

Categorization of selected native species suitability for constructed wetlands - a comprehensive review.

Common Name	Scientific name	Growth habit / Duration	Active growth period	Growth Rate	Propagation Method	pH Range
Alkalai (Maritime) bulrush	<i>Scirpus maritimus</i>	Graminoid / Perennial	Spring, Summer	Slow	Rhizomes/Seed	4 - 7
American bulrush	<i>Scirpus americanus</i>	Graminoid / Perennial	Summer	Moderate	Rhizomes/Seed	3.7 - 7.5
Common cattail	<i>Typha latifolia</i>	Forb-herb / Perennial	Spring, Summer	Rapid	Rhizomes	5.5 - 7.5
Inland saltgrass	<i>Distichlis spicata</i>	Graminoid / Perennial	Spring, Summer, Fall	Slow	Rhizomes	6.4 - 10.5
Baltic rush	<i>Juncus balticus</i>	Graminoid / Perennial	Spring, Summer	Rapid	Rhizomes/Seed	6 - 9
Prairie cordgrass	<i>Spartina pectinata</i>	Graminoid / Perennial	Spring, Summer	Rapid	Rhizomes/Seed	6 - 8.5
Creeping spikerush	<i>Eleocharis palustris</i>	Graminoid / Perennial	Spring	Moderate	Rhizomes/Seed	4 - 8
Streambank wheatgrass	<i>Pascopyrum smithii</i>	Graminoid / Perennial	Spring, Summer, Fall	Moderate to Rapid	Rhizomes/Seed	4.5 - 9
Canada wildrye	<i>Elymus canadensis</i>	Graminoid / Perennial	Spring, Summer, Fall	Rapid	Tillers/Seed	5 - 7.9

Table References:

Uchytel, 1990; Snyder, 1992a; Snyder, 1992b; Uchytel, 1992a; Uchytel, 1992b; Hoag, 1998a; Hoag, 1998b; Hoag, 1998c; Hoag, 1998d; Simonin, 2000; Hoag et al., 2001; USDA-NRCS, 2004; Prairie Seeds, 2004.

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Common Name	Lysimeter Position	Wetland Indicator Status ^A	Pioneer	Competitive	Nitrogen Fixer	C:N Ratio ^B	Root Depth	Root Matrix
Alkalai (Maritime) bulrush	Lower	OBL	Yes	No	No	High	12"	Yes
American bulrush	Lower	FAC, FACW	Yes	Yes	No	Med	14"	Yes
Common cattail	Lower	OBL	Yes	Very	No	High	14"	Yes
Inland saltgrass	Middle	FAC, FACW	Yes	No	No	High	2"	Yes
Baltic rush	Middle	FACW, OBL	Yes	No	Yes*	Med	20"	Yes
Prairie cordgrass	Middle	FACW, OBL	Yes	No	No	High	18"	N/A
Creeping spikerush	Upper	OBL	Yes	No	Yes*	High	14"	Yes
Streambank wheatgrass	Upper	N/A	Yes	No	No	Med	20"	Yes
Canada wildrye	Upper	FACU, FAC	Yes	No	No	Med	16"	No

Explanation of symbols used in this table:

A - Wetland Indicator Status - See Table 2. USDA-NRCS. 2004.

B - Carbon to nitrogen ratio. USDA-NRCS. 2004.

C:N >12 slow decomposition and accumulation. C:N <12 rapid decomposition and accumulation.

* - Reported in PLANTS Database, USDA-NRCS, 2004.

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Common Name	Salinity Tolerance ^C	Anaerobic Tolerance ^D	Drought Tolerance ^E	Moisture Use	Soil adaptation fine/med/coarse	Sustainability Fresh/saline/brackish
Alkalai (Maritime) bulrush	High 77 dS/m*	High	Low	Moderate	ALL	Fresh/saline/brackish
American bulrush	High 42.5 dS/m*	High	Mod-high	Moderate	Fine/Medium	Fresh/saline/brackish
Common cattail	Low-High 17.5 dS/m*	High	None	High	ALL	Fresh/slightly brackish
Inland saltgrass	High 70 dS/m*	High	Moderate	Moderate	Fine/Medium	Fresh/saline/brackish
Baltic rush	High	High	Low	High	ALL	Fresh/slightly saline
Creeping spikerush	Low	High	Low	High	Medium/Coarse	Fresh/slightly saline
Prairie cordgrass	None	High	Low	High	Fine/Coarse	Fresh/slightly saline
Streambank wheatgrass	High 34 dS/m*	Moderate	Moderate to high	Moderate	Medium/Coarse	Fresh/slightly saline
Canada wildrye	Moderate	None	Moderate	Moderate	ALL	Fresh/slightly saline

Explanation of symbols used in this table:

C - Salinity tolerance - Low < 4 dS/m, Mod 4 - 9 dS/m, High > 9 dS/m (Brady and Weil, 1999). USDA-NRCS, 2004.

*From Aronson, 1989.

D - Anaerobic tolerance - USDA-NRCS. 2004.

E - Drought tolerance - USDA-NRCS. 2004.

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Common Name	Forage Quality ^F	Grazing Preference	Resistance to grazing/trampling	Conservation Uses
Alkalai (Maritime) bulrush	Low	Livestock will consume young plants	N/A	Erosion control, wastewater treatment, creation/restoration of wetlands, bank stabilization
American bulrush	Low	Livestock, wildlife -early season	Yes	Erosion control, wastewater treatment, creation/restoration of wetlands, bank stabilization
Common cattail	Low	Waterfowl, muskrats	Will tolerate moderate grazing	Highly invasive-not used for conservation
Inland saltgrass	Fair	Livestock, wildlife	Yes	Good for reclamation of saline sites
Baltic rush	Low to very good	Hay crop for cattle. Forage for livestock and elk	Will increase with heavy grazing	Erosion control, wastewater treatment, creation/restoration of wetlands, bank stabilization
Creeping spikerush	Med-high in Spring	Livestock, big game, ducks, geese	Yes	Erosion control, creation/restoration of wetlands, bank stabilization, sediment trap
Prairie cordgrass	Low	Muskrats, livestock waterfowl	Will tolerate moderate trampling	Erosion control, creation/restoration of wetlands, stabilization, species diversity
Streambank wheatgrass	High in spring	Livestock, big game	Moderate sod formation	Erosion control, reclamation, stabilization
Canada wildrye	Med	Livestock, wildlife	Yes, short-lived	Restoration, erosion control - plants live 2-4 yrs

Explanation of symbols used in this table:

F - Forage quality - Based on crude protein content. USDA-NRCS. 2004.

Selected Plant Species Descriptions

Maritime or Alkali bulrush (*Scirpus maritimus*) is a heavily rhizomatous, native perennial wetland plant found in areas with saturated soils or standing water up to 1 meter deep (Hoag, 1998b; Hoag et al., 2001; USDA-NRCS, 2004). It propagates best when the water table is within 10 cm of the surface (Hoag, 1998b; USDA-NRCS, 2004). Alkali bulrush typically occurs on freshwater sites, but will also form large, dense stands in either alkaline or saline sites, preferring a pH range of four to seven but tolerating values up to nine (Hoag, 1998b; USDA-NRCS, 2004). It is a pioneering species and is usually replaced by other species under good soil and water conditions (Hoag et al., 2001). Mandel and Koch (1992) reported that the large carbon reserves of Alkali bulrush maintain carbohydrate levels through metabolic conservation, and are not affected when under anoxia stress. Alkali bulrush is an excellent choice for wastewater treatment as the rhizomes form a matrix for beneficial bacteria (Mandel and Koch, 1992; USDA-NRCS, 2004). When alkali bulrush is grown at or above the water surface it produces fewer seeds, but has better shoot survivorship, and produces a greater number of tillers, thereby increasing production of underground biomass (Mandel and Koch, 1992; Kantrud, 1996). If it is grown in deeper water it produces a greater number of seeds, but less underground biomass, tillers, and total biomass (Mandel and Koch, 1992). Seeds and rhizomes are food for waterfowl, game birds and songbirds as well as muskrat and beaver (Hoag, 1998b; Hoag et al., 2001; USDA-NRCS, 2004). Reports on use by grazers vary; Kantrud (1996) states that cattle and horses readily graze the young plants while others say grazers rarely use this species (Hoag, 1998b; Hoag et al., 2001; USDA-NRCS, 2004).

Inland saltgrass (*Distichlis spicata*) is a highly salt tolerant, native perennial common in sloping and flood channel bank configurations in drainage systems of Wyoming and the western United States (Uchytel, 1990; USDA-NRCS, 2004). Growth is rapid with plants spreading via a well-developed system of deep underground rhizomes (Uchytel, 1990; USDA-NRCS, 2004). Inland saltgrass has moderate water use rates, and water tables are often at or near the surface (Uchytel, 1990; USDA-NRCS, 2004). Inland saltgrass can withstand anaerobic conditions, and

rhizomes will sprout even when covered by 30cm of sediment (Uchytel, 1990). The lacunae tissue of the roots is apparently continuous with the rhizome and leaf sheath which allows for gas exchange under partial inundation and in heavy soils (Uchytel, 1990). It tolerates slightly acidic to highly alkaline pH values (6.4 - 10.5), (USDA-NRCS, 2004). Inland saltgrass is highly salt tolerant, persisting in EC values up to 70 dS/m (56,000 ppm) (Ungar, 1974). Salt glands are active in the extrusion of salt, which helps maintain adequate osmotic potentials (Uchytel, 1990). Vesicular-arbuscular mycorrhizal fungi have been observed on inland saltgrass roots and are thought to further enhance salt tolerance (Uchytel, 1990). It is a pioneer species, colonizing barren, saline soils with the aid of sharp, pointed rhizomes which are well adapted to piercing heavy clays and shales, effectively loosening hard packed soil. The ability of Inland saltgrass to loosen hard packed soil may help other plants become established (Uchytel, 1990; USDA-NRCS, 2004). Inland saltgrass provides fair forage for cattle and horses because it remains green during periods of drought when most other grasses are dry; ducks are reported to occasionally eat the dried seeds and burning provides tender forage for wild geese (Uchytel, 1990; USDA-NRCS, 2004).

Creeping spikerush (*Eleocharis palustris*) is a native perennial hemicryptophyte that grows along marshes, ditches and streambanks, and in lakeshores, river bottoms, wet meadows and flood areas (Snyder, 1992a; Hoag, 1998d; Hoag et al., 2001; USDA-NRCS, 2004). Reproduction is rhizomatous with rapid vegetative spread, and rhizomes will spread into areas too deep for seedling establishment (Snyder, 1992a; Hoag, 1998d). Creeping spikerush develops a thick root mass that can extend 40+ cm in the soil profile, giving it the ability to resist erosion and compaction, and survive in areas where the water table drops to below 30cm of the surface (USDA-NRCS, 2004). It has high water use rates and will tolerate standing water up to 15 cm deep and three to four months of flooding (Hoag et al., 2001; USDA-NRCS, 2004). Creeping spikerush has a low salinity tolerance, and the optimum pH range is 4 - 8 (USDA-NRCS, 2004). It is a nitrogen fixer, and through recycling, makes nitrogen available to other plants in the wetland (Snyder, 1992a; Hoag et al., 2001). The seeds and rhizomes are food for ducks and geese while rabbits,

muskrats, big game and other grazers utilize it for its high spring protein content (Hoag, 1998d; Hoag et al., 2001; USDA-NRCS, 2004).

Common cattail (*Typha latifolia*) is a native perennial that reproduces by seed dispersal and rapid vegetative propagation from rhizomes (Lorenzen et al., 2000; USDA-NRCS, 2004). Preferred habitats are marshes and pond edges with season-long saturated soils, and/or standing or slow moving water up to 30 cm deep (Allen et al., 1992; Uchytel, 1992b; Hoag et al., 2001; USDA-NRCS, 2004). Reports on salinity tolerance vary widely (Uchytel, 1992b; Hoag et al., 2001; USDA-NRCS, 2004) but, in general, cattails have moderate to high salinity tolerance. Cattails have high water use rates, and can withstand perennial flooding and reduced soil conditions (Allen et al., 1992; Hoag et al., 2001). At the appropriate stage of growth, all parts of the cattail are edible, but forage quality is only high in early spring for livestock and big game and by summer it is a poor protein and energy source (Uchytel, 1992b; USDA-NRCS, 2004).

Prairie cordgrass (*Spartina pectinata*) is a native, rhizomatous species found in a variety of habitats from low-lying roadsides, marshes, streams and flood plains to seasonally dry sites (Hoag et al., 2001; USDA-NRCS, 2004). Two very noticeable features of prairie cordgrass are the presence of aggressive rhizomes, which have the ability to grow 2.5 - 3.5 meters per year and a dense, deep root system with root biomasses up to 3000 g/m² (USDA-NRCS, 2004). Although it is typically a freshwater species, it will tolerate moderate salinity and alkaline conditions (Hoag et al., 2001; USDA-NRCS, 2004). It has high water use rates, can grow streamside in 0.3 m of water, and will tolerate extensive temporary flooding, high water tables and occasional drought (Walkup, 1991). The seeds and rhizomes are food for small mammals, and waterfowl (Hoag et al., 2001). Reports on forage quality are contradictory; Hoag et al. (2001) states that the plants provide high quality forage for muskrats, geese, livestock and other grazers, while the USDA-NRCS (2004) states that it is not a forage resource.

Canada wildrye (*Elymus canadensis*) is a native cool-season bunchgrass inhabiting disturbed sites from riparian areas to wetlands (Simonin, 2000; Prairie Seeds, 2004; USDA-NRCS, 2004). It is typically found along incised channel banks of ephemeral streams in north-central

Wyoming, and along the Missouri River flood plain in Montana (Simonin, 2000). Canada wildrye tolerates a range of hydrological regimes, showing fair to good flood tolerance and moderate water use rates (Prairie Seeds, 2004; USDA-NRCS, 2004). It is a quick starter, and can be prolific from seeds or tillers (Simonin, 2000). It has been noted to be fairly salt tolerant and prefers neutral to alkaline pH (Simonin, 2000; USDA-NRCS, 2004). Canada wildrye provides good early season forage, and good fall regrowth for late-fall and spring forage, but once mature is generally considered inferior (Prairie Seeds, 2004; USDA-NRCS, 2004).

American bulrush (*Schoenoplectus americanus*) is a native perennial, commonly found in backwater areas of streams, lakes, ponds, swamps, wet woods and roadside ditches (Mandel and Koch, 1992; Hoag, 1998a; Hoag et al., 2001; USDA-NRCS, 2004). It has a robust root system, with medium to rapid rates of rhizomatous spread. American bulrush is an obligatory wetland plant which tolerates freshwater, alkaline and saline conditions, and is reported as surviving in brackish waters with EC values of 42.5 dS/m (Uchytel, 1992a). Although it prefers a neutral pH, it can tolerate pH values up to 8.9 (Mandel and Koch, 1992). American bulrush will endure long periods of drought or water levels 5 - 10 cm above the surface for 3 - 4 weeks but growth is inhibited in greater than 60 cm of water (USDA-NRCS, 2004). Seeds and rhizomes of the plant provide food for muskrats, geese and other waterfowl, and grazers will use it for forage in early growth stages but palatability and production are low (Uchytel, 1992a).

Baltic rush (*Juncus balticus*) is the most common and widespread rush in the dry Intermountain and Great Basin regions (Snyder, 1992b; Hoag, 1998c; Hoag et al., 2001). It is a rhizomatous, native perennial found from low elevations to subalpine and alpine sites (Snyder, 1992b; Hoag, 1998c; Hoag et al., 2001; USDA-NRCS, 2004). Typical habitats are wet depressions, marshes, springs and pond or stream edges. Favored environmental conditions are areas which are flooded in spring and dry out in the fall (Hoag, 1998c). *Juncus* species can tolerate a wide range of hydrologic conditions, from severe drought with water tables 3 m or more below soil surface to extreme flooding (Hoag et al., 2001). Baltic rush

is found in a wide range of soil types as well, from acidic to neutral, alkaline or sodic (Hoag, 1998c). Baltic rush is an important part of the nutrient dynamics of wetland plants communities because of its ability to fix nitrogen (Hoag, 1998c). It is resistant to erosion and trampling because of dense root systems (Snyder, 1992b), which also form a matrix for beneficial bacteria (USDA-NRCS, 2004). Baltic rush is an important forage species for livestock and elk, and is used as hay for cattle, although palatability decreases as the season progresses (Snyder, 1992b; Hoag et al., 2001). Seeds and rhizomes are food for small mammals, waterfowl and upland game birds, while the plants provide important cover (Hoag et al., 2001).

Streambank wheatgrass (*Elymus lanceolatus*) is a native perennial sod-forming grass (USDA-NRCS, 2004). It has an extensive rhizomatous root system, and vegetative propagation occurs primarily by rhizomes (USDA-NRCS, 2004). Streambank wheatgrass is found in slightly acidic to moderately saline conditions. It will tolerate moderate flooding and has high drought tolerance, but prefers seasonally saturated upland or terrace soils (USDA-NRCS, 2004). Streambank wheatgrass provides good early season forage for livestock and wildlife until fall when the plant dries out and becomes coarse (USDA-NRCS, 2004).

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