on the stems, but little or no damage has been noted and the vigor of the plant has not been affected.

Cultivars, Improved, and Selected Materials (and area of origin)
The Aberdeen PMC has released four performance tested ecotypes of creeping spikerush from the Intermountain West. The CJ Strike Selection was collected from the CJ Strike Wildlife Management Area (WMA) near Bruneau, Idaho, and was selected for use in Land Resource Region (LRR) B West. The Malheur Selection was selected for use in LRR D North. It was collected from the Malheur National Wildlife Refuge (NWR) near Burns, OR. The Mud Lake Selection comes from the Mud Lake WMA, north of Terreton, Idaho and was selected for use in LRR B East. The Ruby Lake Selection was selected for use in LRR D South. The collection site was the Ruby Lake NWR in Elko County, NV. Generation 0 (G0) seed is maintained at Aberdeen PMC. Later generation seed is not produced, maintained or available through the USDA-NRCS Plant Materials Center. To make collections of these creeping spikerush releases, contact the appropriate managing agency for the original collection site.

Mannagrass
Glyceria elata

Mannagrass inflorescence. Photo from swbiodiversity.org

Alternate Names
Glyceria striata

Description and Adaptation
Tall mannagrass is a long lived, cool season perennial bunchgrass with somewhat succulent stems (culms) that reach a height of 40 to 70 inches. The form is erect, robust, and clumpy despite the production of slow growing rhizomes or underground stems. Rate of spread may vary among populations. Leaf blades are soft, ribbon-like, 0.25 to 0.5 inches wide and 6 to 10 inches long. The flower head (panicle) is loose, broad, pyramid-like, and 3 to 10 inches long with spreading and drooping branches. Populations previously described for *G. striata* include plants that are shorter and tougher with smaller leaves (0.08 to 0.20 inches wide) and flower heads that are more closed. *G. elata* was primarily confined to the western states, but as *G. striata*, it occurs across most of North America.

Key to identification: Physical differences described between tall mannagrass and *G. striata* are inconsequential because they are now listed as the same species. Tall mannagrass can be easily confused with reed mannagrass (*Glyceria grandis*) which has smoother leaves and lack its slightly rough texture. Others mannagrasses are easier to distinguish, but a botanical key should be consulted.

Adaptation
Tall mannagrass widely occurs in bogs**,** seeps, wet woods, thickets or swampy areas, shaded ditches, and along or in streams. It may occasionally be found growing in full sun on summer damp soils as well as in standing water. Reportedly, this species is best adapted to freshwater, semi-aquatic habitats (*G. elata*) or those that are irregularly to seasonally flooded and saturated for up to 25 percent of the growing season (*G. striata*). However, local plants have thrived and flowered under continuous inundation (0.4 to 4.0 inches) for several years. Tall mannagrass tolerates open areas but prefers shady habitats. It may occur as single plants, small colonies, or larger stands that dominate the understory of ash swales as well as willow, aspen, and other wetland forest or shrub communities. Soils range from organic to mineral with a pH of 4 (acidic) to 8 (slightly alkaline). This species does not tolerate salinity and needs moderately good fertility. This species is very shade tolerant, similar to reed mannagrass, yet it can be grown in full sun to produce substantial seed.

Uses
Restoration: Mannagrass is a rapidly establishing native species suitable for restoration of swamps, the edges of marshes, ponds, and streams, and other wetland plant communities where an herbaceous understory is desired. It has versatility for use along creeks and ditch bottoms where exposure may vary from full sun to dense shade, thereby improving soil stability beyond the use of woody plants alone.

Wildlife: Where this species dominates, herbage production is high. Palatability of *G. striata* is rated good to very good for cattle and horses which consume both flower stems and leaves. It is rated fair to good for sheep which tend to use only the leaves. The seed is food for waterfowl and birds while the foliage and tall stems provide good wildlife cover. Foliage is seasonally grazed at a light to heavy rate by deer, muskrat, and bears. Elk make minor use of it as well. Tall mannagrass may be applicable to seeding mixtures targeted to improve species richness and exclude reed canarygrass (*Phalaris arundinacea*) prior to its invasion. It is occasionally planted as an ornamental in and around backyard ponds.

Establishment
The presence of seed dormancy may vary among populations. Seeds can germinate within 2 to 3 weeks without treatment but 14 to 30 days of cold moist stratification (moist pre-chilling) has resulted in faster but not necessarily higher germination rates. Others report the need for 150 days of stratification in cold water. Fall sowing is preferred if dormancy is known or uncertain. Seed hulls readily detach but removal is unnecessary. There are approximately 1,600,000 seeds per pound with hulls intact. A seeding rate of 1lb pure live seed per acre will result is about 37 live seeds per square foot. Seeding rates depend on methods used, objectives, and site conditions.

Management
Management considerations for utilization of *G. striata* by livestock may predictably apply to tall mannagrass. Sites where it occurs are typically too wet for grazing when the herbage is most succulent. Therefore, access must be deferred until late in the season when soils are drier and quality has declined somewhat. Tolerance to fire and heavy grazing is not well documented. Tall mannagrass can be grown for seed on upland sites with medium to fine textured soils if regular irrigation is applied in summer and fall.

Environmental Concerns
Some strains or populations of *G. striata* may contain cynogenetic compounds. Cyanide poisoning from it as well as reed mannagrass has been reported in cattle. Because tall mannagrass is now the same species or closely related, caution is advised for livestock utilization. Likewise, plant diseases that infect *G. striata* may apply to tall mannagrass. This includes the fungal pathogens *Epichloe glyceriae* which causes floral castration and *Ustilago striiformis*, better known as stripe smut. Fungicides may be needed for control. Consult with your local Extension Service agent, plant disease control handbook, or other experts for advice. Other species of mannagrass are described as weedy in certain crops or wet areas, but concerns for tall mannagrass are not widely known.

Cultivars, Improved, and Selected Materials (and area of origin)
Seed sources and plants are regularly available throughout much of the species natural range within the United States.

Baltic Rush
Juncus balticus

Baltic rush. Photo by Derek Tilley

Alternate Names

Description
General: Rush Family (Juncaceae). Baltic rush is a perennial, grass-like, rhizomatous, wetland plant. The leaf sheaths are clustered at the base, 0.8 to 6 inches long, multi-colored from red to light to dark brown, and bladeless. The lowest bract of the Baltic rush inflorescence is round, 0.8 to 8 inches long., and appears to be a continuation of the stem. The inflorescence forms a loose to compact panicle of 10 to 50 flowers up to 3 inches long. Flowers are greenish or brownish, sessile to pedicellate, each subtended by a pair of hyaline-scarious bracts. Tepals are 0.14 to 0.2 inches long. The seeds are brownish red and about the size of ground pepper.

Uses
Wildlife: Juncus species are used by a wide range of mammal and avian species for food and habitat. Rush seeds are eaten by waterfowl, songbirds, small mammals, jack rabbits, cottontail, muskrat, porcupine, quail, and gopher. Rushes help improve habitat for amphibians and spawning areas for fish. Muskrats feed on the roots and rhizomes of soft rush, and various wetland wading birds find shelter among the stems.

Livestock: Cattle generally do not graze rushes, because they have low palatability. Cattle will graze Baltic rush late in the season after more palatable plants are eaten. Rushes tend to be resistant to grazing pressure and fairly unpalatable to cattle, so tend to increase in species composition in stockwater ponds and troughs

Restoration/Erosion Control/Water Treatment: The rhizomatous nature, nitrogen fixation capabilities, dense root system, and phenotypic plasticity to flooding and drought stress provide high soil and slope stabilization capabilities, particularly in areas with flooded soils or fluctuating hydrology. The rhizomes form a matrix for many beneficial bacteria, making this plant an excellent addition for wastewater treatment.

Distribution
Baltic rush occurs throughout California to Alaska, eastern North America, and Eurasia. Baltic rush is the most widespread and common rush found in the Great Basin and dry Intermountain regions. It grows in standing water to seasonally dry places, with an elevation generally below 7,000 feet.

Adaptation: Baltic rush can tolerate shade and flooded, anoxic soil conditions, at least periodically. They can also tolerate mild to moderate soil salinities and alkaline to calcareous soils. Often these plants are found on drier or seasonally fluctuating wetland sites (for example, desert playas) and can tolerate seasonal drought.

Establishment
Juncus species may be planted from bare rootstock or seedlings from container stalk or directly seeded into the soil. Bare rootstock or seedlings are preferred revegetation methods where there is moving water.

Live Plant Collections: Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 12 to 18 inches will fill

in within one growing season. Soil should be kept from saturated conditions up to 3 inches of standing water. Manipulating the water level to rise and fall during the establishment period may speed spread. Water levels can be managed to enhance spread and control weeds.

To collect wild plants, no more than 1/4 of the plants in an area should be collected. A depth of 6 inches is sufficiently deep for digging plugs. This will leave enough plants and rhizomes to grow back during the growing season.

Clip leaves and stems to 6 to 10 inches; this allows the plant to allocate more energy into root production. Transplants should be planted as soon as possible in moist (not flooded or anoxic) soils. Plants should be transported and stored in a cool location prior to planting. Plugs may be split into smaller units, generally no smaller than 2.4 x 2.4 inches, with healthy rhizomes and tops. The important factor in live plant collections is to be sure to include a growing bud in either plugs or rhizomes. Weeds in the plugs should be removed by hand. Soil can either be left on the roots of harvested material or removed. For ease in transport, soil may be washed gently from roots. The roots should always remain moist or in water until planted.

Soil should be kept saturated after planting. Plants can tolerate 1 to 3 inches of standing water as long as the level fluctuates over the growing season. Allow roots to become established before flooding soils if possible. Ideally, plants should be planted in late fall just after the first rains (usually late October to November). This enables plant root systems to become established before heavy flooding and winter dormancy occurs. Survival is highest when plants are dormant and soils are moist.

Fertilization is very helpful for plant growth and reproduction. Many more seeds are produced with moderate fertilization.

Management

Hydrology is the most important factor in determining wetland type, revegetation success, and wetland function and value. Changes in water levels influence species composition, structure, and distribution of plant communities. Water management is absolutely critical during plant establishment, and remains crucial through the life of the wetland for proper community management. *Juncus* species can tolerate periods of drought and total inundation. It is important to keep transplanted plugs moist, not flooded, until roots are established. Water levels can then be managed to enhance or reduce spread as well as control terrestrial weeds.

Muskrats have evolved with wetland ecosystems and form a valuable component of healthy functioning wetland communities. Muskrats use emergent wetland vegetation such as *Juncus* species for hut construction and for food. Typically, an area of open water is created around the huts. Muskrat cleared areas increase wetland diversity by providing opportunities for aquatic vegetation to become established in the open water and the huts provide a substrate for shrubs and other plant species. Muskrats opening up the dense stands of emergent vegetation also create habitat for other species.

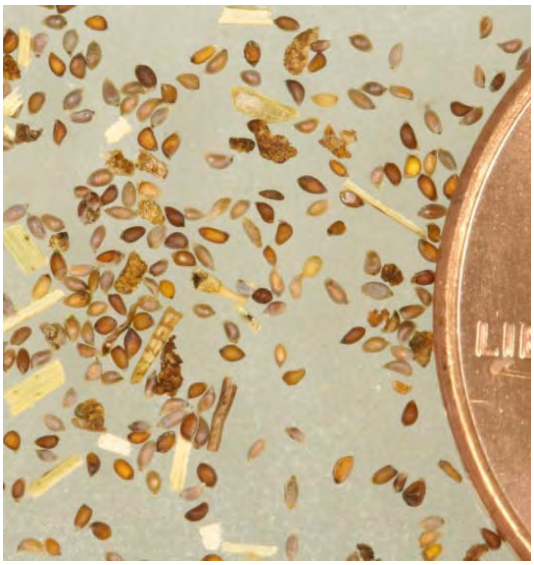
Juncus species tend to be fairly resilient to insect and disease problems. Aphids may feed on the stems, but rarely cause significant damage. Rushes are perennial, rhizomatous plants. In most cases, they will out-compete other species within the wetland area of the site, eliminating the need for manual or chemical control of invasive species.

Seed Collections

For Baltic rush near Aberdeen, Idaho, the flowering period is late May to August, occasionally to September. Seed ripens in early August. Phenology will differ with plant growing in different areas, and for different *Juncus* species.

Seed may be collected by hand, using a pair of hand shears, or with a gas-powered handheld seed harvester. The tiny, black seeds are easily lost from the capsules when collecting by hand. Be careful to keep capsules upright before putting in collection bag. Use paper sacks when collecting seeds for this species.

To clean the seed, run the collection through a hammer mill to break up debris and knock the seeds loose. Use a 1/20 inch screen on the top and a solid sheet on the bottom of the seed cleaner. Adjust the airflow to blow off the chaff. The cleaning process can be speeded up by shaking the hammermilled collection to settle seed to the bottom of the pan. The top portion of the chaff can then be discarded and the seed-rich mixture that is left in the bottom can be run through the seed cleaner.



Baltic rush seed. Photo by Derek Tilley

Seed germination in greenhouse

Seeds need light, moisture and heat for germination. Soaking the seeds in water for 1 - 7 days will decrease the time the seed takes to sprout. To grow seeds, place on soil surface and press in lightly to assure good soil contact. Do not cover the seed. Soil should be kept moist. Greenhouse should be kept hot 95 to 100° F.

Seeds begin to germinate in approximately 1 week. Maintain soil moisture until plants are to be transplanted. Seedlings cannot withstand long periods without water while growing in the greenhouse. Plants are ready in 100 to 120 days to come out as plugs. By planting seeds in August, plugs are ready to plant in soil by November. These plants are very small; growing plants to a larger size will result in increased revegetation success.

Cultivars, Improved and Selected Materials (and area of origin)

Baltic rush is available through selected native plant nurseries within its range. The Aberdeen PMC has released four performance tested ecotypes of Baltic rush from the PMC service area. Railroad Valley Selection was collected from the Railroad Valley Wildlife Management Area (WMA) in Nye County, NV. It was selected for use in Land Resource Region (LRR) D South. The Roswell Selection was selected for use in LRR B West. It was collected from the Roswell WMA near Roswell, ID. The Sterling Selection comes from the Sterling WMA, north of Aberdeen, ID and was selected for use in LRR B East. The Stillwater Selection was selected for use in LRR D North. The collection site was the Stillwater National Wildlife Refuge near Fallon, NV. Fourteen Baltic rush collections were evaluated at the Aberdeen Plant Materials Center from 1991 to 1995. All collections were evaluated for survival, vigor, overall growth and spread, potential seed production, above ground biomass production, stability of land ownership, and public accessibility. The PMC released one selection from each LRR in the PMC service area. The released selections are the accessions with the best overall rating against others from within its respective LRR. Generation 0 (G0) seed is maintained at Aberdeen PMC. Later generation seed (i.e. G1) is not produced, maintained or available through the USDA-NRCS Plant Materials Center. To make collections of these Baltic rush releases, contact the appropriate managing agency for the original collection site.

Hardstem Bulrush
Schoenoplectus acutus

Hardstem bulrush. Photo by Derek Tilley

Description
Hardstem bulrush is a perennial, rhizomatous wetland obligate species that can reach up to 10 feet in height and form dense stands. The stems are upright, gray-green to green, round, 0.4 to 0.8 inches thick and 3 to 10 feet high. The leaves are few and short, found at or near the base, and commonly have a well developed sheath. The inflorescence is a terminal panicle of 3 to 10 spikes which are made up of up to 50 or more spikelets. Each spike may be on a short pedicel or sessile. The inflorescence is exceeded by a 1 to 4 inch lateral bract. The fruit is a dark brown lenticular achene up to 0.1 inches long.

Distribution: Hardstem bulrush is widespread throughout North America, but is most common in the West.

Uses
*Wildlife***:** Livestock rarely use this species when the area is flooded. They will use it as roughage or in the winter under heavy snow cover because the stems stick out of the snow. Waterfowl will feed on the seeds and use the stands for nesting. Muskrats and beaver will eat the rootstocks and young shoots. Muskrats will use the stems for building their houses.

Water Treatment/Erosion Control: Constructed Hardstem bulrush's dense root mass makes this species an excellent choice for soil stabilization. Its above ground biomass will provide protection from erosive wave action and stream currents that erode shorelines or stream banks. The rhizomes also forma matrix for many beneficial bacteria, making this plant an excellent choice for wastewater treatment.

Adaptation
Hardstem bulrush is found at low to mid elevations (generally below 7500 ft) in marshes and along lake, reservoir, and pond shorelines. It forms large stands with the young plants on the outside and the older plants on toward the center. It is generally found in areas of standing water ranging from 4 inches to more than 8 feet in depth. It will not tolerate long periods with very deep water. Hardstem bulrush will grow on soils that range from peat to alkaline and silts to coarse substrates. It will grow and spread on alkaline, saline, and brackish sites and will resprout after fire. Burning will increase its production and protein content. Hardstem bulrush reproduces from seeds and rhizomes. It will spread more than 18 inches in one growing season. Seeds germinate readily on freshly deposited, fertile, moist soils.

Seed Collection
Seeds ripen in late August to September. Seeds are not held tightly in the seed head, and high winds, frost, and brushing against the seed head will cause the seeds to dislodge. Seeds may be collected by hand stripping them from the plant or by clipping the seed head using a pair of hand shears. A handheld power seed harvester may also be used.

Cleaning
A hammermill is needed to break up coarse debris and knock seeds free from the panicle. Cleaning can be accomplished using a seed cleaner with a No. 12 top screen and a 1/20 inch bottom screen. Screens should be sized so desired seed will fall through and debris and weed seed are removed. Air velocity should be adjusted so chaff is blown away. Air flow and screen size may require adjustment to optimize the cleaning process for each collection.

Establishment
The germination rate can be enhanced by wet prechilling the seeds in a mixture of water and sphagnum moss at 35° F for 30-75 days. Another option is to use a 10% acid wash for 45 minutes followed by a thorough washing then wet prechilling the seed for 75 days.

Greenhouse Production: Seeds need light, moisture, and heat for germination. Place seeds on the soil surface and press in lightly to assure good soil contact. Do not cover the seed. Soil should be kept moist. Greenhouse temperatures should be maintained at approximately 95 to 100° F. Germination should begin within about1 week to 10 days. Maintain moisture until plants are to be transplanted.

Wild transplants: Wild plants can be collected and transplanted directly into the desired site. Modest holes will generally fill in within one growing season. Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site. In addition, the hole left at the collection site may fill with undesirable species.

Establishment
Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 12 to 18 inches will fill in within one growing season. Soil should be kept saturated. Standing water should be no deeper than 1.5 to 2 inches during the first growing season. Larger transplanted plugs can handle more standing water if the stems are cut long enough to ensure they are out of the water. Raising and lowering the water level during the establishment period will speed up spreading. Water levels can be managed to enhance spread and to control weeds.

Maintenance
Water level should be fluctuated from saturated conditions up to a maximum depth of 12 inches of standing water. The plants can handle deeper water, but not for an extended period of time. This species can tolerate periods of drought and total inundation. It will spread into water depths of 3 to 5 feet. Water levels can be managed to either enhance or reduce spread as well as to control terrestrial weeds.

Pests and Potential Problems :
Pests are generally not a problem. Aphids will feed on the stems, but generally will not kill the plant.

Cultivars, Improved and Selected Materials (and area of origin)
The Aberdeen Plant Materials Center released four performance tested ecotypes for areas within its service area in 1997.

Camas Selection of hardstem bulrush was released for use in Land Resource Region (LRR) B East. This selection originally came from Camas National Wildlife Refuge (NWR), just west of the town of Hamer, Jefferson County, Idaho.

Hagerman Selection of hardstem bulrush was released for use in Land Resource Region (LRR) B West. It was originally collected at Hagerman Wildlife Management Area, just west of the town of Hagerman, Gooding County, Idaho.

Ogden Bay Selection of hardstem bulrush was collected at Ogden Bay Wildlife Management Area, west of the city of Ogden, Weber County, Utah. It was released for use in Land Resource Region (LRR) D South

Stillwater Selection of hardstem bulrush was released for use in Land Resource Region (LRR) D North. It was originally collected at the Stillwater National Wildlife Refuge, northwest of the town of Fallon, Churchill County, Nevada.

COSMOPOLITAN BULRUSH
Schoenoplectus maritimus

Cosmopolitan or alkali bulrush. Photo by Derek Tilley

Alternative Names
Alkali bulrush, *Scirpus maritimus*, *Bolboschoenus maritimus*

Description
General: Sedge Family (Cyperaceae). Alkali bulrush is a native perennial, heavily rhizomatous, obligate, wetland plant that may reach 5 feet in height and form dense stands. The stems are upright and angular with several leaves, up to 0.4 inches wide, along the lower two thirds of the plant. The flowers are borne in sessile spikelets, densely clustered at the tip of the stem, and nestled in 3 or more leafy bracts. Spikelets are 0.5 to 0.8 inches long. The seeds are brown lenticular achenes, 0.1 to 0.2 inches long.

Distribution
In the U.S., it ranges from the West Coast, east to Minnesota, and south to Louisiana. It is also found in the northeastern United States.

Uses
Erosion Control, Restoration, & Constructed Wetlands: As a pioneering species, it will provide protection from wind and wave erosion especially for newly exposed soil. The rhizomes form a matrix for many beneficial bacteria making this plant an excellent choice for wastewater treatment constructed wetlands.

Wildlife & Livestock: Livestock and big game will rarely use this species for food. Palatability is low.

Waterfowl will utilize the seed and use the stems for nesting cover. Muskrats and beaver will eat the rootstocks and young shoots. They will also use the shoots for building material.

Establishment
Adaptation: Alkali bulrush is found at low to mid elevations in marshes, transient wet spots, pond margins, and backwater areas. It forms large dense stands in alkaline or saline sites. It can handle a pH of up to 9.0. It will grow on soils from fine clay to silt loam to sand. It can survive periods of total inundation of up to 3 feet deep. It tends to spread and reproduce when the water table is within 4 inches of the surface. It can occur in freshwater sites, but is usually a pioneering species that will be replaced over time with more permanent species. Seed and rhizome growth spread it. It is fairly resistant to fire, which will increase its production and protein content.

Seed Collection: Seed ripens in late August to October. Seeds are held tightly in the seed head, which means the collection time can be extended. Seeds may be collected by hand stripping the seed from the plant or clipping it using a pair of hand shears. A power seed harvester may also be used. The bracts, which are found in the seed heads, are very irritating to the skin. Gloves and protective eye wear should be worn, especially when using a power seed harvester.

Seed Cleaning: A hammermill is used to break up the large debris and knock the seed loose from the stem. Cleaning can be accomplished using a seed cleaner with a No. 8 round top screen and a 1/8-inch bottom screen. Screens should be sized so desired seed will fall through and debris and weed seed are removed. Air velocity should be adjusted so chaff is blown away. Air flow and screen size may require adjustment to optimize cleaning process for given situation.

Propagation: Stratifying the seed in a mixture of water and sphagnum moss at 35 °F for 30 days may enhance the germination rate. Seed viability is quite high if stored properly for up to 20 years.

Cosmopolitan bulrush seed. Photo by Derek Tilley

Within the greenhouse, seeds need light, moisture, and heat for germination. Place seeds on surface of soil and press in lightly to assure good soil contact. Do not cover seed. Soil should be kept moist. The greenhouse should be kept hot (95 to 100° F). Germination should begin within about one week. Maintain moisture until plants are to be transplanted.

Wild plants for transplant can be collected and transplanted directly into the desired site. Care should be taken not to collect plants from weedy areas, as these weeds can be relocated to the transplant site, and the hole left at the collection site may fill with undesirable species.

Planting: Planting plugs (greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 12 to 18 inches will fill in within one growing season. Soil should be kept saturated. It can handle from 2 to 3 inches of standing water during the establishment year. Fluctuating the water level during the establishment period is essential. Water levels can be managed to enhance spread and control weeds.

Maintenance: Plants can tolerate up to 3 feet of standing water for short periods of time. Typically, the water will be high in the spring and decrease throughout the growing season to within 3 feet of the surface in the fall. This species can tolerate periods of drought and total inundation. Water levels can be managed to enhance or reduce spread as well as control terrestrial weeds.

Environmental Concerns: Generally, insects and disease are not a problem.

Cultivars, Improved and Selected Materials (and area of origin)

The Aberdeen Plant Materials Center released four performance-tested ecotypes for areas within the Intermountain West in 1997. These are listed below.

Bear Lake Selection of alkali bulrush was released for use in Land Resource Region (LRR) B East. This source originally came from Bear Lake National Wildlife Refuge (NWR), just south of Montpelier, Bear Lake County, Idaho.

Fort Boise Selection was originally collected at Fort Boise Wildlife Management Area, west of Apple Valley, Canyon County, Idaho. It was released for use in LRR B West.

Stillwater Selection was released for LRR D North. This release originated from the Stillwater NWR, northwest of Fallon, Churchill County, Nevada.

Bear River Selection was first collected at the Bear River Migratory Bird Refuge, west of Brigham City, Box Elder County, Utah. It is intended for use in LRR D South.

THREESQUARE
Schoenoplectus pungens

Threesquare. Photo by Derek Tilley

Alternative Names
Basket grass
Scirpus pungens

Description
General: Sedge Family (Cyperaceae). This herbaceous, rhizomatous perennial has upright, triangular, and rarely concave stems. The stems are erect, 6 to 40 inches in height and 0.1 to 0.25 inches wide in the middle. The narrow (0.10 to 0.16 inch) wide, grass-like, basal leaves are all in the lower third of the stem. Leaves are flat to slightly rounded near the base, and become more cylindric toward the tip. The flowers are lateral clusters of 1-7 sessile spikelets subtended by an involucral bract that appears to be a continuation of the stem. The scales are yellowish to reddish brown. Fruits are small, brown, lenticular achenes.

Uses
Ethnobotanic: The soft, spongy stems of basket grass were traditionally used and are still used for basket weaving. The pithy, cylindrical stalks were used to weave matting, as well as for bedding and roofing material. As thatching material, basket grass was spread out in bundles, tied together, then secured in place with poles. Various indigenous peoples of Canada ate the fleshy rootstocks and rhizomes. The Kwakiutl used the stalks and oil on a child's head to make the hair grow long and thick.

Conservation: Threesquare is especially good for stabilizing or restoring disturbed or degraded areas, for erosion and slope control, and for wildlife food and cover. Where it occurs, it is widely distributed in wet ground.

Wildlife: The seeds, being less hairy and larger than cattail, are the choice food for wetland birds: baldpate, bufflehead, mallard, pintail, shoveler, blue-winged teal, cinnamon teal, greater scaup, lesser scaup, avocet, marbled godwit, clapper rail, Virginia rail, sora rail, long-billed dowacher, and tricolored blackbird. The stems provide nesting habitat for blackbirds and marsh wrens. Snow geese are known to utilize *Schoenoplectus pungens* on the Skagit Delta and Bowerman Basin on their migratory flights.

Adaptation
Threesquare occurs in playas, salt marshes, freshwater marshes, ponds, streams, reservoirs, and lake fringes below 6,500 feet elevation. It is usually found in standing water about 4 to 6 inches deep, and will tolerate alkaline and saline conditions as well as freshwater. Threesquare can survive seasonal drought, when the water table is more than 3 feet below the surface. It grows in fine silty clay loam to sandy loam soil.

In its native habitat, threesquare grows primarily in estuarine wetlands. Due to the loss of estuarine wetland habitat throughout the United States, it is rarely appropriate to harvest wild plants in these areas. Wild plant collecting should be restricted to salvage sites with appropriate approvals or permits. Threesquare populations are declining due to loss of habitat and commercial use.

Establishment
Propagation from Cuttings: Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site. In addition, the hole left at the collection site may fill in with undesirable species.

Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a

new stand of this species. Plug spacing of 12 to 18 inches will fill in within one growing season. Soil should be kept saturated. Basket grass can tolerate 3 to 4 inches of standing water during the first growing season. Fluctuate the water levels during the establishment period to increase the rate of spread. Water levels can be managed to both enhance expansion of the clone and to control weeds.

Threesquare can tolerate up to 12 to 18 inches of standing water if the water level is fluctuated during the growing season. This species can tolerate periods of drought and total inundation. This subspecies grows in the high salt marsh, and can tolerate both brackish water and diurnal tidal inundation. In non-tidal situations, water levels can be managed to either enhance or reduce spread as well as to control terrestrial weeds.

The Skokomish Tribe is using a modified clam gun to gather wild transplants. The clam gun consists of a piece of tailpipe with a T-handle and a siphon hole drilled on the top. The edges are sharpened and make a clean cut with the tube approximately 1 foot long and three inches in diameter. Three to twelve tillers are recovered per plug extraction. Transplant success was highest in borrow pits within the diked complex at the Skokomish River where *Schoenoplectus* remnants were already growing.

Propagation by Seed: Seeds ripen from late July through August. Seeds are held in the seed head for a couple of months, if not disturbed by high winds, high tides, or inundation. Seeds may be collected by hand stripping them from the plant or by clipping the seed heads with a pair of hand shears. A power seed harvester may also be used.

To clean the seed, use a hammer mill to break up the large debris and knock the seeds loose from the stem. To clean seed by hand, run your thumbnail along the stem, and then twist the seeds away from the larger chaff. Cleaning can be accomplished using a seed cleaner with a No. 7 screen top screen and a 1/20 in bottom screen. Screens should be sized so desired seeds will fall through and debris and weed seeds are removed. Air velocity should b adjusted so chaff is blown away. Air flow and screen size may require adjustment to optimize the cleaning process for the given situation.

Seed germination is difficult in this species. Wide differences in germination may occur between sites and between different years. Fertilization, especially addition of nitrate, increases the number, the weight, and the germination percentages of the seed. When collecting seed heads, make sure the spikelets feel “full” and that the seeds have developed. The germination rate may be enhanced by light scarification and wet pre-chilling the seeds in a mixture of water and sphagnum moss at 35° F for 30 days. After pre-chilling, place the seeds on the soil surface in pots or flats and provide light, moisture, and heat for germination. Press seed into soil surface very lightly, and do not cover seed. Plants will desiccate if the soil dried out, and will either fail to germinate or die as young seedlings. The greenhouse should be kept hot (95 to 100° F). Germination should begin within a few weeks. Maintain moisture until plants are to be transplanted.

Management

Insectivores have not been a problem with threesquare. Aphids will feed on the stems, but will not kill the plant. Threesquare is tended by gathering and reducing the density between plants to stimulate shoot production. Fire has been used to manage *Schoenoplectus* dominated wetlands in some areas.

Cultivars, Improved and Selected Materials (and area of origin)

Market Lake Selection of common threesquare was released for use in Land Resource Region (LRR) B East. The original collection was made at Market Lake Wildlife Management Area, Jefferson County, Idaho.

Fort Boise Selection of common threesquare is intended for use in Land Resource Region (LRR) B West. This release is from the Fort Boise Wildlife Management Area, , Canyon County, Idaho.

Malheur Selection of common threesquare originated at the Malheur National Wildlife Refuge, Harney County, Oregon. It is intended for use in Land Resource Region (LRR) D North.

Prairie cordgrass
Spartina pectinata

Prairie cordgrass, Photo by USDA-NRCS Bismarck PMC

Alternate Names
Ripgut, cordgrass, marsh grass, slough grass, fresh water cordgrass, broadleaf

Description
General: Prairie cordgrass is a warm-season perennial grass. It is native to the tall grass prairies of most of the United States and Canada. It has an average height of 3 to 8 feet. The leaf blades, 0.12 to 0.5 inches wide and up to 30 inches long, are coarse, very tough, and thick. The margins of the leaf are serrated and sharp. Stems are stiff. It is strongly rhizomatous with very tough, scaly rhizomes. Seedheads are composed of 10 to 20 spikes attached to the main stem. Each spike has up to 40 spikelets, all growing in two rows on the side of the spike away from the stem. The seeds are flat, paper-like with barbed awns that attach firmly to fur or fabric. There are approximately 183,000 seeds per pound.

Habitat: Prairie cordgrass is found in wet meadows, sloughs, potholes, and drainage ways. It is associated with various species including sedges and rushes.

Uses
The stiff stems, vigorous rhizomes and robust size of this species are useful in stabilizing soil, dissipating wave energy and providing cover. This species has applications in wetland restoration and enhancement, streambank stabilization, windstrips, filterstrips, riparian buffers, and in wildlife habitat.

Adaptation
Prairie cordgrass has a broad climatic adaptation. It will grow on seasonally dry sites, tolerates alkaline condition and high water tables but is intolerant of prolonged flooding. It will grow on a wide array of soil types, but prefers a soil other than sand.

Establishment
Prairie cordgrass can be established from seed or vegetative material. Following are guidelines for each of these propagation methods.

Vegetative Material: The strong rhizomes can be used for propagation. The ideal piece of vegetative material is a "J" hook piece of rhizome with buds and 4 to 12 inches of dry stem. Other rhizome pieces can be used if there are roots and at least one bud. The stem length is not critical for growth, but, if attached, makes planting and handling easier.

Local sites such as a ditch or wet meadow
Nursery propagation bed - Material is usually more uniform and plants tend to be larger and stronger making them easier to handle and improving survival.

Collect vegetative material in spring (early April-June) or fall (October/November)- Rhizomes dug in the fall should be stored in controlled conditions of temperatures near freezing. Do not allow pieces to become too warm or dry.

Vegetative material can be dug by hand or with an undercutter, disk or plow. Depth of digging will vary depending on site conditions. In older stands, the intertwined rhizomes are course, stiff, and have sharp buds. Material most easily processed is from younger growth found on the outside edge of an old stand or from newer plantings. Plants 2 to 3 years old would be the easiest material to handle and process. Once rhizomes are dug, pieces should be cut as described above. It is important to keep processed rhizomes cool and moist until

planting. Another method of establishment would be to scatter the rhizomes, cover, and firm the planting bed.

Rhizomes should be planted with the shoot upright. Roots and at least part of the shoot should be buried. The average planting depth should be 3 to 6 inches. Rhizomes have been successfully planted using a tree planter and by hand planting. Air space around the planted rhizome should be removed by packing.

Spacing will vary depending on the purpose of the planting and site conditions. For riparian and wetland plantings, Spacing can vary, depending on slope, stabilization required, mulch, and available plants and resources. Generally, plants are spaced 2 to 10 feet apart and planted in off-set rows. Rhizomes planted along stream banks should be planted several feet beyond the water line. Cordgrass is intolerant of frequent flooding. Ice jams and fluctuating water can wash out plants closer to the water line. Rhizomes planted higher up the slope will readily send shoots down the slope toward the water line.

Seed Propagation
Seed can be drilled or broadcast. At a rate of 30 seeds/ft^2 (7 lbs PLS/acre) or 1/4 to 1 pound PLS/acre in wet meadow mixes. Seed to a target depth of ½ to ¾ inches

Viability of seed decreases when stored under high temperatures and humidity. In controlled storage, germination remains good for about 3 years. Current purity and germination tests (9 months or less) are needed for accurate seeding rates. Germination tests may be difficult to interpret, however, as there are no standardized testing procedures. Dormancy reported on seed tests should be considered in seed viability. Debearded or deawned seed is more flowable, and seeding rate and placement is more accurate and consistent than for awned seed.

Most seed of prairie cordgrass is produced in the northern regions of North America. Insect predation inhibits seed production in more southern climates.

Management
Seedling vigor is only moderate, and seed often germinates throughout the course of the summer. Seedlings develop slowly. Stands are established more quickly by planting vegetative material compared to seeding. Adequate water at planting time is critical for establishment of seed and vegetative material. Once the stand is established, watering is less critical. Due to the rhizomatous growth and size of the plants, weed competition is not usually a problem in established stands. The first few years of establishment by seed may require weed control if heavily infested. Prairie cordgrass has few management needs. Mowing of prairie cordgrass more than once per season can reduce vigor.

Pests and Potential Problems
Pests do not appear to be a problem for vegetative material. Seed predation by insects is a problem in most areas except the extreme northern climates of the United States.

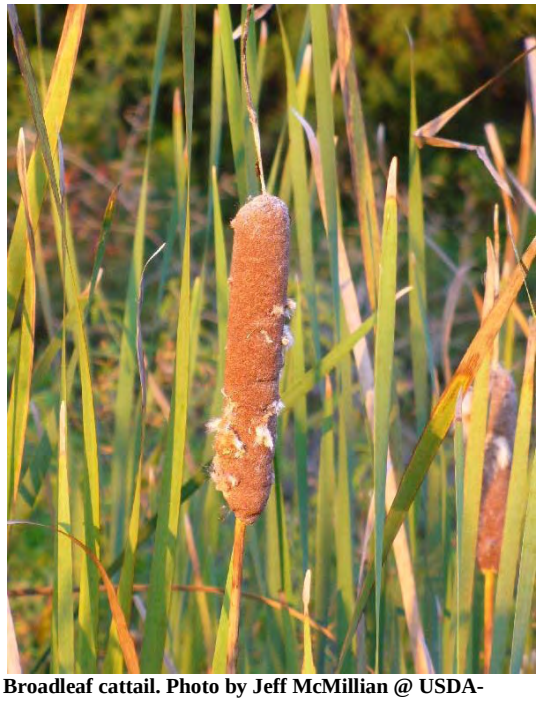
Environmental Concerns
This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed.

Cultivars, Improved, and Selected Materials (and area of origin)
Seed can be purchased from native plant nurseries and commercial seed growers or can be harvested from local populations. Seed can be hand stripped or combined in late fall. Seed fill is often poor in native harvests. Filled seeds have a kernel or embryo. Cut seeds crosswise to determine fill.

'Red River Germplasm' prairie cordgrass is a selection named and released by the Bismarck, North Dakota Plant Materials Center. It is a composite of plant materials from Grant County, Minnesota; Cass and Grand Forks Counties in North Dakota; and Day County in South Dakota. Select Class seed and vegetative material is available in the commercial market of this selection. Red River Germplasm is the only known release with seed commercially available. Performance consistency in released material is greater than for local ecotypes.

'Atkins Germplasm' prairie cordgrass is a selection named and released by the Manhattan, Kansas Plant Materials Center. Material for this release originated from Washington County, Nebraska. This is a Select Class vegetative release. There is no seed produced or available. Vegetative material is available for increase.

Broadleaf Cattail
Typha latifolia



Broadleaf cattail. Photo by Jeff McMillian @ USDA-NRCS PLANTS Database

Alternate Names
Flags, rushes, bulrushes, cat o'nine tails

Description
General: Cattail Family (Typhaceae). Cattails are herbaceous, rhizomatous perennial plants with long, slender green stalks topped with brown, fluffy, sausage-shaped flowering heads. Mature plants can reach 5 to 10 feet tall. The spike-like, terminal, cylindric inflorescence has staminate (male) flowers above and pistillate (female) flowers below with a naked axis between the staminate and pistillate flowers. The spike is green when fresh, becoming brown as it matures. The basal leaves are thin with parallel veins running the long, narrow length of the leaf. These plants are rhizomatous and colonial.

Distribution
Broad-leaved cattails are common throughout the United States and temperate and tropical places worldwide. Broadleaf cattail occurs in coastal and valley marshes at elevations lower than 6,500 feet.

Uses
Wildlife: Wetland restoration, wastewater tertiary treatment, edible (young shoots, base of stem, flower stalks, pollen, rhizomes), and aesthetics. The multitudes of tiny, wind-carried seeds are generally too small and too hairy to be attractive to birds; however, the seeds are eaten by several duck species. Cattail rootstocks are much more valuable as food for wildlife than are the seeds. Geese and muskrats prefer the stems and roots. Moose and elk eat fresh spring shoots. Shelter and nesting cover are provided for long-billed marsh wrens, red-wing blackbirds, and yellow-headed blackbirds.

Adaptation:
Cattail generally occurs in shallower water than narrowleaf cattail (*Typha angustifolia*). Compared to *T. angustifolia*, *T. latifolia* is exploitative in its ability to clone rapidly and produce a large leaf surface area, which may contribute to its superior competitive ability. *Typha latifolia* has been found to be tolerant of water level fluctuations and moderate soil salinity. Cattail spreads both vegetatively and by seed, particularly under drawdown.

Cattails are always found in or near water, in marshes, ponds, lakes and depressions. They are obligate wetland indicator plant species. Cattails tolerate perennial flooding, reduced soil conditions and moderate salinity. With influxes of nutrient or freshwater, cattails are aggressive invaders in both brackish salt marshes and freshwater wetlands.

Cattails, like many emergent wetland species, tolerate flood drawdown cycles that occur to varying degrees in different wetland and riparian systems. Flood and drought are disturbance factors that vary in frequency, magnitude, and predictability. Frequency relates to the number of episodes per unit time while magnitude of flooding can be expressed in terms of water volume, velocity, gradient, depth, duration, and season of inundation. When planting cattails, the flood-draw-down cycles must be taken into consideration for successful revegetation.

Establishment
Typha species may be planted from bare rootstock or seedlings from container stalk or directly seeded into the soil. Bare rootstock or seedlings are preferred revegetation methods where there is moving water. Cattail seeds germinate readily and are a cost-effective means

to propagate cattail on moist soils. To ensure a long-term stable ecosystem, it is recommended that *Typha* be just one of the species in the mix for wetland restoration.

Select seed collection sites where continuous stands with few intermixed species can easily be found. Seed is harvested by either taking hand clippers and cutting the stem off below the seed heads or stripping the seed heads off the stalk. Collect and store seeds in brown paper bags or burlap bags. Seeds are then dried in these bags.Seeds can be harvested when they are slightly immature. Seeds and seed heads need to be cleaned in a seed cleaner.

Seed should be planted in the fall in a clean, weed free, moist seed bed. Flooded or ponded soils will significantly increase seedling mortality. Broadcast seed and roll in or rake 1/4" to 1/2 inch from the soil surface. Some seed may be lost due to scour or flooding. Recommended seed density is unknown at this time.

Greenhouse Propagation: To grow seeds, plant in greenhouse in 1" x 1" x 2" pots, 1/4" under the soil surface. Keep soil surface moist. Greenhouse temperature should be 100° F (plus or minus 5 degrees). Seeds begin to germinate after a couple weeks in warm temperatures. Plants are ready in 100 to 120 days to come out as plugs. By planting seeds in August, plugs are ready to plant in soil by November. These plants are very small; growing plants to a larger size will result in increased revegetation success.

Live Plant Collections: No more than 1/4 of the plants in an area should be collected. If no more than 1 ft^2 is removed from a 4 ft^2 area, the plants will grow back in the hole in one good growing season. A depth of 6 inches is sufficiently deep for digging plugs. This will leave enough plants and rhizomes to grow back during the growing season. Donor plants, which are drought-stressed, tend to have higher revegetation success.

Live transplants should be planted in moist (not flooded or anoxic) soils as soon as possible. Plants should be transported and stored in a cool location prior to planting. Plugs may be split into smaller units, generally no smaller than 2.4 x 2.4 inches, with healthy rhizomes and tops. The important factor in live plant collections is to be sure to include a growing bud in either plugs or rhizomes. Weeds in the plugs should be removed by hand. For ease in transport, soil may be washed gently from roots. The roots should always remain moist or in water until planted.

Clip leaves and stems from 6 to 10 inches; this allows the plant to allocate more energy into root production. Plant approximately 3 feet apart. Plants should be planted closer together if the site has fine soils such as clay or silt, steep slopes, or prolonged inundation. Ideally, plants should be planted in moist soils in late fall just after the first rains (usually late October to November). This enables plant root systems to become established before heavy flooding and winter dormancy occurs. Survival is highest when plants are dormant and soils are moist. Fertilization is very helpful for plant growth and reproduction. Many more seeds are produced with moderate fertilization.

Management

Heavy grazing will eliminate Cattail species as well as other native species from riparian corridors. However, cattails are fairly resistant to moderate grazing, providing wet soils are not compacted.

Because cattails have relatively little value for ducks, they are often regarded as undesirable weeds in places intended primarily for ducks. It has been found that mowing cattails after the heads are well formed but not mature and then following up with another mowing about a month later, when new growth is two or three feet high, will kill at least 75% of the plants. This will enable other emergent vegetation with more palatable and nutritious seeds to become established.

Ecologically, cattails tend to invade native plant communities when hydrology, salinity, or fertility changes. In this case they out compete native species, often becoming monotypic stands of dense cattails. Maintaining water flows into the wetland, reducing nutrient input and maintaining salinity in tidal marshes will help maintain desirable species composition. If cattails begin to invade, physical removal may be necessary.

Cultivars, Improved and Selected Materials (and area of origin)

Local sources are recommended. This species should be available from any local nursery specializing in aquatic plants.

REDTOP
Agrostis gigantea Roth

Redtop (*Agrostis gigantea*). Photo by Robert Soreng @ USDA-NRCS PLANTS database.

Alternate Names

Agrostis alba, Agrostis depressa, Agrostis palustris, Agrostis stolonifera var. *major*, Black bent, Carpet bentgrass, redtop bent, redtop bentgrass

Description

General: Grass family (Poaceae). Redtop is a cool season (C-3), sod-forming, perennial grass native to Europe. The plant produces culms up to 4 feet in height which can be erect, decumbent or semi-prostrate in form. The leaf blades are flat, folded or curled, approximately 1/8 to 3/8 inches wide with a prominent ligule at the junction of the leaf blade and sheath. The inflorescence is an open panicle with ascending branches. The spikelets are small with the lemma reaching 0.08 inches long. The name redtop is derived from the reddish coloring of the panicle. The scaly, creeping rhizomes make a coarse, but fairly dense turf. The roots of redtop can reach 4 ft deep under favorable conditions. There are approximately 4.85 million seeds/lb.

Uses

Livestock: Cattle prefer nearly all other cultivated grasses to redtop. It remains green summer long and is useful in western states in pasture plantings in mountain meadows. It is considered preferred feed for cattle and horses in spring and summer and a desirable feed in fall and winter. It is considered a preferred feed for sheep in spring and a desirable feed in summer.

Hay: One of the primary uses of redtop is for grass hay.

Turf: Though creeping bentgrass (*A. stolonifera*) is much more prevalent in the turf industry than redtop, this species is used throughout North America and Europe in lawns and golf courses. It is also used for overseeding as a winter lawn grass in the South East.

Erosion control: Redtop is commonly used for erosion control in plantings along riparian zones and wetlands. It germinates very rapidly and performs well on acidic low fertility soils. Its root system is well suited for holding soils on wetlands, waterways, ditchbanks and burned or cutover-timberland.

Revegetation: This species has been used to recapture sites which are very acid to land affected with heavy metals and poor soil quality such as mine spoils. It has been shown to have a higher tolerance of acidic soils than Kentucky bluegrass.

Wildlife: Redtop is a preferred feed for elk in spring, but is used sparingly by deer. It is commonly used as cover by numerous species of birds and small mammals. Ducks and geese use redtop for nesting cover, and it is grazed by geese.

Distribution

Redtop is native to Eurasia and North Africa and was introduced to North America in the 18th century as a lawn, meadow and pasture grass. It has since become naturalized and widely distributed throughout the U.S. and Canada. It grows better in the moist mountain areas of the West and humid areas of the Northeast than in the warmer climates of the southern states. For

current distribution, consult the Plant Profile page for this species on the PLANTS Web site.

Habitat:
Redtop has been cultivated and planted extensively throughout North America and has been widely naturalized in numerous habitats. It occurs in areas with shallow water, wet meadows and stream banks from sea level to 8,000 ft. Redtop can be found growing in pure stands or with other wetland/wet meadow species such as sedges, rushes, and other grasses. It is also common in riparian areas growing in association with cottonwood, alder and willow species.

Adaptation
This species is broadly adapted to a wide range of soil and weather conditions. It thrives in cool moist habitats and is best adapted to the northern states but has been successfully established throughout North America, especially with management and irrigation. Redtop is best adapted to mesic to semi-hydric soils, and is well suited to areas receiving 18 to 40+ inches mean annual precipitation. The plants are tolerant of poorly drained and sub irrigated sites and sites that are frequently flooded.

This species performs best on clay loam to loamy soils, but under irrigation will perform on nearly any soil type with the exception of limestone based soils. Redtop is adapted to soils with a pH of 4.5 to 8.0. It has a low tolerance to salinity.

Redtop displays good grazing resistance due to its rhizomes, its low palatability and semi-prostrate growth form. Stands of redtop often increases in pasture mixes and will decrease under light to non-grazed situations.

Weediness
Redtop has been described as weedy or invasive in some states and European countries. It may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Consult your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Establishment
Redtop can be established by seed, sprigs, or sod. For seeding, plant at a depth of 0-1/4 inch into a smooth, firm, well-drained, weed free seed bed. For turf plantings, seed at a rate of approximately 1 lb/1000 ft^2. For pasture and range plantings a rate of 0.5 lbs/ac is recommended. Broadcast and lightly harrow to cover seed. Compaction of soil over seed may cause crusting which is impenetrable by seedlings. Use of an inert carrier or dilutent when drill seeding can improve seed flow and metering small seed such as redtop.

The soil surface should be kept moist during establishment. Early fall seeding is recommended which allows a minimum of 45 growing days prior to frost for good establishment if irrigation is available. If irrigation is not available, an early spring seeding is recommended. Do not apply nitrogen until the second growing season.

Seedlings have low vigor and seeding often results in poor stands; however, once established, stands of redtop will readily spread and persist for many years.

Redtop is seldom seeded alone. Better forage and high quality hay is produced if redtop is mixed with species such as timothy, creeping foxtail and/or clover species. Redtop grows rapidly after seeding and excessive seeding rates are not recommended, particularly in mixtures.

Management
Stands of redtop should not be grazed until the plants are at least 8 inches tall. Pasture mixes will need to be grazed closely in a rotation to keep plants producing palatable regrowth on wet and sub-irrigated sites. Redtop should not be grazed closer than three inches.

Cut hay in early flowering stage for best quality. Forage contains 8 to 9 percent protein when cut at full bloom and 12 to 14 percent when cut before bloom. Stands respond well to applications of fertilizer and lime. Low fertility critical areas should be fertilized prior to seeding.

Pests and Potential Problems
Redtop is known to develop ergot which can lead to livestock poisoning. This species can also develop leaf rusts, spotting and snow mold, but these have generally not been a problem.

Redtop is an introduced species which can displace native vegetation under ideal conditions. It should not be planted in sites where revegetation of native species is desired. It

hybridizes with other *Agrostis* species, so numerous non-typical plants can be found in most populations.

Seeds and Plant Production
Seed production fields should be soil tested before planting to determine soil nutrient levels and fertilizer needs.

Stands should be combined or swathed when plants are in the hard dough stage. Seed shatters readily, so delaying harvest can significantly reduce yields. Seed should be cleaned with air screens or clippers with a 28x28 upper screen and 50x50 lower screen.

Seed production fields yield approximately 75 lbs/ac with 90 percent purity and 90 percent germination.

Cultivars, Improved, and Selected Materials (and area of origin)
There are several released materials of the stoloniferous creeping bentgrass, which are used readily as lawn and golf course varieties. There is currently only one known released variety of redtop.

'Streaker' redtop was released in 1982 by Jacklin Seed Company and Lofts Seed. It was chosen from among 21 lots of seed which were evaluated for uniformity, vigor, seed yield and mechanical purity and cleanliness. It's intended use is for overseeding of dormant warm season grasses; low maintenance turf, reclamation and pasture.

Creeping Foxtail
Alopecurus arundinaceus

Creeping foxtail. Photo by Derek Tilley

Alternate Names
Creeping meadow foxtail, *Alopecurus ventricosus*

Description
General: Grass Family (Poaceae). Creeping foxtail is a large, long-lived, rhizomatous, sod-forming, perennial grass introduced from Eurasia. Culms are tall and stout, 20 to 48 inches tall and 0.3 inches wide. Cauline leaves are numerous, flat and green, mostly 0.25 to 0.30 inches across, glabrous above and scabrous beneath. The inflorescence is a spike-like, cylindrical panicle, typically 1.5 to 4 inches long and around 0.3 inches thick, turning purplish or black with maturity. It has a very similar appearance to the seed heads of timothy, but creeping foxtail heads turn the dark colors described above with maturity and Timothy seed heads turn a brownish – buff color. Individual spikelets are single flowered and urn-shaped, 0.16 to 0.20 inches long and 0.04 to 0.06 inches. Anthers are usually purple but are occasionally yellow or orange.

Anthesis occurs early in the season. Seed maturation begins at the top of the inflorescence and proceeds downward. Spikelets disarticulate below the glumes with the spikelet falling as a single unit.

Creeping foxtail should not be confused with other grass species that share the common name foxtail. Creeping foxtail is a close relative of meadow foxtail (*Alopecurus pratensis*) and can be distinguished by having broader leaves (0.30 to 0.45 inches vs. 0.16 to 0.32 inches) and a dark purplish inflorescence. There are also many weedy species that bear the name foxtail, i.e. foxtail barley (*Hordeum jubatum*) and green foxtail (*Setaria viridis*). These may occupy the same habitats as creeping foxtail, but bear little or no resemblance.

Distribution
This species is native to the colder regions of Europe and Asia. Records indicate that creeping foxtail was introduced into the United States around the end of the 19th century. At the time, it was little used by farmers who lacked the specialized equipment to plant and harvest its small fluffy seeds. With the advent of more advanced machinery in the 1930's and 40's, it became more widely used in forage practices. Presently, it is most commonly utilized throughout the Pacific Northwest, Intermountain West, Northern Great Plain States and western Canada. It is projected that creeping foxtail could be used as far east as the New England states.

Uses
Grazing/livestock/pasture: Creeping foxtail is very well suited for pastureland or hayland. Because it does not undergo dormancy during the summer, creeping foxtail produces high yields of season long palatable forage. Plants break winter dormancy early in spring, and leaves remain green and palatable even during the hottest months. Studies indicate that creeping foxtail yields equal or exceed those of other comparable grasses.

Creeping foxtail is palatable to all classes of livestock. Cattle show preference to creeping foxtail over other widely employed pasture grasses. It can be seeded in pure stands or combined with a legume.

This species produces numerous aggressive underground rhizomes. These contribute to long-lived-stands and an ability to recover quickly from grazing.

Filter fields: Because of creeping foxtail's tolerance to high levels of fertilizer, particularly nitrogen and water, it can be used in filter fields for liquid waste disposal. It can also be used in a variety of other water settings including sewage treatment, food processing and livestock waste removal programs. With suitable moisture, creeping foxtail can also be used as an excellent silt trap. This species is known to tolerate up to six inches of silt per single deposition.

Erosion control: Creeping foxtail's vigorous rhizome production (up to 48 inches crown diameter/year) and water tolerance make it well suited to erosion control and stream bank stabilization. Creeping foxtail can tolerate both high water levels and periods of drought, it can be used on earthen dams where water levels fluctuate. It survives in a broad range of pH, making it suitable for mine spoils, saline seeps (tolerant to ECs of 12) bogs and acidic roadways.

Wildlife: All manner of wildlife benefit from the forage and cover provided by creeping foxtail. Elk and deer eat the succulent forage in the spring and fall. The tender spring growth also provides forage for geese and other waterfowl. Numerous species of birds use the dense growth for cover and nesting habitat. Creeping foxtail has been used for plantings around ponds, lakes, grassed waterways and other waterways.

Adaptation

Creeping foxtail is adapted to cold temperatures and wet conditions. It is extremely winter hardy. It can establish and survive in areas where frost-free periods average less than 30 days annually. Studies indicate creeping foxtail outperforms smooth brome on flooded permafrost soils in Alaska. It also grows well at a broad range of elevations (500 to 9,000 ft), but grows best on middle to high elevation wet to semi-wet sites.

This species is well adapted to areas of high moisture typically too wet for good production of most forage grasses, i.e. brome (*Bromus* species) and orchardgrass (*Dactylis glomerata*) and is a superior forage to other semi-wetland grasses, such as tall fescue and other wetland grasses, such as reed canarygrass, meadow foxtail and timothy. It usually occurs in areas receiving more than 18 inches of precipitation. It also grows readily along margins of ponds, lakes, bogs, ditches and in mountain meadows. It can withstand periodic flooding of 24 to 35 inches for up to 45 days. Some varieties are also somewhat drought tolerant, being able to survive in areas with widely fluctuating water levels and drought during later summer periods.

Creeping foxtail does well in a broad spectrum of soils provided there is sufficient available water. It can grow in sand, clay, peat and muck. It is moderately salt tolerant (up to 12 millimhos/cm) and tolerates both moderately acidic soils (pH 5.6 to 6.0) and slightly alkaline soils (pH 7.9 to 8.4).

Weediness

In addition to aggressive rhizomes, creeping foxtail proliferates by windborne and waterborne seeds. Rapid reproduction can be useful in repairing damaged sites; however, creeping foxtail's ability to spread quickly may create management problems in canals, irrigation ditches and other waterways.

Establishment

Creeping foxtail establishment techniques are similar to those for other forage grasses. For best results the seedbed should be weed free, moist and firmly packed. Follow seeding with a light harrowing or packing operation. Optimum seeding depth is 1/8 to 1/4 inch and no deeper than ½ inch.

Timing depends almost entirely on available moisture. Irrigated fields can be seeded in early to mid spring or late summer avoiding the hot mid-summer period. Irrigated fall seedings can be successful as late as early to mid-September allowing for enough time (6 to 8 weeks) for seedling establishment before freezing temperatures. Where precipitation is required, seed when soil is moist but firm enough or frozen to support seeding equipment. Late fall dormant seedings (after October 20th in most areas), winter and very early spring seedings are most effective under non-irrigated conditions where seeds are not allowed to germinate until spring.

This species produces very light seed (750,000 seeds/lb) which allow for low relative seeding rates for adequate stand establishment. It is recommended that a minimum seeding rate of 3 to 4 lb/acre is used for ease of handling and uniform distribution through seeding equipment. This rate provides 51 to 68 seed/ft^2.

It is popular to dilute the seed with inert materials, i.e. rice hulls, cracked corn or other cracked grains. For rice hulls, cracked wheat or cracked barley, dilute 3 to 4 lbs/acre seed with 2 bushel/acre dilutor, and set the drill to seed the equivalent of 2 bushels of barley per acre. For cracked corn reduce dilutor to 1 bushel/acre.

When seeding with a legume, it is recommended that one plant in alternate rows. Studies conducted with 'Lutana' cicer milkvetch (*Astragalus cicer*) and 'Eski' sainfoin (*Onobrychis viciaefolia*) showed increases in yield over a four-year period when planted in alternate rows.

Management
Young seedlings are small and weak. Growth is slow for the first 4 to 6 weeks even under irrigated conditions. Rhizomes can emerge as early as 8 weeks. With the emergence of rhizomes, growth is rapid. With adequate soil moisture inflorescences may develop in mid to late summer, but first year plants typically do not produce seed heads, or when they do, there is not enough seed for a profitable harvest.

Under non-irrigated conditions, it is not uncommon to have difficulty determining stand establishment the first growing season. Stand success should not be determined until the second or third growing season under non-irrigated conditions.

Applications of commercial fertilizer are not required during the establishment period; however, creeping foxtail responds very favorably to applications of 50 to 60 lbs/acre actual nitrogen once established. Creeping foxtail plants show little response to applications of potassium, phosphates and secondary elements. When planted with a legume, adjust fertilizer rates according to desires: For more grass production increase nitrogen, for more legume production increase phosphorus and potassium.

Weeds can be controlled using standard herbicide practices, although weeds should cause few problems with adequate fertilizer.

Pests and Potential Problems
Creeping foxtail has historically shown little damage from insects and other diseases; however, in some years leaf spot diseases have been recorded as a problem in Canada.

Cultivars, Improved and Selected Materials (and area of origin)

'Garrison' creeping foxtail was named and released by the Natural Resources Conservation Service Plant Materials Center in Bismarck, North Dakota in 1963. The original collection was made in 1950 near Max, North Dakota where plants were growing on the margins of potholes. 'Garrison' is adapted to cold temperature regions where there is abundant water. It is especially well suited to higher elevation areas that receive 18 inches or more precipitation annually or along the margins of ponds, lakes, ditches and other waterways. It provides excellent forage for cattle and other classes of livestock by producing highly palatable leaves throughout the growing season. 'Garrison' has a high moisture tolerance and produces vigorous rhizomes making it an excellent choice for controlling streambank and shoreline erosion. Certified seed is available. Breeder and Foundation seed is maintained by the Bridger, Montana PMC.

'Retain' creeping foxtail (was selected by the South Dakota Agricultural Experiment Station and released in 1979. This is a five-clone synthetic single plant selection from 'Garrison.' 'Retain' is very similar to 'Garrison,' but this cultivar retains seed on the panicle making it possible to harvest with a direct cut combine. Like 'Garrison,' it is well adapted to wet areas and is flood tolerant. It is highly palatable to livestock. It matures early, heading in mid-May. Breeder and foundation seed are maintained by South Dakota State University.

RS HYBRID WHEATGRASS
Elymus hoffmannii

'Newhy' Hybrid Wheatgrass. K. Jensen, ARS, UT

Alternate Names
Elytrigia repens x Pseudoroegneria spicata,
RS wheatgrass *x*
Pseudelymus
'Newhy'

Description
General: Grass Family (Poaceae). The botanical description of *Elymus hoffmannii* is from a breeding line of plants developed from seeds collected in Erzurum Province, Turkey by J.A. Hoffman and R.J. Metzger in 1979. There is no information regarding its native distribution.

RS hybrid wheatgrass is slightly to moderately rhizomatous with glabrous culms reaching 21 to 53 inches. Leaves are evenly distributed along the culm; sheaths are glabrous and auricles absent to 0.003 inches long. Leaf blades are 0.02 to 0.05 inches wide, flat to involute, the top surface smooth and glabrous, the bottom surface smooth with the veins closely spaced, more or less equally prominent, smooth or scabrous. The spikes are 4 to 20 inches long, 0.3 to 0.7 inches wide with 1 spikelet per node. *Elymus hoffmannii* differs from quackgrass (*Elymus repens*) primarily by having longer leaves, shorter awns on the glumes, and less rhizome development. *Elymus hoffmannii* is predominantly cross-pollinated and chromosome number is 2n = 42, x = 7. The description for *Elymus hoffmannii* was written to encompass the released cultivar 'Newhy' and some taxonomists believe the cultivar should be identified as *x Pseudelymus* 'Newhy' because it is derived from an artificial cross between *Elymus repens* and *Pseudoroegneria spicata*.

Distribution: The description of *Elymus hoffmannii* was described from a breeding line of plants developed from seeds collected in Erzurum Province, Turkey by J.A. Hoffman and R.J. Metzger in 1979. There is no information regarding its native distribution. In North America, its distribution is limited to sites that have been planted with this species either as a component of a seeding mix or as a monoculture.

Uses
Grazing/range/pasture: RS hybrid wheatgrass is an advanced-generation hybrid between quackgrass (*Elymus repens*) and bluebunch wheatgrass (*Pseudoroegneria spicata*). It has fair to good forage quality for cattle, sheep and horses.

Hay: RS hybrid wheatgrass can provide more than one crop of hay each year with proper management. Under high soil fertility and adequate irrigation, forage yields are lower than other forage grasses such as orchardgrass, meadow brome and tall fescue.

Wildlife: RS hybrid wheatgrass provides fair to good cover for small mammals, nongame birds, upland game birds and waterfowl.

Erosion control/reclamation: RS hybrid wheatgrass is especially suited for erosion control and reclamation on slight to moderate saline soils.

Adaptation
RS hybrid wheatgrass is a long-lived perennial grass adapted to temperate semiarid rangelands that receive at least 13 inches of annual precipitation. It is adapted to foothills, sagebrush and juniper sites up to 8,000 feet elevation and on saline dry or wet bottomland. It is well-suited for sites with moderate to high levels of salinity and can be used for irrigated

and limited irrigation pasture. On a saline site near Roosevelt, Utah, forage yields of RS hybrid wheatgrass were similar to tall wheatgrass and intermediate wheatgrass, and significantly greater than Russian wildrye, creeping foxtail, basin wildrye and Altai wildrye.

Under irrigation, it yields significantly less than orchardgrass, tall fescue or meadowbrome but is significantly more drought tolerant than these grasses. Forage quality compares well with brome and orchardgrass and exceeds crested wheatgrass. Compared with intermediate wheatgrass, it has improved palatability and similar levels of drought tolerance. Although it is a cool season grass, its leaves retain their green color and succulence during the late summer better than other wheatgrass species, and if ample soil moisture exists, high quality forage is often available after seed maturity.

In two plant materials salinity trials conducted in Utah, RS hybrid wheatgrass (RS-H) performed well. RS-H and 'Newhy' performed about the same but it appeared that RS-H utilized nitrogen better and did not display chlorosis to the same extent as Newhy. Both materials were rated as having excellent palatability.

Establishment
Some problems exist with germination and seedling vigor which can reduce initial stands. However, once established, it becomes a vigorous, high yielding, nutritional forage that can withstand repeated grazing with good regrowth. Seed quality and germination is lower than other wheatgrass species and improved seed quality continues to be a breeding objective.

RS hybrid wheatgrass should be planted with a drill to a depth of ¼ to ½ inch. The single species seeding rate is 8 pounds PLS per acre. If used as a component of a mix, adjust to percent of mix desired. When broadcast planting seed and for harsh critical planting areas and saline sites, the seeding rate should be increased to 14 – 16 pounds PLS per acre. Excellent stands have been obtained on dryland sites when seed is planted in late fall to ensure that germination does not occur until the following spring. Spring seedings on dryland can be effective, but can be risky because weather conditions and excess soil moisture can delay planting until there is insufficient time for seeding establishment before hot temperatures of summer.

Stands may require weed control measures during establishment, but application of broadleaf herbicides such as 2,4-D should not be made until plants have reached the four to six leaf stage. Mow above seedlings when weeds are beginning to bloom to reduce weed seed production. Grasshoppers and other insects may damage new stands and use of insecticides may be required. Always read and follow label directions when applying pesticides.

Management
RS hybrid wheatgrass begins growth early in the spring, retaining succulence and palatability for livestock later in the summer than many grasses. It can provide two or more crops of hay with proper management and can withstand repeated grazing with good recovery. Another option to consider is to harvest a hay crop in early summer and graze regrowth in late fall or early winter. Under intensive management, RS hybrid wheatgrass requires at least 25 days between grazing events. During hot summer temperatures, resting periods should be extended to 35 days. It is very responsive and somewhat dependent on applications of nitrogen during the growing season. Split applications of nitrogen (approximately 50 pounds per acre) after each grazing cycle or cutting are recommended. However, if only one application is possible, apply nitrogen in the spring at approximately 150 to 200 pounds per acre. Soils should be tested to determine precise fertilizer application rates.

Pests and Potential Problems
RS hybrid wheatgrass has shown moderate susceptibility to injury by the grass billbug *Sphenophorus parvulus* under ideal soil and moisture conditions for this insect.

Environmental Concerns
Although RS hybrid wheatgrass is morphologically distinct, its seed is similar in appearance to the quackgrass parent. Therefore, to avoid problems with noxious weed laws, the cultivar 'Newhy' was licensed under Title 5 of the Plant Variety Protection Act of 1970. Conditions of this protection specify that Newhy seed can be marketed only as a class of Certified seed.

Contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for

each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Seed Production

Seed production of RS hybrid wheatgrass is very successful under cultivated conditions. For optimum seed production, seed should be drilled in 30 to 36 inch rows at 25 to 30 pure live seeds per foot of row. Application of fertilizer should be based on soil tests. Typically, new seedings should not need fertilizer unless soil tests indicate deficiency of nitrogen, phosphorus and potassium. Mature seed production fields should be fertilized in the fall with 40 to 60 pounds of nitrogen per acre. Cultivate to maintain row culture and to control weeds. Follow instructions on labels when using herbicides for weed control. Seed yields range from 200 pounds per acre on dryland areas receiving 16 or more inches of annual precipitation to 400 pounds per acre on irrigated land.

Since seed maturity within a seedhead is variable, harvest the field when most of the seeds are mature. Windrowing is a good alternative to direct combining because it allows seed to mature more evenly. The crop should be windrowed about a week before seed maturity. If crop is direct-combined, set the platform high enough to cut the seed and as little green growth as possible. Seed should be dried immediately after direct-combining.

Cultivars, Improved, and Selected Materials (and area of origin)

'Newhy' was developed and released by the USDA-ARS in December, 1989 in cooperation with the Utah Agricultural Experiment Station and the USDA-SCS. Breeder and Foundation seed is maintained and produced by the USDA-ARS at Logan, Utah. It is an artificial hybrid of *Elymus repens* and *Pseudoroegneria spicata*. Because of the morphological similarity of Newhy seed to that of quackgrass, the variety has protection under the Plant Variety Protection Act of 1970. The conditions of the license specify that Newhy seed can only be marketed as a class of Certified seed.

RS-H hybrid wheatgrass was developed and released in May, 2002 by the USDA-ARS in cooperation with the Utah Agricultural Experiment Station as Tested class Pre-variety Germplasm. RS-H is a natural hybrid and is cytologically similar to and is infertile with the cultivar Newhy but is less rhizomatous, taller in stature and has longer flag leaves than Newhy. Seed of RS-H is maintained by the USDA-ARS at Logan, Utah.

'AC Saltlander' was developed and released by Agriculture Canada, Prairie Agricultural Research Centre in Swift Current Saskatchewan in 2006. A series of mass selection breeding cycles were performed on RS-H hybrid wheatgrass obtained from the USDA-ARS. Evaluations for resistance to root-zone salinity, winter hardiness, uniform plant color, plant vigor, leafiness, seed-set and freedom from plant pests were conducted. The resulting progeny has salinity tolerance equal to tall wheatgrass (*Thinopyrum ponticum)*. A private seed company has exclusive rights to increase and market seed in Canada and the United States.

TIMOTHY
Phleum pratense

Timothy (*Phleum pretense*). James R. Johnson @ USDA-NRCS PLANTS Database / USDA NRCS. 1992. *Western wetland flora: Field office guide to plant species.* West Region, Sacramento.

Alternate Names

Herd grass, herd's grass, meadow cat's-tail, *Phleum nodosum*

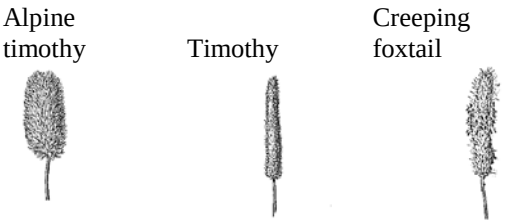
Description

General: Grass family (Poaceae). Timothy is a relatively short-lived, cool-season, introduced perennial grass that grows in stools or clumps. It has a shallow, compact, and fibrous root system. It grows in erect culms 20 to 40 inches tall. Leaves vary in length from a few inches to more than a foot and are about 0.25 inches wide, narrowing gently toward the tip. Seedheads are spike-like and dense, from 2 to 6 inches in length and 0.25 inches in diameter. The sheath is split and hairless with overlapping margins.

Timothy is different from most grasses in that one or occasionally two of the basal internodes of the stem swell into a bulb-like growth called a "haplacorm". This characteristic is often used for identification of the plant during its early stages of growth.

Timothy resembles the "native" alpine timothy (*P. alpinum*) to some extent. Alpine timothy is usually found in alpine meadows and bogs and occasionally at medium elevations along the west coast. Alpine timothy usually flowers in late July to early August in the mountains. The seedheads of alpine timothy are much shorter and the plant is also shorter in stature than timothy.

Timothy is also confused with meadow foxtail (*Alopecurus pratensis*) and creeping foxtail (*A. arundinaceus*). Meadow and creeping foxtail have short twisted awns giving the inflorescence a somewhat fuzzy appearance. Timothy is awnless. Additionally, cured seed heads of creeping foxtail have a dark to somewhat black appearance, while cured seed heads of timothy are tan to buff colored.



Differences in seedhead morphology between alpine timothy, timothy, and creeping foxtail. Ben Zamora, Oregon State University, Range Plant Leaflet No. 47. Seed head examples are not to scale.

Seed is very small and usually remains enclosed in the glumes. There are approximately 1,230,000 seeds per pound.

Timothy seed. Steve Hurst. Provided by ARS Systematic Botany and Mycology Laboratory.

Distribution
Timothy is distributed throughout the entire United States; however, it grows best in the northern half of the nation and along mountain chains further south. Agricultural use of timothy in the U.S. occurs primarily in the Northwest, upper Midwest, and Northeast. For a current distribution map, consult the Plant Profile page for this species on the PLANTS Website.

Habitat: Timothy can be found growing in waterways, dry to wet meadows and other mesic environments. It is commonly found volunteering in canals and roadside borrow ditches.

Uses
Livestock: Timothy is preferred by cattle and horses, and timothy hay is a premium feed for horses. Sheep utilize timothy during the summer in mountainous areas. Timothy is used for pasture and silage, but mostly for hay. It is palatable and nutritious. It makes a first rate companion grass with alfalfa, birdsfoot trefoil, or clover species as it is one of the grasses least competitive with legumes.

Erosion control: Timothy can be used with legumes and/or other grasses in seed mixtures for cover, filter strips, herbaceous buffers, waterways, and other critical area applications. It can also be used for erosion control on cut- or burned-over forestland. Keep in mind that timothy is shallow-rooted and thus should not be considered the primary species for erosion control plantings.

Wildlife: Timothy is commonly found in wildlife seed mixtures for nesting, brood rearing, and escape cover.

Weediness
Timothy is a relatively short-lived, introduced perennial grass that grows in stools or clumps. It spreads via seed distribution. It is not considered a "weedy" or invasive species, but can spread into adjoining vegetative communities under ideal climatic and environmental conditions. It is known to coexist with native plants. On favorable sites where it is best adapted, it can exist as a monoculture. There is no documentation that it crosses with native species. It is considered a weed in seed lots in the eastern states of Delaware, Maryland, New Hampshire, New Jersey, Pennsylvania, Virginia and West Virginia. Consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Adaptation
Timothy is an introduced bunchgrass adapted to cool, humid areas and to high elevations. It performs well, with moderate to high yields, on wet fertile lands. It is adapted to irrigation and areas with effective annual precipitation of at least 18 inches. It prefers finer textured soils, such as clays to clay loams to loams and is adapted to soils with a pH of 5.5 to 7.0. It is tolerant of partially shaded conditions. Timothy is very winter-hardy. It exhibits tolerance to both cold temperature, and ice encasement, a major factor affecting winter survival. It is not well adapted to wet, flat land where water stands for extended periods of time, though it can withstand somewhat poorly-drained soils. It does not tolerate drought or prolonged high temperatures and it does not tolerate alkaline conditions.

Timothy is compatible in mixes with legumes. It establishes cover quickly, volunteers readily on preferred sites, is late maturing, and is very palatable early in the growing season (jointing stage) and only moderately palatable later in the growing season (post seedhead development). Timothy hay is a premium feed for horses and is compatible in legume mixes. Severe damage can result from early grazing under wet conditions. It regrows very slowly following grazing or haying. Other recommended sites include cool, moist meadows and open forests.

Timothy establishes quickly and volunteers readily on preferred sites. It invades wet areas along ditches, canals, drains, and streams and can be a weed in these areas.

Establishment
Timothy is usually seeded in mixtures with legumes. This mixture may be planted with a small grain. If planted with a winter grain, the timothy is seeded with the grain in the fall, and the legume is planted early the following spring. Seeding depth of timothy should be about 0.3 to 0.125 to 0.5 inches. A firm, weed-free seedbed is a key to a successful planting. Common seeding rates are 3 to 6 pounds per acre when seeded alone and 1 to 3 pounds per acre when seeded in mixtures. Seeding rates should be doubled if seed is broadcast planted.

Management

Timothy is a short-lived, shallow-rooted, introduced, perennial bunchgrass. In spring, the crowns form swollen, bulblike internodes that store energy. Close grazing and trampling during moist conditions can damage these internodes and severely reduce stands.

Timothy should be grazed before the jointing stage and hayed before seed heads have emerged from boot to early bloom stage. Begin grazing during the vegetative stage, after grass has reached at least 6 inches in height. A 4 inch stubble height should remain following grazing. It regrows slowly following grazing or haying. A 28 to 35 day recovery period between grazing or haying cycles is recommended.

Timothy is highly responsive to fertilizers, which should be applied frequently based in accordance with soil tests. Fertilizer, especially nitrogen, is important when legumes such as clover species have almost disappeared from the hay or pasture mixture.

Timothy stands become weak under close and continuous grazing. A fundamental reason for the decline of timothy under poor grazing practices is injury to the bulblets (haplacorm). These bulblets form in the spring at the same time the stem elongates. Food reserves are stored in the bulblets, and they may be destroyed through trampling by grazing animals in the spring.

Timothy can be initially grazed before jointing and again between early head to full head. Second and successive grazing periods should occur before jointing and when basal sprouts appear at the soil surface. After the second grazing period, plants usually do not joint; therefore, sprouts are the primary grazing guide. Timothy should be cut for hay or silage from boot stage to early head or flowering stage. Make successive harvests for hay and silage when basal sprouts appear at the soil surface. Sterile seed-heads may be 15 to 20 inches up the stems when sprouts appear at the time of second cutting. Growing points stay below ground level after the second cutting. Graze or cut to heights of 4 inches or more.

Pests and Potential Problems

Stem rust is a disease that can cause loss of vigor and forage quality to timothy. Rust-resistant varieties have been developed to control this disease. Purple eyespot (*Cladosporium phlei*) and leaf streak (*Drechslera phlei*) are diseases commonly found across western Canada. Timothy is also damaged by brown leaf blight and grasshoppers. New fields are also susceptible to wireworm or cutworms. European skipper larvae (a bright orange butterfly) are a pest of timothy in eastern Canada.

Seed Production

Seed production fields should be soil tested before planting to determine soil nutrient levels and fertilizer needs. Seed should be drilled or broadcast into a weed free, firm seedbed. The optimum seeding depth is 0.125 to 0.5 inches. The drill seeding rate of 1 to 2 pounds PLS per acre in 18 to 24 inch rows provides a good stand. Wider row spacing may be beneficial to seed production in dry climates.

Under irrigated conditions, seed yields average 400 to 500 lb/ac. Seed production under dryland conditions is not recommended in the western United States. In the eastern United States, seed production yields of 300 to 400 lb/ac can be expected.

Timothy shatters readily but should not be swathed too soon. It is usually ready to swath when 5 to 10 percent of the seed have shattered (late July to early August). The seedheads will have a tan color and the stems and leaves will be a golden color. Swathing early in the morning will help reduce seed shatter. Allow 5 to 14 days of drying before combining.

Cultivars, Improved, and Selected Materials (and area of origin)

Most of the timothy grown in the U.S. is common timothy. Improved cultivars and places of development are: ‘Essex’ and ‘Cornell 1777’ (New York); ‘Lorain’ and ‘Marietta’ (Ohio); ‘Itasca’ (Minnesota); ‘Clair’ (Kentucky), and ‘Verdant’ (Wisconsin). Canadian releases are ‘Bounty’, ‘Climax’, ‘Drummond’, ‘Medon’, ‘Milton’, ‘Paton’, and ‘Swallow’. Common timothy and most cultivars can be readily obtained from commercial sources. There are many proprietary timothy varieties grown under contract for seed companies.

Tall Wheatgrass
Thinopyrum ponticum

Tall wheatgrass herbarium specimen. Photo by Anna Gardner, Ada Hayden Herbarium, Iowa State University

Alternate Names
Rush wheatgrass, *Agropyron elongatum Agropyron varnense, Elymus elongatus, Elytrigia elongata*, *Elytrigia pontica*,

Description
General: Grass family (Poaceae). Tall wheatgrass is a robust, long lived perennial bunchgrass reaching 3 to 10 feet tall. Leaves are green or glaucus bluish with blades flat to curling, 0.08 to 0.31 inches wide. The blades are often covered with short, stiff hairs making them scratchy to the touch. Auricles are well developed and ligules reach approximately 0.02 inches long. The inflorescence is a spike with a continuous rachis with 0.3 to 0.8 inch long internodes. Spikelets are solitary at each node each with five to 18 flowers. Glumes are thick and hardened, 0.2 to 0.4 inches long with 5 to 7 nerves. The tips of the glumes are truncate (abruptly rounded). Lemmas are also thick and hardened, 0.4 to 0.5 inches long with a truncate to acute apex. Anthers are 0.15 to 0.20 inches long.

Uses
Grazing/pasture/hayland: Tall wheatgrass is used for hay and pasture in the northern Great Plains and intermountain region. It produces high yields of good quality forage; however it is typically less palatable than other wheatgrasses. It is best suited for early season rotational grazing.

Erosion control: Tall wheatgrass is often used for erosion control along roadsides and other critical areas. It has been recommended in the northern Great Plains for passive terrace formation.

Saline and sodic soils: Tall wheatgrass is planted as forage on saline and sodic soils where few other species will survive. It is one of the most saline tolerant grasses commercially available. In the San Joaquin Valley of California, it is used to manage salinity in irrigation water recovery systems.

Nutrient removal: In Texas, applications of composted dairy manure increased dry matter yields and phosphorus and potassium concentrations in tall wheatgrass, indicating it could be used for nutrient removal.

Wildlife: Tall wheatgrass provides nesting cover and food for upland birds. Because of its late maturing characteristic, tall wheatgrass provides a long grazing period.

Distribution
Tall wheatgrass is originally from Turkey, Asia Minor and Russia. It was introduced to the U.S. from Turkey in 1909 and is now found throughout all western states of the U.S. and most Canadian provinces.

Adaption
Tall wheatgrass is adapted to a wide range of soil types and climates. It is often recommended for 12 to 14 inch and higher precipitation zones or sites with high water tables at 4,300 to 6,000 feet elevation zones. It is well adapted to wet, alkaline soils such as greasewood and saltgrass communities where the water table is from a few inches to several feet below ground surface. It is less drought tolerant than crested wheatgrass, however it is adapted to sagebrush, mountain brush and juniper sites. Basin wildrye is a good

indicator of where tall wheatgrass will be successful.

Tall wheatgrass is one of the most saline or alkali tolerant cultivated grasses. It can tolerate up to 1% soluble soil salts. Tall wheatgrass increases production yields with salinity levels of 6,000 to 18,000 ppm and persists in soils with conductivity up to electrical conductivity (EC) of 26 mmhos/cm.

Tall wheatgrass production field. Photo by Greg Fenchel, USDA NRCS NMPMC, Los Lunas, NM

Establishment

Tall wheatgrass should be planted with a drill into a firm, weed-free seed bed. The drill should be set to a depth of ½ of an inch on medium to fine textured soils and no more than 1 inch deep on coarse textured soils. Recommended seeding rates are 10 pounds Pure Live Seed (PLS) per acre on non-saline soils and 15 pounds PLS per acre on saline soils. It is usually seeded in pure stands or in mixtures with grasses also having moderate palatability. If seeded in a mix, adjust seeding rate accordingly. Under dryland conditions, heavy to medium textured soils should be seeded in the very early spring, and medium to light textured soils should be seeded in the late fall. Irrigated land should be seeded in spring or late summer. Late summer (August – September) seedings are not recommended unless irrigation is available.

Tall wheatgrass has excellent seedling vigor but is slow to establish. Applications of 2,4-D may be necessary to control weeds. The herbicide should not be applied until plants have reached four to six leaf stage. Weeds should be mowed at or prior to bloom stage.

To ensure plants become well established, haying and grazing should be deferred for at least two growing seasons on dryland one growing season on irrigated land.

Management

Tall wheatgrass responds well to irrigation and fertilization. Apply nitrogen in fall or early spring at a rate based on soil test results and fertilizer guide recommendations.

To maintain stands, 6 inches of stubble should be left at the end of the growing season. Grazing the following season should be delayed until there is at least 8 inches of new growth. Tall wheatgrass is most palatable during the early spring months and should be managed during this time. If the grass is not managed, old coarse growth may inhibit grazing the following year. Tall wheatgrass must be grazed heavily to maintain plants in the vegetative state. However it does not tolerate continuous close grazing and a rest period is required between grazing events. Highest yields of tall wheatgrass were produced when clipped at 4 week intervals. Supplemental protein must be provided if used for winter forage.

Tall wheatgrass is long-lived and spreads slowly. It is not considered a "weedy" or invasive species, but can spread into adjoining vegetative communities under favorable climatic and environmental conditions. Research indicates that most seedings do not spread from original plantings. It is known to coexist with native taxa. On sites where it is best adapted, it can maintain dominance and exist as monoculture. There is no documentation that it crosses with native species.

Cultivars, Improved and Selected Materials (and area of origin)

Six cultivars of tall wheatgrass have been released in the U.S. and Canada. Four of the six cultivars: Alkar, Nebraska 98526, Orbit and Platte, were all derived from PI 98526, which

was presented to the USDA by N.I. Vavilov in 1932.

'Alkar' tall wheatgrass was developed by the NRCS Pullman PMC with seed originating from PI 98526. It was released in 1951, under accession P-2326 for certified seed production in Idaho, Washington and Oregon. In 1958 it was named 'Alkar' and was accepted for certification in those states and California. Its intended use was for pasture in wet, alkaline conditions and semi-arid regions of the west within 270 to 5,500 feet elevation. Certified seed is commercially available and the Pullman PMC maintains breeder seed.

'Jose' tall wheatgrass was selected at the former NRCS nursery in Albuquerque, MM from seed received by Beltsville, MD as BN-3654 and PI 150123. It is native to Eurasia but was introduced from Australia. It was selected for its drought and saline tolerance. The nursery released 'Jose' in 1965 cooperatively with the New Mexico AES and Plant Materials Center in Los Lunas, NM. It is used in areas where only very saline water is available for use. It is not as coarse as other tall wheatgrasses. Certified seed is commercially available and breeder seed is maintained by the Los Lunas PMC.

'Largo' tall wheatgrass was developed by the former NRCS nursery in Albuquerque, NM as A-1876, and at Utah AES, Logan, ARS cooperating, as PI 109452. Seed was originally collected by the Westover-Enlow expedition near Bandirma, Turkey. It was introduced as *Agropyron intermedium* (Host) Beauv., now *Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey, and later identified as *A. elongatum* (Host) Beauv. It was selected for forage production on saline and sodic soils. The Los Lunas PMC maintains breeder seed. Certified seed is not commercially available. 'Largo' has been replaced by 'Jose'.

'Nebraska 98526' tall wheatgrass was increased at NRCS nurseries in cooperation with Nebraska AES in Lincoln. The seed was first grown at Colorado AES in Fort Collins, and in 1936 distributed by the NRCS as PI 98526 to nurseries in the Dakotas and Nebraska. In 1950 it was grown on Nebraska farms for seed production under field certification by Nebraska Crop Improvement Association on recommendation of Nebraska AES, NRCS and ARS. Its intended use was for sodic and saline soils in the central and northern Great Plains and intermountain west. It has been replaced by the variety 'Platte', and is no longer commercially available. Nebraska AES maintains breeder seed.

'Orbit' tall wheatgrass was developed by the Canada Department of Agriculture Research Station in Swift Current, Saskatchewan. It was developed from crosses made between 'Nebraska 98526' and locally selected strains. It was released in 1966 by the Canada Department of Agriculture. It was selected for its superior winter hardiness and was intended for hay, pasture and conservation plantings in the northern Great Plains. It withstands flooding for three to four weeks in the spring. Certified seed is commercially available. The Canada Department of Agriculture Research Station in Swift Current maintains breeder seed.

'Platte' tall wheatgrass was developed by the Nebraska AES in Lincoln, ARS, with L.C. Newell cooperating. It was developed as a cross between 'Nebraska 96526' and a selection of introductions with unknown origin from the Cheyenne, WY, Horticultural Field Station. It was released in 1972 cooperatively by the Nebraska AES and USDA-ARS, University of Nebraska-Lincoln. Its intended use was for vegetating saline-alkali soils in the Great Plains. Certified seed is commercially available. The Nebraska AES and USDA-ARS, University of Nebraska-Lincoln maintains breeder seed.

APPENDIX
CHARACTERISTICS OF HERBACEOUS SPECIES FOR RIPARIAN REVEGETATION IN INTERMOUNTAIN WEST

Table 1. Species Description

Latin Name	Common Name	Origin	Plant Height (in)	Character	Rate of Spread	Plant Indicator Status[1]
Agrostis spp.	Redtop bentgrass	Introduced	18-36	Sod	Rapid	FACW
Alopecurus arundinacea	Creeping foxtail	Introduced	24-48	Sod	Rapid	FACW
Beckmannia syzigachne	Sloughgrass	Native	36	Sod	Rapid	OBL
Calamagrostis canadensis	Blue-joint reedgrass	Native	24-36	Sod	Medium	FACW+
Carex aquatilis	Water sedge	Native	10-24	Sod	Medium	OBL
C. nebrascensis	Nebraska sedge	Native	10-24	Sod	Medium	OBL
C. utriculata	Beaked sedge	Native	10-40	Sod	Rapid	OBL
Deschampsia cespitosa	Tufted hairgrass	Native	18-30	Bunch	Medium	FACW
Distichlis spicata	Inland saltgrass	Native	12-18	Sod	Medium	FACW
Eleocharis palustris	Spikerush	Native	6-30	Sod	Rapid	OBL
Elymus hoffmannii	RS Hybrid wheatgrass	Introduced	8-18	Sod	Slow	FAC
Glyceria elata	Mannagrass	Native	24-36	Sod	Rapid	OBL
Juncus balticus	Baltic rush	Native	18-24	Sod	Medium	OBL
J. ensifolius	Swordleaf rush	Native	12-24	Sod	Medium	OBL
J. mertensianus	Mertens' rush	Native	4-16	Sod	Medium	OBL
J. tenuis	Poverty rush	Native	6-12	Sod	Slow	OBL
Phleum pratensis	Timothy	Introduced	24-48	Sod	Medium	FACU
Puccinellia nuttalliana	Alkali grass	Native	6-12	Bunch	Medium	OBL
Schoenoplectus acutus	Hardstem bulrush	Native	60-72	Sod	Rapid	OBL
S. maritimus	Cosmopolitan bulrush	Native	24-36	Sod	Medium	OBL
S. pungens	Common threesquare	Native	24-48	Sod	Rapid	OBL
Spartina pectinata	Prairie cordgrass	Native	24-48	Sod	Rapid	FACW
Thinopyrum ponticum	Tall wheatgrass	Introduced	36-120	Bunch	Rapid	FAC
Typha latifolia	Cattail	Native	60-72	Bunch	Rapid	OBL

[1]Plant Indicator Status: OBL =Obligate; FACW=Facultative Wetland; FAC=Facultative; FACU=Facultative Upland; Upland=Upland

Table 2. Species Adaptation						
Latin Name	**Common Name**	**Elevation Range**	**Hydrologic Regime**	**Acidity Tolerance**	**Saline Tolerance**	**Flood Tolerance**
Agrostis spp.	Redtop bentgrass	Low-Med.	Seasonally Flooded	High	Low	High
Alopecurus arundinacea	Creeping foxtail	Low-Med.	Seasonally Flooded	Med.	Med.	High
Beckmannia syzigachne	American Sloughgrass	Low-Med.	Seasonally Flooded	Unknown	Unknown	High
Calamagrostis canadensis	Blue-joint reedgrass	Med.-High	Seasonally Saturated	Med.	Low	High
Carex aquatilis	Water sedge	Med.-High	Up to 3”	Med.	Low	High
C. nebrascensis	Nebraska sedge	Low-High	Seasonally Saturated	Low	Med.	High
C. utriculata	Beaked sedge	Low-High	Seasonally Saturated	Med.	Low	High
Deschampsia cespitosa	Tufted hairgrass	Med.-High	Seasonally Saturated	Med.	Med.	High
Distichlis spicata	Inland saltgrass	Low-Med.	Seasonally Saturated	Low	V. High	High
Eleocharis palustris	Spikerush	Low-High	Seasonally Flooded, up to 6”	Low	Med.	High
Elymus hoffmannii	RS Hybrid wheatgrass	Low-Med.	Seasonally Saturated	Low	V. High	High
Glyceria elata	Mannagrass	Med.-High	Seasonally Flooded	Unknown	Low	High
Juncus balticus	Baltic rush	Low-High	Seasonally Saturated	Med.	Med.	High
J. ensifolius	Swordleaf rush	Low-High	Seasonally Saturated	Med.	Med.	High
J. mertensianus	Mertens’ rush	Med.-High	Saturated, Seasonally Saturated	Unknown	Unknown	High
J. tenuis	Poverty rush	Med.-High	Saturated, Seasonally Saturated	Unknown	Unknown	Med.
Phleum pratensis	Timothy	Low-High	Seasonally Flooded	Med.	Low	High
Puccinellia nuttalliana	Alkali grass	Low-Med.	Seasonally Saturated	Low	High	High
Schoenoplectus acutus	Hardstem bulrush	Low-High	Up to 36”	Low	High	High
S. maritimus	Cosmopolitan bulrush	Low-Med.	Up to 6”	Low	High	High
S. pungens	Common threesquare	Low-Med.	Up to 6”	Low	Med.	High
Spartina pectinata	Prairie cordgrass	Low-Med.	Seasonally Flooded	Low	Med.	High
Thinopyrum ponticum	Tall wheatgrass	Low-Med.	Seasonally Flooded	Low	High	High
Typha latifolia	Cattail	Low-Med.	Up to 12”	Med.	High	High

Table 3. Seeding and Transplanting Information						
Latin Name	**Common Name**	**Commercial Availability**	**Availability in Field**	**Seed/lb**	**Hydrologic Planting Zones**	**Seeding Rate[1] (lbs PLS/ac)**
Agrostis spp.	Redtop bentgrass	Seed	NA	4,990,000	3-5	0.5
Alopecurus arundinacea	Creeping foxtail	Seed	NA	750,000	3-6	3
Beckmannia syzigachne	American Sloughgrass	Seed & Plugs	Fairly Common	238,000	3-5	5
Calamagrostis canadensis	Blue-joint reedgrass	Seed & Plugs	Common	3,837,000	3-5	0.5
Carex aquatilis	Water sedge	Seed & Plugs	Fairly Common	408,600	2-4	3
C. nebrascensis	Nebraska sedge	Seed & Plugs	Common	1,225,000	2-4	2
C. utriculata	Beaked sedge	Plugs	Common	444,000	2-4	3
Deschampsia cespitosa	Tufted hairgrass	Seed	Common	2,500,000	3-4	1.5
Distichlis spicata	Inland saltgrass	Seed & Plugs	Very Common	519,000	3-5	4
Eleocharis palustris	Spikerush	Seed & Plugs	Very Common	1,335,000	2-5	1
Elymus hoffmannii	RS Hybrid wheatgrass	Seed	NA	139,000	3-6	8
Glyceria elata	Mannagrass	Seed & Plugs	Fairly Common	1,600,000	3-5	1.5
Juncus balticus	Baltic rush	Seed & Plugs	Very Common	7,500,000	2-6	0.3
J. ensifolius	Swordleaf rush	Seed & Plugs	Fairly Common	24,000,000	2-5	0.1
J. mertensianus	Mertens' rush	Seed & Plugs	Fairly Common	45,400,000	3-5	0.05
J. tenuis	Poverty rush	Plugs	Fairly Common	16,000,000	3-5	0.2
Phleum pratensis	Timothy	Seed	NA	1,230,000	3-6	3
Puccinellia nuttalliana	Alkali grass	Seed & Plugs	Common	2,108,000	3-6	1
Schoenoplectus acutus	Hardstem bulrush	Seed & Plugs	Very Common	504,000	2-4	2
S. maritimus	Cosmopolitan bulrush	Seed & Plugs	Common	195,000	2-5	6
S. pungens	Common threesquare	Seed & Plugs	Very Common	220,000	2-4	5
Spartina pectinata	Prairie cordgrass	Seed & Plugs	Fairly Common	639,000	2-5	3.5
Thinopyrum ponticum	Tall wheatgrass	Seed	NA	78,000	3-6	10
Typha latifolia	Cattail	Seed & Plugs	Very Common	10,000,000	2-4	0.2

[1]Seeding rates are based on full stands with a target of 20 to 30 seeds/ft² for the larger seed size accessions (< 500,000 seeds per pound), and 40 to 50 seeds/ft² for the smaller seed size accessions (> 500,000 seeds per pound).

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RIPARIAN/WETLAND PLANT NURSERIES & CONTRACTORS 2011

Note: *This list is not intended to be exclusive, nor does it imply an endorsement of those listed*

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Hobbs & Hopkins, Ltd.
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Portland, OR 97214
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IFA Nurseries, Inc.
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North Fork Native Plants
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Driggs, ID 83422
(877) 444-6996

Northplan / Mountain *Seed*
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Moscow, ID 83843
PH: (208) 882-8040

Oasis Environmental, MT
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Livingston, MT 59047
PH: (406) 222-7600

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Western Native Seed
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Salida, CO 81201
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Westlake, OR 97493
PH:(503) 997-3803

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Bozeman, MT 59715
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Parkdale, OR 97041
PH: (503) 352-7497

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American Water Resources
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PH: (208) 788-2860

TerraGraphics Env. Inc
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Moscow, ID
PH: (208) 882-7858