# Kentucky bluegrass

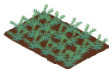
*Poa pratensis*

Kentucky bluegrass is often used in roadside mixes because it is widely available commercially and produces dense sod that is good at stabilizing soil. The species has excellent freezing tolerance and is an aggressive competitor such that it will persist in cool climates. However, Kentucky bluegrass receives a Poor to Good rating (grade = D+) as a turfgrass for roadside management owing to a variety of management concerns:

Kentucky bluegrass provides very poor ecosystem benefits. It is a non-native species that may become invasive in some areas outside of Maryland. It also has high nutrient leaching potential.

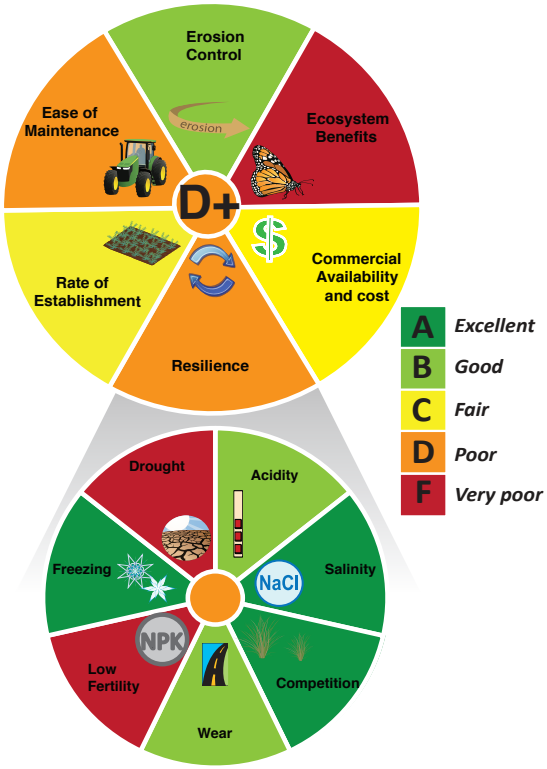
Kentucky bluegrass is moderatly expensive when seeded in a large area.

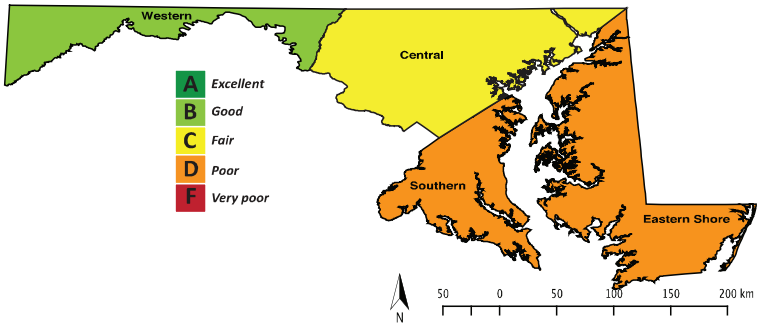
Although a low-stature plant, Kentucky bluegrass requires fertilization and irrigation to maintain turf quality.



Kentucky bluegrass germinates slowly and has a long juvenile stage. It is therefore slow to establish.

Kentucky bluegrass has poor resilience because it is sensitive to drought, low fertility, and salinity, allof which are conditions frequently encountered along roadsides.




Owing to its freezing tolerance, it is most adapted to Western Maryland and somewhat Central Maryland but is likely to perform poorly in Southern Maryland and the Eastern Shore due to drought susceptibility. For these reasons, Kentucky bluegrass is not recommended for planting along Maryland roadsides.

Proven and promising Kentucky bluegrass cultivars for Maryland include Aries, Barvette HGT, Beyond, Bluebank, Blue Coat, Blue Note, Cabernet, Diva, Endurance, Everglade, Full Back, Granite, Hampton, Impct, Keenland, Legend, Midnight, Noble, NuChicago, NuGlade, Oasis, Skye, Solar Eclipse, Sudden Impact, and Touche.

Biology: Kentucky bluegrass is a perennial cool-season turfgrass species that is native to Eurasia (Beard 1973) and was introduced as an agronomic crop to the United States with the early settlers (Huff 2003). It is now the most widely cultivated cool season turfgrass worldwide and is used as a lawn grass as well as a forage grass and for conservation purposes (Huff 2003). Its vigorous and dense root and rhizome system allows the species to recuperate from stress (Beard 1973) and to stabilize soil (Huff 2003). Under proper culture (irrigation, fertilization), it forms a high quality turf (Beard 1973). Vegetative expansion is very high in Kentucky bluegrass, where one shoot can produce 20-60 ft of rhizomes within one growing season (Beard 1973). Kentucky bluegrass is often used in large proportions is roadside mixes because it a good sod producer; however, it establishes slowly and over-winter survival is low (Friell et al. 2012). It is therefore not recommended for use along roadsides in Maryland (Turner *pers. communication*).

*Seeds per pound:* 2,200,000 (University of Tennessee extension)
*Cost per pound:* $2.95 per pound from Chesapeake Valley Seed
*Cost per acre:* $256.65 per acre
*Suggested sowing rate:* 87 pounds per acre (Tuner *pers. communication*)
*Sowing depth*: ¼ inch
*Germination time:* 14 days minimum
*Seeding timing:* spring or fall
*Length of growing season:* early spring to fall
*Leaf length:* 2-16 inches (Huff 2003)
*Height at seed head stage:* 12-47 inches (Huff 2003)
*Shade tolerance:* Full sunlight or only slight shading are preferred. Kentucky bluegrass will not persist under shaded conditions in cool climates (Beard 1973).
*Suggested mowing height:* should not be cut lower than 1.5 to 2 inches (Center for Turfgrass Science, Pennsylvania State University)
*Tolerance of wet conditions:* may cause leaf spot
*Humidity tolerance:* Kentucky bluegrass is adapted to cool humid climates (Beard 1973) and is therefore tolerant of humid conditions. However, humid conditions may cause leaf spot (Turf Care Omaha)
*Disease resistance:* Cultivars of Kentucky bluegrass differ in their resistance to diseases. Diseases are numerous and include *Helminthoporium*, rust, stripe smut, *Fusarium* blight, powdery mildew, *Fusarium* patch, *Pythium* blight, dollar spot, brown patch, *Ophiobolus* patch, and *Typhula* blight (Beard 1973).

Services:

*Commercial availability and cost*: Kentucky bluegrass is commercially available. Seeds cost only slightly more than tall fescue, perennial ryegrass, and fine fescues. Over a large area the cost of seeding Kentucky bluegrass is similar to the fine fescues.

*Rate of establishment:* Kentucky bluegrass takes relatively long to establish compared to other cool season grasses (Erdmann and Harrison 1947, Huff 2003, Friell et al. 2012). It germinates relatively slowly (14 to 28 days) and has a long juvenile stage (Huff 2003), which increases susceptible to drought conditions during establishment.

*Ease of maintenance:* Kentucky bluegrass is a low stature plant but requires fertilizer and irrigation to maintain acceptable turf quality and survival.


*Erosion control:* Kentucky bluegrass produces a dense sod and has a high root-to-shoot ratio (Dziamski et al. 2012; but Sprague (1933) observed a low root-to-shoot ratio owing to vigorous top growth). It has a well-developed root system with most roots within the top 1.5 to 2 feet of soil but some roots reaching to 3 ft (Weaver 1958). Beard (1973) reported a higher concentration of roots within the top 6-10 inches of soil with some roots penetrating up to 25 inches. Kentucky bluegrass can start root growth early in the growing season, reaching 9 inches soil depth in April whereas colonial bentgrass reached the same soil depth 1 month later in New Jersey (Sprague 1933). Sprague (1933) concludes that Kentucky bluegrass is an excellent species to use as an agricultural crop owing to the combination of early root growth and high root biomass that supports a high above-ground biomass. However, on poor soils where survival is more important than biomass yield, hard fescue is superior to Kentucky bluegrass owing to higher root growth and better root-to-shoot ratio (Sprague 1933). Despite a dense root system, water retention in the soil cultivated with Kentucky bluegrass was not as high as tall fescue and perennial ryegrass owing to differences in root morphology among species (Glab and Szewcyk 2014). Thus, Kentucky bluegrass is not as effective as other cool season species in increasing infiltration capacity of trafficked soils.

*Ecosystem benefits:* Cultivars that are grown for turfgrass originated from European sources (Huff 2003) with the center of origin in Eurasia; however, some evidence exists that some Kentucky bluegrass may be native to North America prior to European settlement (Johnson 2008). Kentucky bluegrass is first mentioned as growing in the United States in 1685 (Johnson 2008). Therefore, Kentucky bluegrass can be considered native or non-native and naturalized irrespective of origin with intercrossing and hybridization likely. Kentucky bluegrass can be competitive in some situations and it has been observed to compete with native species in national parks and national forests. It has been listed as invasive species, or potentially invasive species, in some areas but not in Maryland (Johnson 2008, Turner *pers. communication)*. An estimated 90% of Kentucky bluegrass growing in pastures and along roadsides (Huff 2003) and at least 8-11% of Kentucky bluegrass established on reclaimed mine sites planted with native grasses (Thorne and Cardina 2011) were established without being intentionally planted highlighting the species' ability to disperse and establish in new potentially unintended areas. Soil nitrate concentrations are higher under Kentucky bluegrass plots than under tall fescue or perennial ryegrass plots with concentrations approaching drinking water standards in the non-growing season (Liu et al. 1997). Cultivar 'Liberty' had soil nitrate concentrations consistently over the drinking water standard, and other cultivars exceeded the standard intermittently. In contrast, other cultivars such as 'Eclipse', 'Able', 'Midnight', and 'Joy', never exceeded the drinking water standard. This suggests that leaching potential may be higher from turf that it composed of Kentucky bluegrass but cultivars differ in nitrate removal from soil. Kentucky bluegrass is a host plant for moths such as the pepper and salt skipper and Peck's skipper. It is considered a valued forage plant for herbivores.

<u>Resilience</u>:

Drought: Kentucky bluegrass prefers moist, well-drained sites (Beard 1973, Wakefield et al. 1974) and will only persist in semi-arid or arid regions when irrigated (Beard 1973). It is not considered to be tolerant of drought or heat stress (Beard 1973, Brown et al. 2011). The species has a high evapotranspiration rate (Feldhake et al. 1984, Beard and Kim 1989) and therefore requires more water than fine fescues (Johnson 2008), zoysia,

bermudagrass and tall fescue (Fu et al. 2004) to maintain acceptable turf quality when water is limited. Under rain-fed conditions in Wyoming (Islam et al. 2013), Kentucky bluegrass and tall fescue turf quality were inferior to buffalograss and blue grama. Kentucky bluegrass declined rapidly when soil water potential reached -50 to -80 kPa as opposed to hard and chewings fescue, which demonstrated a greater ability to thrive under limited soil moisture (Aronson et al. 1987). Similarly, Kentucky bluegrass showed a fast killing time and high electrolyte leakage when subjected to heat stress (Wallner et al. 1982). These results however contrast with McKernan et al. (2001) who observed that Kentucky bluegrass cultivar 'Washington' had excellent drought tolerance. The excellent drought tolerance was only specific to this one cultivar of Kentucky bluegrass and was attributed to the plants reestablishing after a drought from their extensive rhizomes. In fact, Johnson (2008) suggests that Kentucky bluegrass can withstand extended periods of drought through dormancy. Tests in Utah showed that Kentucky bluegrass survived 120 days of drought, which was longer than perennial ryegrass, creeping red fescue and prairie junegrass. An early British study (Carroll 1943) showed Kentucky bluegrass had high drought endurance and was the most resistant among 15 grass species to drawdown of soil moisture from 5% to 3%. Kentucky bluegrass had low tolerance to increased soil temperatures but high tolerance to increased air temperatures. Cultivars of Kentucky bluegrass can vary greatly in drought tolerance (Wallner et al. 1982); drought resistant include 'Unique', 'Apollo', 'Brilliant', and 'Showcase' (McCann and Huang 2008).

Low fertility: Kentucky bluegrass prefers fertile sites (Beard 1973, Wakefield et al. 1974, Brown et al. 2011) and responds well to fertilizer applications (DeBels et al. 2012). In a low input study in Maryalnd, Kentucky bluegrass performed well for the first 4 summers but quality declined during a severe summer drought in the 5th summer (Turner pers. communication). Of 15 monoculture and polyculture treatments, Kentucky bluegrass had the worst quality ratings under low fertilizer use (Horgan et al. 2007). In a low-input fairway study in Minnesota (Watkins et al. 2010), Kentucky bluegrass turf quality was acceptable in the first year of the study and only surpassed by bentgrasses, but turf quality declined to unacceptable quality in the second year. In a low-maintenance study in Minnesota, Kentucky bluegrass had acceptable summer performance in only 3 of 8 locations (Watkins et al. 2014). In an early British study that compared 15 turfgrass species, Carroll (1943) found that Kentucky bluegrass had the highest survival rates under low and high-N conditions.


Freezing*:* Kentucky bluegrass has good freezing tolerance (Beard 1973, Bhowmik et al. 2008, Stier and Fei 2008) and can grow from sea level to 4000 m (Huff 2003). Survival of Kentucky bluegrass was the highest observed among 15 grass species in a British study (Carroll 1943). While -15$^{o}$C was the killing temperature for most of the other species, Kentucky bluegrass survival was 25% at -15$^{o}$C and 20% at -20$^{o}$C under low-N conditions.

Salinity: Kentucky bluegrass is sensitive to salinity (Lunt et al. 1961, 1964, Hughes et al. 1975, Harivandi et al. 1992, Alshammary et al. 2004, Marcum 2008a, Brown et al. 2011, Uddin and Juraimi 2013, Kazlauskiene and Brukstute 2015). Biesboer et al. (1998) suggest that Kentucky bluegrass should never be used along roadsides that are heavily salted in the winter. Observations along Illinois roadsides suggest that planted Kentucky bluegrass does not last along roadsides that receive deicing salts in the winter. Rather, Kentucky bluegrass is succeeded by quackgrass that is invaded and outcompeted by weeping alkaligrass (Butler et al. 1971). Germination of Kentucky bluegrass decreased from 85% to 54% when subjected to NaCl during emergence but was alleviated by gypsum, KCl, and $KNO_3$ (Neid and Biesboer

2004). Similarly, Kentucky bluegrass had the lowest germination percentage under salinity treatments among 6 turfgrasses tested (Harivandi et al. 1982); the greatest yield reduction among 5 (Hughes et al. 1975) and 4 (Alshammary et al. 2004) grass species; the greatest dry matter yield reductions and most severe foliage injury when treated with salt among 40 grass and legume species and cultivars (Greub et al. 1985); and the lowest survival in Minnesota roadside trials among 74 cool-season species and cultivars (Friell et al. 2012). However, differences in salt tolerance among cultivars are observed (Rose-Fricker and Wipff 2001, Koch et al. 2011) and vary by location (Brown et al. 2011, Koch et al. 2011, Friell et al. 2012, 2013) with cultivar 'Diva' performing well in many (Brown and Gorres 2011, Koch et al. 2011) but not all locations (Friell et al. 2012). Among 26 Kentucky bluegrass cultivars tested in salt baths, cultivars 'North Star', 'Ascot' and 'Moonlight' showed the best tolerance based on percent survival and leaf firing (Rose-Fricker and Wipff 2001). Koch et al (2011) showed that cultivars 'Eagleton', 'Moonshadow, 'Fairfax', 'Cabernet', and 'Liberator' were the most tolerant to saline irrigation. However, Marcum (2008a) highlights inconsistencies among studies in ranking of Kentucky bluegrass cultivars for salt tolerance and suggests that conflicting trends may be due to a narrow range of salt tolerance within the species. Salinity tolerance is also influenced by deicer products where injury to Kentucky bluegrass was highest for rock salt and urea sprayed on turf (Minner and Bingaman 1998).


Acidity: Kentucky bluegrass is adapted to soil pH between 6 and 7 and does not tolerate extremes in acidity or alkalinity (Beard 1973). Liu et al. (2008) suggest that cultivars differ in aluminum resistance and that Kentucky bluegrass was the least aluminum resistant among three Poa species.


Wear tolerance: Kentucky bluegrass is ranked as having medium to good wear tolerance (Beard 1973, Canaway 1981, Dunn et al. 1994) with cultivars showing a range of tolerances (Brosnan et al. 2005, Park et al. 2010). In a study of 7 turfgrasses and 37 cultivars, Kentucky bluegrass ranked slightly lower in wear tolerance than perennial ryegrass and tall fescue (Glab et al. 2015). In a low-input fairway study in Minnesota, Kentucky bluegrass turf quality in the first year after establishment declined under different traffic treatments and declined to unacceptable quality in the second year (Watkins et al. 2010). Kentucky bluegrass recovers well from traffic and wear through its extensive rhizomatous growth (Johnson 2008).


Competition: Kentucky bluegrass is competitive under moist and fertile conditions (Beard 1973) and may outcompete native species under some environmental conditions (Johnson 2008). In some areas it is even considered invasive or potentially invasive (Johnson 2008). Kentucky bluegrasss is often mixed with tall fescue (Beard 1973) to increase sod strength especially under extreme wear conditions (Gibeault et al. 1993, Hunt and Dunn 1993). Rhizomotous lines of tall fescue were more competitive with Kentucky bluegrass, which can dominate mixtures with tall fescue and decrease turf quality (Macolino et al. 2014). A 95/5 percent by weight tall fescue to Kentucky bluegrass mixture produces a stand with approximately equal number of both species; however, composition of the mixture can gradually shift to Kentucky bluegrass at lower mowing heights, greater nitrogen fertility and more frequent irrigation which are conditions that favor Kentucky bluegrass (Dunn et al. 2002). Kentucky bluegrass is similar in competitive ability to chewings fescue and the species can therefore be used in mixture without significant changes in yield in either species. Kentucky bluegrass is susceptible to

competition with perennial and annual ryegrass (Erdmann and Harrison 1947, Dunn et al. 2002) owing to the rapid establishment of ryegrass; however a high Kentucky bluegrass to perennial ryegrass ratio can yield a high performing sward (Brede and Duich 1984). Kentucky bluegrass is an inferior competitor to alkaligrass (Tarasoff et al. 2009), which the authors hypothesize is due to alkaligrass' rapid establishment and growth, and inferior to Canada thistle (Gabruck et al. 2013). In areas that are eroded and have low fertility soils, Kentucky bluegrass high fertilizer inputs to resist weed invasion and maintain quality (DeBels et al. 2012).

Mixes: Kentucky bluegrass is frequently used in mixture with red fescue (Davis 1958, Juska and Hanson 1959, Beard 1973, Ebdon and Skogley 1985) and chewings fescue (Erdmann and Harrison 1947, Beard 1973, Ruemmele et al. 2003). Seed mixtures containing at least 50% red fescue were able to maintain the desired species composition (Juska and Hanson 1959). An initial seed mixture of 48% Kentucky bluegrass and 52% creeping red fescue maximized turf quality that was acceptable when lawns received 150 and 300 lb/acre deicing salts (Butler et al. 1971). Under high intensity culture, Kentucky bluegrass will dominate (Davis 1958), but under droughty, low-input environments, red fescue will dominate (Beard 1973, Ebdon and Skogley 1985). In a New Mexico field study, a mix of 70% hard fescue, 25% sheep fescue, and 5% Kentucky bluegrass showed good germination, excellent turfgrass coverage, and was fastest in achieving 50% coverage at normal and reduced seeding rate and at lower irrigation (Leinauer et al. 2010). Beyond fine fescue, a ratio of 70-95% Kentucky bluegrass to 5-30% perennial ryegrass providing the best compromise for fast establishment and an even sward (Brede and Duich 1984), as did a mix of Kentucky bluegrass with rhizomatous tall fescue lines (Macolino et al. 2014). The mix outperformed the respective monocultures. However, in a low-maintenance study, a Kentucky bluegrass blend of 3 cultivars had unacceptable quality ratings and was not competitive with weeds compared to fine fescue, tall fescue, and native grass mixes (Miller et al. 2013).

Cultivars: Considerable variable exists among cultivars in turf quality, stress tolerance, cultural requirements, and disease resistance (Beard 1973). Common type cultivars collected from old pastures and high-cut turfs often outperform improved cultivars under low maintenance conditions (Huff 2003). Cultivar 'Merion' was the first turf-type cultivar that was low-growing and had higher disease resistance (Huff 2003).

Hybrids: Kentucky bluegrass has the most shared genomes with other bluegrasses due to interspecific hybridization and may be one reason for why the species is so widely adapted (Huff 2003, Johnson 2008). Breeding efforts work on enhancing drought tolerance of Kentucky bluegrass through hybridization with native bluegrasses, such as with Texas bluegrass (*Poa arachnifera*; Johnson 2008, Su et al. 2007). However, in an eight-state low-maintenance study, Watkins et al. (2014) found that *Poa arachnifera* did not perform at a level that showed any adaptability to the North Central US region.