ELEMENT STEWARDSHIP ABSTRACT
for

Festuca arundinacea (Schreb.)
Synonym: *Festuca elatior* L.

Tall fescue
Kentucky fescue

To the User:

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SCIENTIFIC NAME

Festuca arundinacea (Schreb.)
Synonym: *Festuca eliator* L.

COMMON NAME

Tall fescue; Kentucky Fescue. Cultivars include 'Alta', 'Goar', and 'Fawn' used in the western U.S.; 'Kentucky 31' used in the eastern and central USA and 'Kenmount' used in both the southeast and in the Great Plains.

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

F. arundinacea is a densely cespitose to short-rhizomatous, cool-season, long-lived, perennial grass (Poaceae) (Wasser 1982). It is native to Europe but has been widely planted in North America and elsewhere as a turf and forage grass. A tuft produces 10-30 flowering stalks with the inflorescence an open to narrow branched panicle. Seeds are somewhat dark in color and, as in all grasses, the fruit is a caryopsis. *F. arundinacea* roots are tough and coarse and penetrate to a depth of 150 cm in moist soils (Wheeler and Hill 1957).

F. arundinacea culms are hollow and grow 0.5-2 m from basal tufts. Leaf blades are coarse and thick and prominently ridge-veined above. Blades are 5-70 cm long and 4-10 mm wide with ciliate auricles. The first node of the panicle has 2-3 branches, each with 5-15 spikelets, 3-6-flowered. The first glume is 4-6 mm long, the second 5-9 mm long. Lemmas are 7-8.5 mm (or more) long, scabrous distally. The awn is 0.3-2 mm long (Gleason and Cronquist 1991).

F. arundinacea can be distinguished from many other grasses in seed by a slightly purple cast to the panicles. It can be distinguished from the closely related *F. pratensis* (meadow fescue) by the presence of macroscopic hairs on the auricles.

PEST STATUS

While an invasive species on native grasslands, where it is often considered a pest, *F. arundinacea* is also a valued turf and forage plant in managed pastures.

STEWARDSHIP SUMMARY

F. arundinacea can invade grassland, savanna and woodland habitats and the edges of some open marsh and fen systems. It is a persistent perennial that can compete strongly with many native species. It is also commonly planted and managed for turf and for forage in pastures. An endophytic fungus that infects the plant can cause illness in both domestic and some wild mammals that graze on it, creating both economic hardship and ecological damage. The fungus also confers a competitive advantage on infected plants. As a result, the level of plant diversity in successional fields in which tall fescue is found tends to decrease over time as highly competitive endophyte-infected plants increase in number and size.

F. arundinacea can be controlled by planting competitors, especially legumes; by applying herbicides such as metsulfuron, glyphosate, and imazapic; by spring burning; and by a combination of herbicide application and burning.

Where soils are droughty or soil nitrogen levels are low, tall fescue may decline over time without intervention.

RANGE

F. arundinacea occurs throughout the continental United States and southern Canada. It was introduced to North America from northern Europe where it is native. It has also been introduced to South America, Australia, and New Zealand (*Fire Effects Information System* [Online] 1996).

F. arundinacea occurs in most ecosystems, but particularly grasslands. USA states and Canadian provinces reporting the species in the Natural Heritage Program database are Alabama(SR), Alaska(SR), Alberta(SR), Arizona(SR), Arkansas(SR), British Columbia(SR), California(SR), Colorado(SR), Connecticut(SR), Delaware(SR), District of Columbia(SE), Florida(SR), Georgia(SR), Hawaii(SE), Idaho(SR), Illinois(SE), Iowa(SE), Kansas(SR), Kentucky(S?), Louisiana(SR), Maine(SR), Manitoba(SRF), Maryland(SR), Massachusetts(SR), Michigan(S?), Minnesota(SR), Missouri(SR), Montana(SR), Nebraska(SR), Nevada(SR), New Brunswick(SR), New Mexico(SR), New York(SR), Newfoundland Island (Newfoundland)(SR), North Carolina(SR), Nova Scotia(SR), Ohio(SR), Ontario(SE5), Oregon(SR), Quebec(SR), Rhode Island(SRF), Saskatchewan(S?), South Dakota(SR), Tennessee(SR), Texas(SR), Utah(SR), Vermont(SR), Virginia(SR), Washington(SR), West Virginia(S?), Wisconsin(SR), Wyoming(SR), Yukon Territory(SR). Tall fescue has also been reported from Indiana, Mississippi, New Hampshire, North Dakota, Oklahoma, and Pennsylvania.

IMPACTS AND THREATS POSED BY TALL FESCUE

F. arundinacea can invade open, natural communities and displace native species. This is most likely when *F. arundincacea* already grows in the area, (i.e. along nearby roadsides or other disturbed areas) and when the natural community has either been subjected to disturbance or where the natural fire regime has been suppressed (Eidson 1997).

Some *F. arundinacea* plants infected with the endophytic fungus *Neotyphodium coenophialum* (synonym *Acremonium coenophialum)* which produces toxic alkaloids (Ball et al. 1993). Domesticated grazing animals and small mammals grazing on infected plants may develop a series of disease reactions including heat intolerance, poor weight gain, abortion or foaling problems in mares, reduced reproductive capacity in small mammals and, in domestic stock, a gangrenous condition known as fescue foot. These conditions may cause over one billion dollars in agricultural losses each year (Ball et al. 1993). Endophyte-infected *F. arundinacea* is less palatable to dometicated stock (Wheeler and Hill 1957) and presumably to wild mammals too.

Diagnosis of the fungus requires laboratory analyses and cannot be performed in the field. The fungus does not spread by spores, rather the fungus concentrates in the seed heads and is transmitted from one plant generation to the next. The fungus can survive in the seed for over one year. All parts of the plant, whether green or dry, may contain the alkaloid poison at any time of year. (No alkaloids have been found in meat or milk from animals eating endophyte-infected tall fescue (Ball et al. 1993).) Infected *F. arundinacea* seeds have more rapid germination rates in some environments than do uninfected seeds, and infected seeds produce seedlings with greater biomass that are more likely to survive. Infected plants have been shown to be capable of higher seed production and tillering than uninfected plants (Ball et al. 1993). Therefore, the level of *F. arundinacea* endophyte infection tends to increase in a field over time as infected plants outcompete uninfected plants (Ball et al. 1993). Conversely, the level of plant diversity in successional fields in which tall fescue is found tends to decrease over time as highly competitive endophyte-infected plants grow in number and size (Clay and Holah 1999).

Studies have shown that *F. arundinacea* produces allelopathic compounds that inhibit the growth of other plants. In Pennsylvania, *F. arundinacea* hindered woody plant growth and survival on strip-mined sites. On low-fertility acid mine sites, tall fescue either prevented establishment or retarded growth of several species including silky dogwood (*Cornus amomum*), northern arrowwood (*Viburnum recognitum*), black locust (*Robinia pseudoacacia*), sweetgum (*Liquidambar styraciflua*), black walnut (*Juglans nigra*), northern red oak (*Quercus rubra*) and sycamore (*Platanus occidentalis).* When *F. arundinacea* was chemically controlled, survival and height growth of both shrub and tree species were greater (Anderson et al. 1989). In a study of mine reclamation techniques using forest soils, tall fescue seed was added to the seedbank in topsoil derived from a native species forest community. The resulting community had both fewer native species and produced less total biomass of native species than a control community without tall fescue (Wade 1989).

HABITAT

F. arundinacea is adapted to a wide range of conditions and is cultivated for pasture, from which it often escapes, and may be found in grazed woodlands. Large areas of native grasslands have been replanted with this and other forage species. Tall fescue occurs in disturbed habitats such as along roads, ditches, railroad tracks, and other moist, disturbed places. *F. arundinacea* can also be found as a weed in cultivated areas, fallow and abandoned fields, meadows, and marshes (*Fire Effects Information System* [Online] 1996).

F. arundinacea is mesic in its moisture requirements, but is also tolerant of poor drainage, winter flooding, fairly high water tables, and drought (Wasser 1982). *F. arundinacea* yields are reduced by soil water level fluctuations and periodic flooding, but the species is more tolerant of such conditions than several other forage grasses. Tall fescue grows best on deep, fertile, silty to clayey loam (medium to heavy texture) soils, with considerable humus content (Burns and Chamblee 1979). However, with adequate moisture *F. arundinacea* is tolerant of most soil textures, including sandy soils (Wasser 1982).

Although *F. arundinacea* responds well to high fertility, it persists satisfactorily in low nutrient soils or water-stressed environments if it is not overgrazed. Tall fescue can tolerate both saline and alkaline soils (Wheeler and Hill 1957). It grows at a wide range of pH from as low as 3.6 to as high as 7.7, though a pH of 4.5 is usually considered its lower growth limit (Vogel 1997). Best growth is obtained at pH 6.2 (Rosiere et al. 1989).

F. arundinacea is adapted to a wide range of climatic conditions (Buckner and Bush, 1977). In the northern and mountainous west, tall fescue produces good growth in areas with over 450 mm mean annual precipitation. Optimal growth in the east occurs in areas with over 760 mm mean annual precipitation. *F. arundinacea* demonstrates good cold tolerance, making fair winter growth in the south central U.S. and the mid-South (Wasser 1982).

ECOLOGY AND BIOLOGY

F. arundinacea is a long-lived, aggressive perennial. Its competitive ability and persistence is increased by the allelopathic compounds it produces (Anderson et al. 1989) and the endophytic fungus which infects many individuals and some cases, entire stands (Clay and Holah 1999; see

Impacts and Threats Posed by Tall Fescue section above). It colonizes bare soil, and is a strong competitor in many species mixtures (Wheeler and Hill 1957). *F. arundinacea* can invade open, natural communities and displace native species. Tall fescue grows best in open sunlight and is somewhat suppressed by shade (Wasser 1982). *F. arundinacea* can sprout from short rhizomes after aerial portions are burned. Tufts formed by the leaves may protect basal buds from fire damage (*Fire Effects Information System* [Online] 1996).

Reproduction

F. arundinacea reproduces by seed and spreads vegetatively, forming dense, solid stands. Minimum temperature for seed germination is 4.5°C; optimum ranges of both 12 to 18°C and 20-25°C have been found (Wolf et al. 1979). Imbibition of water by seeds occurs rapidly and activates metabolic systems that initiate germination. Seeds survive passing through the digestive tracts of many domesticated animals and viable seeds may be found in manure (Burchick 1993). Seeds can remain viable in the seedbank for a significant length of time (*Fire Effects Information System* [Online] 1996). For seeds kept in storage, the percentage of *F. arundinacea* seeds germinating was 93% in the year grown; this percentage fell to 4.5% for seeds stored 19 years (Hull 1973).

Temperature and Growth

F. arundinacea grows when mean weekly temperature exceeds 4.4°C. Tillers emerge throughout the winter if mean weekly temperatures exceed 4.4°C. Tall fescue can tolerate temperatures above 25°C if not subjected to water stress (Burns et al. 1979), but grows best under relatively cool conditions. Optimal growth was found to occur with 12-hour day/night temperatures with day/night temperatures ranging from 24/19°C 15/10°C (*Fire Effects Information System* [Online] 1996). In much of the USA, above-ground growth begins in April followed by flower and fruit development in May and anthesis in June.

Root development occurs at lower temperatures than does above-ground growth and continues into autumn when soil temperatures may exceed air temperature (Wolf et al. 1979).

F. arundinacea spreads slowly by short rhizomes and by tillering. Development of flowering tillers depends on a short-day, long-night photoperiod in autumn and winter followed by a long-day, short-night photoperiod with cool nighttime temperatures in spring. Tillering does not occur during summer due to low auxin levels associated with high summer temperatures. Tall fescue dry yields are high throughout the growing season due to its wide temperature adaptation. (Wolf et al. 1979). Tillers increase rapidly in the spring after mean weekly temperatures reach 4.5°C; a large number are formed from bud populations developed in the previous autumn. When tiller buds are shaded, tillering ceases. High leaf area and light competition at the flowering stage cause nonflowering tillers to die. Nitrogen fertilization also increases tillering. Cut *F. arundinacea* produces new tillers from the root crown, although regrowth and tiller production may be poor when high-yielding canopies are cut after flowering (McKee et al.1967).

F. arundinacea requires one growing season to establish and is sensitive to competition from other plants during early development, possibly due to poor mobilization of seed reserves (Hayes 1976). When *F. arundinacea* stands become sod-bound, seed production declines (Wheeler and Hill 1957). Maximum photosynthetic rates and maximum leaf area both occur 3-6 weeks after emergence of the leaf (Wolf et al. 1979).

F. arundinacea is a C3 grass, and becomes photosynthetically light-saturated at 25-50% of full sunlight. Irradiance required for saturation decreases as leaves age, with maximum carbohydrate exchange rates occurring 28-35 days after emergence. Photosynthate transfer from upper to lower leaves appears to be nil, so shaded leaves die with increasing age and shading from canopy cover. Total nonstructural carbohydrates provide the major source of energy for biochemical processes. Stored total nonstructural carbohydrates are important for regrowth following defoliation (Wolf et al. 1979).

ECONOMIC AND OTHER USES

Forage

F. arundinacea is commonly planted as a cool-season forage grass with yields often exceeding other forage species and with a wide range of tolerance of soil, temperature and moisture conditions. Plant breeding to improve tall fescue and to develop improved yields and palatability has been extensive. The species is palatable to livestock when the leaves are young, but becomes somewhat coarse, tough, and unpalatable with age. Its nutritive value drops during its summer dormant period. Energy value is rated fair while protein value is rated fair to poor (Buckner and Bush, 1977). *F. arundinacea* grows best in cooler seasons and stays green into late fall. Although it withstands high temperatures and maintains some production during the summer, it does not produce good quality forage under these conditions (Wheeler and Hill 1957). Tall fescue can be grazed earlier than warm-season grasses, a feature which lengthens the grazing season and the carrying capacity of pasture and range. In the southern and midwestern U.S., *F. arundinacea* may remain productive through drought periods as the extensive root system enables it to obtain moisture from deeper soil layers (Wheeler and Hill 1957). However, tall fescue is intolerant of protracted drought (Wasser 1982).

Allelopathic compounds in tall fescue inhibit the growth of other plants, making it difficult to maintain legumes in the mixtures. This is problematic for establishing *F. arundinacea* as it is most easily established if planted with legumes. Tall fescue responds well to nitrogen fertilization (Wasser 1982).

Wildlife

Songbirds consume tall fescue seeds, and both seeds and foliage are used by small mammals (Wasser 1982). However, some small mammals feeding on fescue infected by the endophyte may become ill as a result of the toxins the endophyte produces (see Impacts and Threats Posed by Tall Fescue section above). Fields dominated by *F. arundinacea* were found to be poor habitat for bobwhite and quail in Kentucky due to lack of high quality, preferred foods, and improper vegetation structure and composition for nesting and foraging habitat (Barnes et al. 1994). Tall fescue palatability for elk has been reported as poor (Wasser 1982) and elk may show a preference for other grasses. Several studies showed varying preferences by white tailed deer for *F. arundinacea* (*Fire Effects Information System* [Online] (1996). Because of its ability to outcompete native vegetation, tall fescue should not be used for wetland mitigation, reforestation, or rehabilitation where managing for wildlife and plant diversity are intended (Burchick 1993).

Planting and Reclamation

Tall fescue provides good cover for areas where a long-lived, tenacious, deep-rooted grass is needed, such as airports, playgrounds, parking lots, cuts and fills, eroding gullies, and waterways and dikes (Wasser 1982). The species has been used to revegetate highway corridors (Rosiere et al. 1989) but care should be taken to avoid planting it where it can easily spread into adjacent natural grasslands.

F. arundinacea may be useful in some reclamation and rehabilitation work. It produces coarse, tough roots that prevent erosion and decrease soil density. Large amounts of organic matter are left behind after each season that also act to improve soil texture for other species (Burns and Chamblee 1979). Tall fescue is one of the most easily established cool-season grasses on mine spoils (Rosiere et al.1989), although it seldom thrives unless it is planted with a legume or fertilized occasionally (Vogel 1997). Tall fescue can be used to revegetate acid mine spoils high in manganese, but it does not tolerate high aluminum concentrations. *F. arundinacea* was found to be tolerant of a pH of 4-6 and manganese at 4-64 ppm. However, concentration of 4 ppm aluminum severely inhibited top and root development (Fleming et al. 1974). Although some studies have found it to be unusually persistent (Rosiere et al.1989), others have found persistence on revegetated sites inconsistent. Twenty years after initial establishment of a dense stand of tall fescue on newly graded and filled quarries in the Ozark Highlands of eastern Oklahoma, the species had disappeared. Plant succession on the quarries had moved toward oak-hickory/tallgrass prairie savanna. Site soil pH (4.0 to 5.6) was substantially below the optimum, and soils were deficient in nitrogen and phosphorus. Low nitrogen levels were probably a factor in the replacement of tall fescue by native prairie grasses (Rosiere et al.1989). In areas with more favorable soil conditions, however, tall fescue may persist and spread into native grasslands where it may have serious negative impacts, especially if the plants are infected with the endophytic fungus. Because of its potential to outcompete native vegetation, tall fescue should not be used for wetland mitigation, reforestation, or rehabilitation where managing for wildlife and plant diversity are intended (Burchick 1993).

MANAGEMENT

Potential for Restoration of Invaded Sites

The potential for large-scale restoration of unmanaged wildlands infested with *F. arundinacea* is probably low, unless the entire area is tilled and/or herbicided and then reseeded. For managed wildlands infested with *F. arundinacea*, restoration potential is probably moderately low, unless large areas are tilled, herbicided and reseeded, or unless large scale, resource-intensive prescribed burn programs, coupled with herbiciding and other restoration programs are implemented. If attacked early, managed wildlands only recently colonized by *F. arundinacea*, have a moderate to high potential for restoration.

Festuca arundinacea has high reproductive vigor and is moderately adaptable. There are apparently no reports indicating that pests or predators appreciably effect *F. arundinacea* populations in North America. The species is widespread and occasionally locally abundant. Control is difficult in natural areas or wildlands because the application of herbicides can reduce populations of native grasses. (This can be true even with selective herbicides) An exception is spring applications of herbicides to control *F. arundinacea* which may have little effect on warm season grasses as they are not yet actively growing.

Cultural Controls

F. arundinacea growth can be reduced by competition from some other species, especially legumes. *Sericea lespedeza,* a nonnative legume that is itself an invasive pest in some North American grasslands, produces residues that reduce tall fescue germination, seedling growth, aboveground biomass, and nitrogen concentration (Kalburtz and Mosjidis 1993).

Herbicide

F. arundinacea can be effectively controlled with several herbicides (Smith 1989). Chlorsulfuron (brand names Telar and others) and metsulfuron (brand names Escort and others) were effective in reducing *F. arundinacea* while avoiding significant impacts to bluegrass (Dernoeden 1990). Glyphosate (brand name Roundup, Rodeo, Accord and others) applied in the late fall can be used to target *F. arundinacea* when other species are dormant (Smith, no date). A single spring application of glyphosate at 3-5 pints per acre has been shown to kill 80-95% of tall fescue in tests in Kentucky, Missouri and Georgia (in Washburn et al. 1999). Spraying with a 2.5% glyphosate solution at The Nature Conservancy's Clymer Meadow preserve in Texas reduced tall fescue populations by 70% (Randall and Meyer-Rice. unpublished). Imazapic (brand name Plateau) applied shortly after a spring burn of tall fescue-dominated fields in Kentucky greatly reduced or entirely eliminated *F. arundinacea* (Washburn et al. 1999). In a later study of six of the Kentucky sites, imazapic application reduced or eliminated tall fescue that had invaded since the earlier treatment, and at the same time released existing native grass species (Washburn et al. 1999).

Prescribed Burning

Species that grow early in the season, including cool-season grasses such *F. arundinacea*, should suffer greater damage from early spring burns or fall burns following summer dormancy. Prescribed burn experiments during dormancy (winter), spring, summer and fall found that burning during active growth in the spring reduced yields in the following growing season, but that a summer burn increased tall fescue seed production in the following year (Probasco 1977). In south-central Iowa, *F. arundinacea* was burned to test the effectiveness of spring fire in eliminating or suppressing cool-season grasses. Plots within livestock exclosures were burned in late March or early April. *F. arundinacea* relative shoot frequency increased significantly ($p<0.10$) after fire in the same year, but this increase did not persist in subsequent years. Longer term effects were inconclusive (*Fire Effects Information System* [Online] 1996). Spring burns in the Great Plains have reduced tall fescue infestations (Bob Hamilton, Tallgrass Prairie Preserve, The Nature Conservancy, personal communication), but heavy infestations require the use of herbicides (James Eidson, The Nature Conservancy, personal communication).

MANAGEMENT

There is a great deal of interest in controlling *F. arundinacea* in pasture and range situations because stands infected with the endophytic fungus *Neotyphodium coenophialum* are toxic to domesticated grazing animals (see Impacts and Threats Posed by Tall Fescue section above). Little published material exists on control of the species in natural areas, however. There is also a large body of work on prairie and grassland management in which fire management is used to restore or maintain native grasslands. Generally, such management has been directed toward reducing a number of invasive species, and not just *F. arundinacea.*

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MONITORING

In natural areas management, monitoring programs will likely need to assess changes in abundance of *F. arundinacea* and in abundance of desirable native species or changes in community attributes that are the targets of management. Such programs should have explicit objectives that can be measured and that are meaningful from both a biological and management standpoint. These objectives may vary depending on the abundance of *F. arundinacea* and other invasives. For instance, the objective of managing a grassland with 40% cover of *F. arundinacea* may be to reduce cover to 20%, while in an area with 10% tall fescue cover the objective may be to prevent an increase of more than 10% of total cover (i.e. less than 20% total cover). Monitoring the status of other conservation targets, such as invertebrates dependent on specific nectar sources, may be more important than tracking invasives. In general, the monitoring objectives should support and inform the management objectives.

In terms of effort (number of plots established and monitored), transects or long, linear plots are usually more effective in providing sufficient statistical power to determine change in the abundance of tall fescue and other grassland or meadow species than square, broadly rectangular, circular or other regularly shaped quadrats. Analyses of plant species composition and abundance can be simplified by (1) collecting data on abundance of dominant species; (2) collecting data on all species and pooling data on less abundant species; and/or (3) pooling data on species by placing them in guilds (invasive grasses, invasive legumes, native grasses, etc.).

Monitoring change, or lack thereof, in control (untreated) areas can be an effective way of determining whether or not any changes which are detected actually result from management. As tall fescue acts as an early successional species in some systems, declines in abundance may occur with time without management.

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RESEARCH

Further research is needed on the impacts of *F. arundinacea* on natural areas, on the effects of herbicides on native species, especially where grassland communities are conservation targets, and on selective control measures.

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